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Hormonal doping and androgenization of athletes: a secret program of the German Democratic Republic government

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Several classified documents saved after the collapse of the German Democratic Republic (GDR) in 1990 describe the promotion by the government of the use of drugs, notably androgenic steroids, in high-performance sports (doping). Top-secret doctoral theses, scientific reports, progress reports of grants, proceedings from symposia of experts, and reports of physicians and scientists who served as unofficial collaborators for the Ministry for State Security ("Stasi") reveal that from 1966 on, hundreds of physicians and scientists, including top-ranking professors, performed doping research and administered prescription drugs as well as unapproved experimental drug preparations. Several thousand athletes were treated with androgens every year, including minors of each sex. Special emphasis was placed on administering androgens to women and adolescent girls because this practice proved to be particularly effective for sports performance. Damaging side effects were recorded, some of which required surgical or medical intervention. In addition, several prominent scientists and sports physicians of the GDR contributed to the development of methods of drug administration that would evade detection by international doping controls.

INDEXING TERMS: androgenic-anabolic steroids • testosterone • performance-enhancing drugs • abused drugs • sports medicine • urine

A Global Experiment in Secrecy

One of the largest pharmacological experiments in history has been running for more than three decades, namely, the administration of drugs to athletes to enhance performance in many different kinds of sports. Notably, androgenic-anabolic steroids were used with particular success for virilization of adolescent girls and female athletes. Perhaps the most remarkable aspect of this large and still ongoing global experiment is its widely accepted clandestine nature. Although the drug experiments involved many thousands of athletes, physicians, scientists, and sports and government officials, and although the success of these programs has been publicized through print, radio, and television, the nature of the program and its results largely have been kept inaccessible to direct scientific, medical, or judicially valid investigation.

Since the mid-1970s, the use of androgenic steroids and other hormonal performance-enhancing drugs has been officially banned by sports authorities, and their usage has been controlled through analysis of urine samples taken at the time of competition, i.e., after drug withdrawal, a rather inefficient and insensitive method. In addition, in many countries the use of such drugs in sports has been declared illegal and prosecuted. But these measures have had relatively little impact. Occasionally, some athletes tested positive and were banned from competition for a period, but these occurrences were generally considered exceptions, and the athletes caught were regarded as "black sheep." The reasons for this secrecy and misinformation of the public are multifold and may include the desire to protect the clean image of international sports for political and mercantile purposes.

Athletes and coaches deny publicly and tenaciously the use of these drugs—not only because of the official ban and the recognition that such use is a violation of the principles of fairness and openness in sports, but also because athletes and sports organizations do not want to acknowledge that their achievements were not "all-natural," i.e., solely due to individual talent and effort, but instead were drug-dependent. Consequently, deception is basic to doping, and athletes, coaches, physicians, and officials have frequently and emphatically denied any use of androgenic hormones, even before these drugs were officially banned.

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The role that scientists and physicians have played in this clandestine system is particularly sad, not only because these professionals actively contributed to the worldwide cheating, but also because they violated scientific and medical ethics. Remarkably, only a few of the physicians involved in doping have been held accountable for their misconduct and unethical behavior.

After a period of scientific controversy, it is now clear that androgenic-anabolic hormones are effective in enhancing performance in sports (for reviews, see refs. *[1–5]*). Moreover, as has been demonstrated through scientific and official court documents, including secret doctoral theses and scientific reports, the positive effects of these and other hormonal drugs on muscle strength, aggressiveness, and performance in elite sports were common knowledge and had been in practice since the early 1960s for male athletes and since 1968 for female athletes. By far the most extensive and detailed documentation of this systematic drug abuse has come from the secret government files of one of the most successful sports nations of all times, the German Democratic Republic (GDR).

Documents of the GDR Government's Doping System

All documents of the governmentally organized and controlled hormonal doping in the GDR sports system were classified and accessible only to selected persons ("cadres"): The security was controlled by the Ministry for State Security (Ministerium für Staatssicherheit, MfS; colloquially abbreviated Stasi).[3] After the political turn ("die Wende") in late 1989, some information about a systematic doping system in the GDR, although undocumented, leaked to the Western press. At the same time, some of the officials of the GDR sport system apparently took care to assure that all compromising documents were either destroyed or collected by the Sports Medical Service (Sportmedizinischer Dienst; SMD). Many documents "disappeared" from official libraries, including several doctoral theses.

Some documents were saved, however, particularly those stored at the Medical Academy of the National People's Army in Bad Saarow, east of Berlin. We, the authors of this article, succeeded in acquiring several of the secret (military classification Vertrauliche Verschlußsache) doctoral theses (for the degrees of Doctor of Medicine or Doctor of Medical Sciences) that report the results of the effects, side effects, and damages observed during controlled administrations of steroids and certain peptide hormones to students, world-class athletes, and minors *[6–8]*. Most of this work had been performed in Saxony, at the Research Institute for Physical Culture and Sports (Forschungsinstitut für Körperkultur und Sport; FKS) in Leipzig, and at the Central Doping Control Laboratory (Zentrales Dopingkontrollabor; ZDKL) in Kreischa. In addition, one of us (W.W.F.), who in late 1990 served on a committee of the German Science Council that evaluated the research institutes of the former Academy of Sciences of the GDR, identified and copied some classified documents showing the involvement of the GDR research ministry and some of the Academy of Science institutes in the development and administration of doping drugs in sports, in particular, the Central Institute for Microbiology and Experimental Therapy (Zentralinstitut für Mikrobiologie und Experimentelle Therapie; ZIMET) in Jena and the Institute for Research on Active Agents (Institut für Wirkstoff-Forschung) in Berlin (see, e.g., ref. *[9]*).

Also found were a series of scientific reports from the FKS and the research centers of the various sports associations and a handwritten protocol book, giving the times and dosages of administration of androgenic-anabolic steroids to hundreds of male and female athletes. In addition, the Deputy Director and Chief Physician of the SMD (and the GDR doping system), Manfred Höppner, himself sold some of the most incriminating documents to the weekly magazine *Stern* (no. 49, 1990).

Furthermore, since 1994, highly classified reports have been found that identify MDs and PhDs of the GDR sports system who acted as "unofficial collaborators" with the MfS and security police, Stasi; in this capacity they regularly reported (under a code name) "problems," notably, those related to international sports affairs, the doping system, and possible signs of impending defection of persons from the GDR. These Stasi reports, some of which cover >30 years and >1000 pages, like other Stasi reports include examples in which a "friend" spies on a friend, a coach on his athletes, a physician on his patients, or even a husband on his wife; some also spied on their colleagues in other countries.

Altogether, >150 documents have been discovered that deal with the systematic doping in the GDR sports system. These documents provide detailed information—e.g., type of drugs, times of administration and of precompetition withdrawal, annual and daily dosages, damaging side effects to specific athletes—of the specific doping drug programs of >400 individual athletes. We have documented this evidence in several recent publications, including an expert report published by the Bund-

[3] Nonstandard abbreviations: MfS (Ministerium für Staatssicherheit; "Stasi"), GDR Ministry for State Security; SMD (Sportmedizinischer Dienst), Sports Medical Service; FKS (Forschungsinstitut für Körperkultur und Sport), Research Institute for Physical Culture and Sports; ZDKL (Zentrales Dopingkontrollabor), Central Doping Control Laboratory of the GDR; ZIMET (Zentralinstitut für Mikrobiologie und Experimentelle Therapie), Central Institute for Microbiology and Experimental Therapy; KJS (Kinder- und Jugendsportschulen), special sports-oriented schools of higher education for talented children; UM (Unterstützende Mittel), supporting means (i.e., the doping drugs such as anabolic steroids); ZK (Zentralkomitee), Central Committee of the GDR Socialist Party; LSK (Leistungssportkommission), Commission for High Performance Sport; IOC, International Olympic Committee; DGV (Deutscher Gewichtheberverband), GDR Weightlifting Association; T:E, testosterone:epitestosterone ratio in urine samples; DHEA, dehydroepiandrosterone; and hCG, human chorionic gonadotropin.

estag, the German parliament *[10–12]*. Some of these classified documents of GDR doping and doping research are referenced here *[6–8, 13–48]*.

The Early Phase, 1966–1974: An Irresistible Temptation for a Prestige-Seeking Government

In the 1960s the GDR was a relatively obscure country with a Cold War image and dominated by the "Iron Curtain" surrounding it. GDR politicians soon discerned that athletic performance would be one of the fastest and cheapest means of obtaining international prestige for a country with a population of only 17 million. Great efforts were made to improve athletic success, from the systematic selection of talented children for special sports schools (Kinder- und Jugendsportschulen; KJS) to the systematic use of illegal drugs. All of these efforts were organized efficiently and with totalitarian security measures.

Success was real and obvious; from 1972 on, the small GDR was consistently in the top ranks of the medal counts, along with the US and the Soviet Union. Most of these medals were won with the help of banned drugs used for performance enhancement. Oral-Turinabol, the androgenic-anabolic steroid produced by the state-owned pharmaceutical company, VEB Jenapharm (Jena, Thuringia, GDR), was the compound most frequently used.

This steroid, a chlor-substituted version of methandrostenolone, had been introduced for clinical use in 1965 *[49]*; by 1966, it was already being abused and administered to male athletes in the GDR sports system to enhance muscle strength, aggressiveness, and performance. At that time, androgenic steroids were already in widespread use among athletes proficient in muscle strength-dependent events in many countries, notably the US (see, e.g., refs. *[1, 2, 50–55]*). In their preparations for the Olympic Games of 1968, however, GDR officials crossed another ethical barrier and administered androgenic hormones to female athletes.

The results of the administration of Oral-Turinabol to male and female athletes during the 1968–1972 Olympic cycle were systematically evaluated in various kinds of events. One of the most important documents, a 1973 secret report by prominent doctors and coaches *[13]* on the "on–off" analysis of drug effects in the shot-put and throwing events in athletics shows the drug-induced enhancement of performance for 40 world-class athletes. Fig. 1 presents a spectacular example, the drug effects on a woman shot-putter, and shows how her performance was reproducibly increased by ~2 m after daily intake of two tablets (10 mg) of Oral-Turinabol for only 11 weeks. Similarly marked effects were reported for other athletes, particularly women, and starting in 1969, this effect was further enhanced by the administration of increasingly higher doses of the drug discontinuously in cycles of a few weeks each (Fig. 1c). In their report, these authors *[13]* also introduced new terminology to code the substances used. They proposed henceforth to refer to these drugs as Unterstützende Mittel (UM; i.e., "supporting means"), stating, "Under UM we refer exclusively to anabolic steroids" (*[13]*, p. 3, footnote 1).

The use of the drug rapidly spread to other kinds of sports, and according to Höppner, many, if not all, medal-winning GDR athletes in strength- and speed-dependent events at the Olympic Games of 1972 in Munich had been treated with Oral-Turinabol. The effects of the treatment with androgenic hormones were so spectacular, particularly in female athletes in strength-dependent events, that few competitors not using the drugs had a chance of winning.

In the GDR of the 1970s, the use of this and other androgenic hormones became customary among athletes, including minors. For a talented female athlete, it was a no-win situation: They could either take it (the drug) or leave it (give up competitive sports). The dosages were also drastically increased, at least until the late 1970s, when some of the damaging side effects became so overt that in the swimming events of the Olympic Games in Montreal 1976, where the GDR won 11 out of 13 events, journalists were inquiring about the strangely deep-sounding voices of the broad-shouldered GDR female swimmers.

In a summary report to the Stasi on March 3, 1977, SMD Deputy Director Höppner (Vol. II of his Stasi reports under the code name "Technik," pp. 243–44), described the GDR results and concluded:

> At present anabolic steroids are applied in all Olympic sporting events, with the exception of sailing and gymnastics (female)[4], . . . and by all national teams. The application takes place according to approved basic plans, in which special situations of individual athletes are also considered. The positive value of anabolic steroids for the development of a top performance is undoubted. Here are a few examples. . . Performances could be improved with the support of these drugs within four years as follows: Shot-put (men) 2.5–4 m; Shot-put (women) 4.5–5 m; Discus throw (men) 10–12 m; Discus throw (women) 11–20 m; Hammer throw 6–10 m; Javelin throw (women) 8–15 m; 400 m (women) 4–5 sec; 800 m (women) 5–10 sec; 1500 m (women) 7–10 sec. . . Remarkable rates of increase in performances were also noted in the swimming events of women. . . . From our experiences made so far it can be concluded that women have the greatest advantage from treatments with anabolic hormones with respect to their performance in sports. . . . Especially high is the performance-supporting effect following the first administration of anabolic hormones, especially with junior athletes.

[4] As carefully protocolled *[44]* by W. Schäker (FKS), this restriction ended in 1979 when the national and the Olympic team in female gymnastics, including many minors, were systematically treated with mestanolone (STS 646; Table 1) because this steroid was believed to be more psychotropic, resulting in positive aggressiveness and a higher capacity of training load without much body weight increase—although the GDR doctors had reported that STS 646 was more androgenic than Oral-Turinabol, thus posing a higher risk of virilization in these young girls (see, e.g., *[23]*).

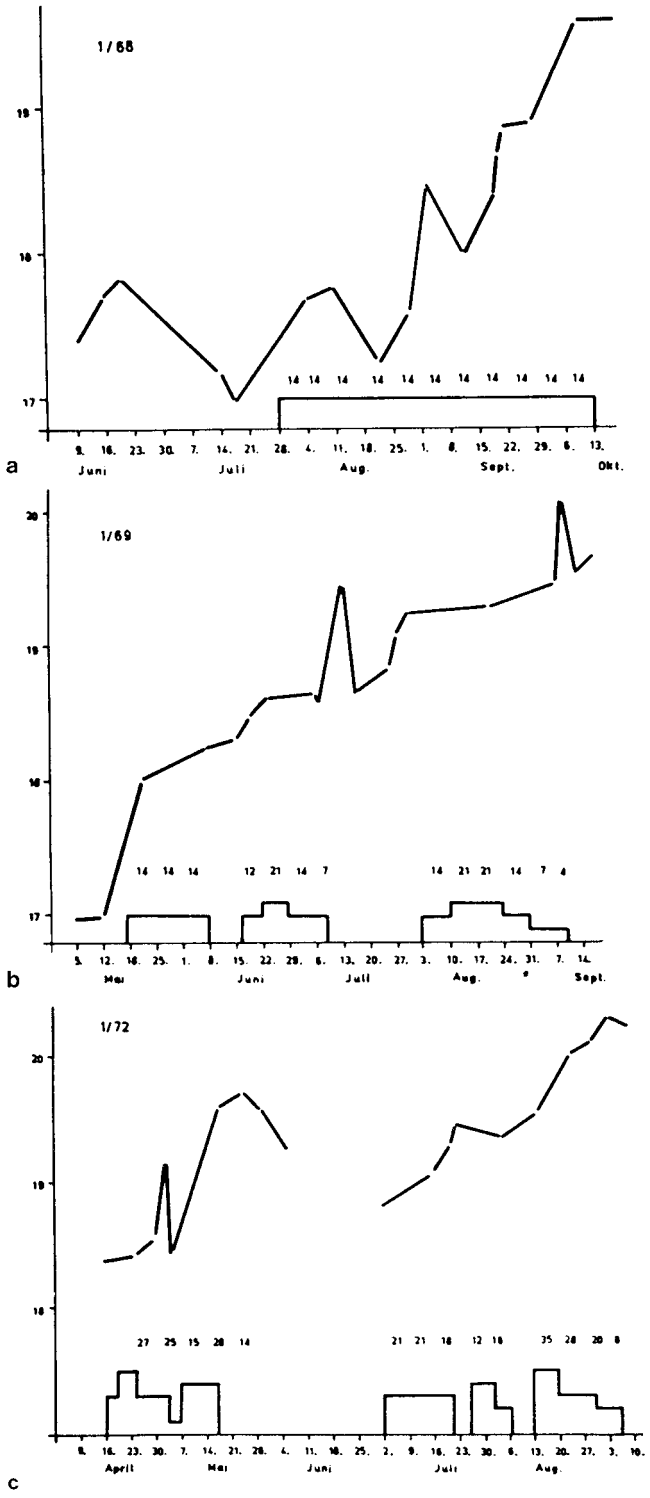

Fig. 1. Effects of an androgenic-anabolic steroid, Oral-Turinabol, on the shot-put performance (in meters, *y*-axis) of a female athlete (code identification 1/68 in *a*, 1/69 in *b*, and 1/72 in *c*) directly photographed from the secret scientific report of Bauersfeld et al. *[13]*, as one of the numerous examples documented, chosen here because of its historic importance as the first documented case of androgenic doping of a woman (for a detailed account, see ref. *[11]*).

Since the early 1970s many athletes of the GDR, notably females, were given not only oral androgenic steroids but also injections with androgenic hormones, including nandrolone esters or, most frequently, testosterone esters. The strong virilizing side effects of injectable testosterone esters were accepted by most female athletes, but some refused to participate in this additional testosterone injection program. Moreover, several other classes of doping drugs, from stimulants (e.g., amphetamines) to oligopeptides (e.g., oxytocin), were also used. A list of the doping substances described as having been used in GDR sports is given in Table 1.

Because the effect of doping with androgenic hormones was so spectacular in female athletes, the abuse of such drugs rapidly spread not only to Eastern Block countries but also, since the mid-1970s, to countries of the Western world, including West Germany and in particular the US *[1, 2, 10, 11, 50–61]*. Thus, the women with natural ambiguity of sex characteristics, who had played a significant role in female sports until the introduction of sex test controls in the late 1960s, were soon followed by the pharmacologically induced ambiguous sex characteristics. The androgenic changes in phenotype were obvious in 1968 at the Olympic Games in Mexico City, and one of us (B.B.), a finalist in the discus throw there, later described in several articles (e.g., *[50, 51, 56, 57]*) the imminent threat of androgenization to women's sport and proposed out-of-competition control by analyzing athletes' urine with gas chromatography. (For international discussion, see also ref. *[51]*.) This alarming prediction and the proposed solution were met with hostile silence and were not adopted for almost two decades.

The marked effects of androgenic hormones on performance in strength-dependent sports of men and in practically all disciplines of women's sports are also evident from the decline in top performances worldwide after the

(a) 1968. The *rectangle* from July 28 to October 13 shows the period of drug administration, and the numbers above each date show the number of tablets taken per week (here, 14, or 10 mg per day). The *curve* presents the results of the specific competitions, showing the increase of strength and performance in a fully trained woman. At the time of the first drug application in 1968, the athlete had been well trained for almost 14 years. Under the influence of the drug, however, she gained unprecedented muscle strength and improved her records dramatically within a few weeks. *(b)* 1969. The steroid was given in three cycles and at various dosages, from 7 to 21 tablets per week (i.e., 5–15 mg daily). Without the drug, she could not reach 18 m but when taking the drug, she improved her world record once more, to 20.10 m. *(c)* 1972. She took even more of the androgenic hormone, with daily dosages of up to 7 tablets per day (35 mg), in four cycles, for a total androgenic load of 1450 mg for the year. This led to her top performances in the winter indoor season *(left curve)* as well as in the summer *(right curve)* and another personal best (20.22 m). Note the much lower performance at times off the drug or after only short periods of androgenization. Also, after 4 years of systematic androgenization, her basic strength level even when not taking the drug had also increased by ~1 m, indicative of a residual effect.

Table 1. Major doping substances used in high-performance sport of the GDR.

Trivial name	Alternative or international name	Code name	Chemical name
Androgenic-anabolic steroids			
Oral			
Oral-Turinabol (tablets)	—	OT, M1	Dehydrochloromethyltestosterone, 4-chlor-1-dehydro-17α-methyl-testosterone
Steroid substance 646	Mestanolone	STS 646, M2	17α-Methyl-17β-hydroxy-5α-androstane-3-on
Steroid substance XII	—	SXII, U2	11-β-Hydroxy-OT
Steroid substance 482	—	STS 482	4-Chlor-17α-methyl-17β-hydroxy-5α-androst-4-en-3-one
Steroid substance 648		STS 648	4-Chlor-17α-methyl-17β-hydroxy-5α-androstane-3-one
Dianabol	Methandienone, methandrostenolone	—	17α-Methyl-17β-hydroxy-1.4-androstandiene-3-one
Injectable			
Testosteron-Ampullen	Testosterone propionate	TP	—
Testosteron-Depot-Ampullen	Testosterone enanthate	TD	—
Testo-Tropin-Ampullen[a]		TT	—
Turinabol-Ampullen	Nandrolone phenylpropionate, Durabolin	TA	Phenylpropionate ester of 17β hydroxy-19-norandrost-4-en-3-one
Turinabol-Depot-Ampullen	Nandrolone decanoate, Deca-Durabolin		Decanoate ester of the same compound
Nasal spray			
Testosterone esters			
Androstendione	—	AD	—
Substances stimulating testosterone synthesis			
Gonabion-Ampullen (injectable)	Chorionic gonadotropin (hCG)		—
Clomiphen, Clomifen (tablets)	—	—	—
Neuropeptides			
Lysine-vasopressin	—	LVP	
Oxytocin	—	OXT, B17	
Substance P	—	SP	—
Stimulants			
Amphetamine			
Methamphetamine (Pervitin)			
Neurotropics, psychotropics			
Corticotropin			
Piracetam			
Nicergolin			
Nivalin			
Polypeptide hormones			
Human growth hormone	Somatotropin		

[a] 25 mg of TP and 1000 IU of hCG per milliliter.

introduction in 1989 of some out-of-competition controls—despite the insufficient and imperfect nature of these tests. Fig. 2 shows the decline in "world best" performances, using as examples women's shot-put, discus, and javelin throw—typical indicator events of doping with androgenic hormones. Similarly revealing declines can be seen in most other women's events and in the men's shot-out, discus, and hammer throw.

This abrupt decline in performances after the introduction of random out-of-competition testing has been passed over in painful silence, even in scientific journals (see, e.g., the 1996 pre-Olympic issue of *Nature*, 382:12–6), but cannot easily be overlooked. For example, the best result of the 1996 Olympic gold medal winner of the shot-put in Atlanta, GDR-derived athlete Astrid Kumbernuss, would have finished only in sixth place at the 1980 Olympic Games in Moscow, almost 2 m behind the GDR winner at that time, who tossed for 22.56 m. This trend of decline, however, does not prove that today's best athletes are free from doping; it merely suggests that there is less doping than previously. In particular, the studies of GDR scientists established that "androgenic initiation" has per-

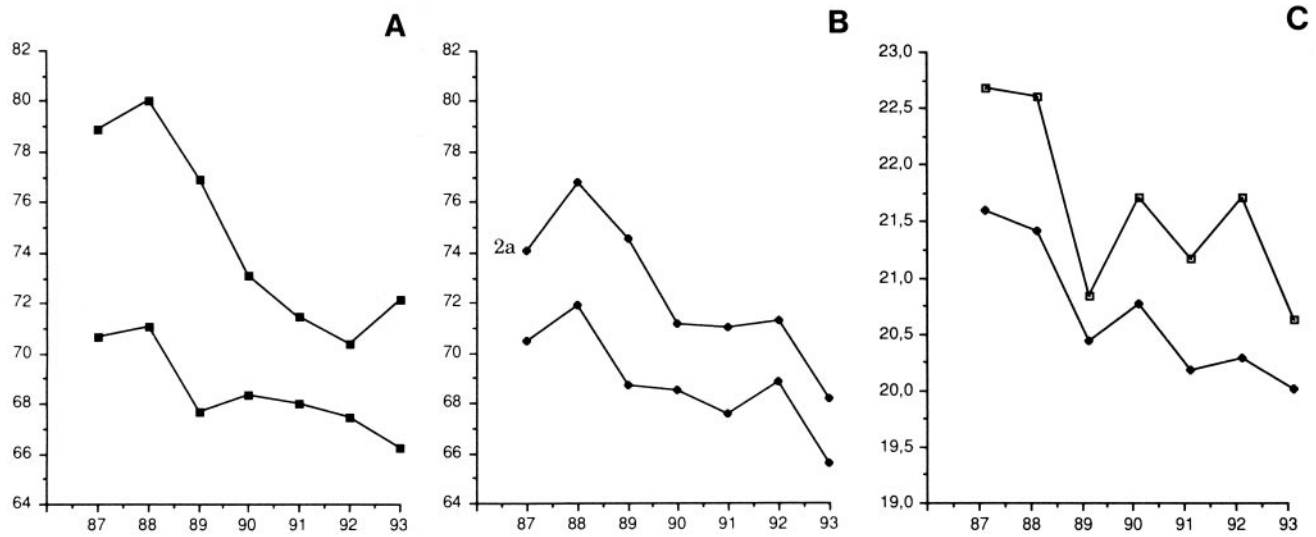

Fig. 2. Decreased performances in women's strength-dependent events worldwide, after implementation in 1989 of some (though still insufficient) out-of-competition doping controls: *ordinates* present meters of performance of the world best *(upper curve)* and the average of the ten best *(lower curve)* athletes in the javelin throw *(A)*, discus throw *(B)*, and shot-put *(C)* for the years 1987–1993.

This decrease since 1989 has further continued until today. In 1996, for example, no woman put the shot beyond 21 m, only two reached 20 m, and the average of the 10 best is now only 19.89 m. In 1996, many athletes were 2 m or more below their personal best from previous years. In the discus throw, no woman in 1996, including the Olympic champion, threw beyond 70 m, well short of the junior record of 74.40 m set in the GDR in 1988 by the then 18-year-old champion to be. And the best javelin throw of 1996 was shorter than the 1988 world record by >10.50 m(!).

manent effects in girls and women: After a critical period of androgenization and an increase in muscle strength, a higher performance level is reached that does not return to pretreatment values after the drug is withdrawn (see also Fig. 1). In this respect, many of today's top athletes still profit from their previous androgenization.

1974: The GDR Organizes and Controls Systematic Doping

In 1974, GDR sport officials and the government faced an emerging dilemma. On the one hand, the effectiveness of androgenic hormones in most sporting events implied that to be internationally competitive one had to take these drugs as long as even a few of one's competitors did. On the other hand, the GDR, which, like most other countries, had officially denied the administration of such drugs and repeatedly pledged to fight against doping, was now being exposed to the problem of drug testing for androgenic-anabolic steroids at major international competitions.

In fact, analyses of urine samples for androgenic steroids were announced for the 1974 European Athletic Championships in Rome, but no positive results were published. Obviously, what the GDR Government feared most were positive test results from their successful athletes at international sporting events,[5] which would damage not only the image of the GDR as a "sports nation" but also the whole concept of the superiority of the socialist system as the better and more humane way.

Therefore, a general strategy and a centrally organized system were developed to secure both efficient hormonal doping and evasion of detection. Because of the political importance of the problem, a crucial decision was taken at the governmental level, i.e., by the Central Committee (Zentralkomitee; ZK) of the reigning Socialist Party. The final government bill, classified Top Secret, was discussed and approved on October 23, 1974, by the Commission for High-Performance Sport (Leistungssportkommission; LSK) of the ZK. Great care apparently was taken that all copies of the 9-page bill and the original protocol of the session were destroyed; ironically, however, a single copy made a few days before by the MfS survived in the Stasi files and now provides evidence that the final decisions were made at the highest governmental level and enacted by government order.

The bill of 1974 provided, among other things, that the administration of doping substances, notably androgenic steroids, to male and female athletes should:

1) be an integral part of the training process and of preparations for major international competitions;
2) be organized tightly and centrally, including regular evaluations of the results obtained and the experiences made by the sports physicians involved;

[5] During the 1975 European Junior Championships in Athens, Greece, the 17-year-old rising 100-m sprint star, Marlies Oelsner, later known as Marlies Göhr, a world-record holder and Olympic gold medal winner, tested positive for androgenic steroids but the result was not published by the European Association. Then in fall 1977, the female shot-put star Ilona Slupianek was found positive for nandrolone at a Europe Cup meeting in Helsinki and was banned. However, she was soon allowed to compete again and to improve her German record in the summer of 1978, and in 1980 to win the Olympic gold medal and improve the world record to 22.45 m. These were the only two cases in which GDR athletes had ever publicly tested positive for steroids.

3) be directly controlled by the SMD, including the establishment of a centralized drug distribution and documentation system;
4) be further developed and optimized by research on doping in high-performance sports, with special emphasis on the development of new substances and the most efficient patterns of administration, considering both the requirements of the specific sporting event, the time of drug administration and withdrawal, and other methods to avoid detection at international meetings;
5) be taught to sports physicians and coaches in special documents and courses; and
6) take place in absolute secrecy and be classified as an Official State Secret.

It was also agreed that the research in this area should be coordinated by the FKS in Leipzig as a "Working Group Supporting Means" in a special research program financed by special government SKS grants. This comprehensive and, by GDR standards, well-funded program was originally called "Research Program 08" and later "State Plan Research Theme 14.25." Some of the reports to the government on the results of this research program have been saved *[23, 31, 32, 45–48]*; for further references, see *[10–12]*. Medical records of most doped athletes were kept in the central office of the SMD in Berlin and at the SMD Institute in Kreischa, which consisted of a research hospital and the ZDKL (Claus Clausnitzer, Director), a laboratory accredited by the International Olympic Committee (IOC).

The ZDKL was of increasing political importance, being primarily used not to detect drug abuse but to avoid the detection of drug abuse by GDR athletes in international doping controls. Therefore, after the positive doping case of shot-put star Ilona Slupianek in 1977,[5] every GDR athlete was required to provide a urine sample a few days before departing to an international competition at which doping controls would be performed; these precompetition samples were taken by a special delivery system to the ZDKL and analyzed. The results were transmitted, in coded fashion, first by telephone and then in written form to Höppner and the sports officials, and athletes testing positive were excluded from participation (for cases involving misuse of testosterone, however, see below). This screening system, commonly called Ausreisekontrolle ("departure control"), was apparently effective and resulted in a number of last-minute exclusions, including some prominent athletes.

The activities of seven ministries were integrated in this doping and research program, and the Central Working Group for the Protection of State Secrets of the Stasi developed a network of >1000 sport collaborators, informants, and spies ("unofficial collaborators"). The final version of the improved Security Concept of January 10, 1979, was approved by a Stasi general and included "operative espionage" in sport and research institutions of other countries, especially in relation to developments in improved methods for detection of doping drugs.

In this drug administration program, >2000 athletes preparing for international competitions were treated each year. In addition, numerous "cadre B and C" and junior athletes, including minors, were also treated with androgenic hormones and with substances such as human chorionic gonadotropin (hCG) and clomiphen, which stimulate endogenous testosterone synthesis (see Table 1), depending on the specific sporting event. For example, in weightlifting, the "official" steroid treatments were usually started at age 16 or 17, although cases of administration to younger children have been also documented in events in which minors could be world-class athletes: In swimming, girls of 14 or younger were given androgenic hormones; 14- to 15- year-old girls and boys were also hormone-doped in canoeing and kayaking, rowing, and various winter sporting events. All hormone-treated athletes, including minors, and the physicians and coaches involved were sworn to keep the state secret. Care was taken that adolescents swallowed the Oral-Turinabol tablets, described as "vitamin pills," in the presence of their coaches; they were not allowed to take the tablets home or talk about such treatments with anybody, including their parents. Injections of steroids or of other drugs (Table 1) were also explained as necessary medications or prophylaxis.

In special "secrecy instructions" for physicians and scientists working in this program, the Director of the SMD identified those persons allowed to be informed about the doping details and determined the procedures for controlling the secrecy. Remarkably, the secrecy was, by and large, maintained, despite the large numbers of athletes, physicians, scientists, coaches, and officials involved.

How hormone doping was organized within the individual sport associations is documented in detail in the May 1979 Stasi report of Hans-Henning Lathan (under code name "Klaus Müller"), chief physician and international representative of the GDR Weightlifting Association (Deutscher Gewichtheberverband; DGV):

> . . . In the DGV a first agreement is obtained by the head coach, the special coaches, and the team physician as to which athlete should receive "UM". A detailed conception for drug administration is then worked out by the team physician in a written form and sent, via the classified document office of the FKS, to Dr. Höppner and the classified document office of the SMD of the GDR. . . . From the central SMD office in Berlin the individual sports medical district advisory offices of the SMD in the individual counties are informed which athlete shall participate in the drug program. A selected sports doctor is then nominated as the responsible MD for all doping drug [UM] problems in each of these county offices. This central county office doctor will inform the corresponding doctors in the sports clubs and sports associations [Sektionsärzte] about the decision concerning the drug administration to a specific athlete and will

swear them to absolute secrecy. When information is given by telephone the doctors talk in coded terms; in the DGV the UM drugs are usually called "vitamins." The sports doctors [Sektionsärzte] will swear the athletes and the coaches to secrecy and this will be recorded in special "secrecy books" for classified information. The sports doctors will then hand out the weekly doses to the specific coach who in turn will give the drugs to the athlete.

This conception is controlled at all levels by random checks of the amounts of drugs distributed, consumed, and left-over. In the DGV, the athletes usually know that the drugs they receive are anabolic steroids. Here the special problem exists that so many athletes, i.e., all members of the cadres A, B and C, are part of the anabolic steroid program, so that secrecy leaks could occur.

The drug dosages of the DGV weightlifters were very high, sometimes exceeding, in the upper weight categories, 10 g per year. In 1979, for example, one GDR weightlifter took 11.550 g of Oral-Turinabol plus 13 injections of testosterone esters and hCG (for details see ref. *[28]*, evaluated in refs. *[10, 12]*).

Altogether, the specific drug consumption of 400 GDR athletes is now well documented, including numerous world-record holders and medal winners at Olympic Games and World and European Championships (for details, see refs. *[10, 11]*). These athletes included most GDR gold medal winners in the swimming events since the 1976 Olympic Games (see also the next section) and all GDR gold medal winners in the throwing events of the 1988 Games.

The androgenization of girls and young women was a most effective part of the GDR doping program. The doses given were surprisingly high, and many of the top women in track and field events and in swimming took amounts of androgenic steroids that were higher than the doses taken by male athletes in the same or comparable events. As shown by a short list of examples in Table 2, many female throwers, sprinters, and jumpers took higher doses than their male teammates in the same event. For example, several female gold medal sprinters took higher amounts of male hormone than did the male GDR sprinters. The leading female athlete in one track event (sprint) was given a maximum annual dosage of 1460 mg, more than double the dosage recorded for the leading male GDR athlete in the same event.

In the 1980s, special work was devoted by the GDR sports physicians and scientists to the basic problem of increased tolerance, i.e. the need to increase drug dosage over time. Therefore, they tried to determine the minimal dosage necessary for an optimal effect on performance in young athletes. The evaluations presented in Fig. 3 show two examples of the many studies conducted on teenage athletes, illustrating the effects of the initial Oral-Turinabol doping on a long jumper and a decathlete, who also received combinations of Oral-Turinabol with mestanolone, the second most frequently used oral androgenic steroid in GDR sports (code name, STS 646; see Table 1).

Mestanolone, which was available only as an experimental preparation from the research institute ZIMET, was also given to female gymnasts and handball and volleyball players (e.g. *[44]*) without having been approved for administration to humans, not even in clinical phase I trials. Höppner reported it to the Stasi as something he was not willing to be held responsible for. However, the person responsible for the illegal use of STS 646 and other steroids, a pharmacology professor, was even honored for his supportive role in the GDR doping system *[32]*.

The treatment of young girls with androgenic hormones was especially rewarding in the medal-rich swimming events, where it secured consistent international success (e.g., *[8, 32, 38]*). Although most of the physicians involved were aware of and documented (see below) the damaging side effects of the drugs, and even found this treatment unethical (as they reported to the Stasi), they were subservient to the political system. Consequently, the treatment of talented swimmers in the mid-1980s with androgens started usually at age 14, with a total annual dosage of 670 mg given in three cycles with maximal daily doses of 10 mg (see refs. *[38, 44]* and the Stasi reports of code name "Rolf").

Table 2. Some documented dosages of androgenic-anabolic steroid (Oral-Turinabol)[a] taken by female GDR medal winners (track and field) in Olympic Games, World Championships, and European Championships.[b]

Annual dosage, mg	Events
3680	Shot-put
3190	Discus
2900	Shot-put
2615	Shot-put
2590	Shot-put
1670	Sprint
1560	Hurdles
1480	Hurdles
1474	Sprint
1460	Sprint
1450	Shot-put
1405	Sprint
1380	Heptathlon
1375	Sprint
1340	Heptathlon
1255	Discus
1230	Heptathlon
1230	Hurdles
1185	Javelin

[a] Additional injections of testosterone esters have not been considered here.

[b] Data taken from ref. *[11]*, which gives names and details. At least 12 of the drug-receiving competitors listed in this table set world records.

In keeping with Journal policy regarding confidentiality of patients and subjects, the names of subjects have been omitted.

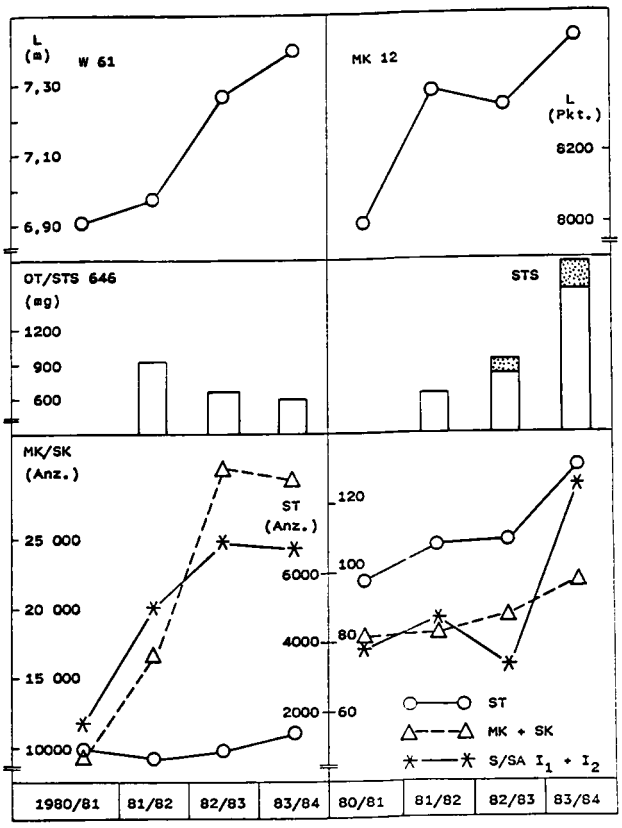

Abb. 21: Beziehungen zwischen den eingesetzten Haupttrainingsmittelkomplexen, der Leistungsentwicklung und des AS-Einsatzes vor und nach dem Jahr der Erstanwendung von AS (1981/82) am Beispiel einer Weitspringerin und eines Zehnkämpfers

Fig. 3. Examples of the analyses of the performance-enhancing effects of the first-time administration of the androgenic-anabolic steroid Oral-Turinabol (OT), alone or together with mestanolone (STS 646), in two junior athletes: a female long jumper (W 61, *left panels*) and a decathlete (MK 12, *right panels*).

The *upper panel* shows the best performances (*L* Leistung) in the seasons from 1980/81 to 1983/84 (*x*-axis) in the long jump in meters (m, *ordinate*) and in the decathlon in points (Pkt, Punkte). The *middle panel* presents in a histogram the annual dosages of androgenic steroids (mg OT: additional STS doses shown in *dotted bars*). In addition to the OT-tablets the long-jumper was in 1984 twice injected with 25 mg of testosterone propionate, and the male decathlete received additional testosterone propionate injections totaling 30 mg (3×10) in 1982 and 1983 and 320 mg (3×100, 2×10) in 1984. The *bottom panel* presents the corresponding curves of the developments of certain test performances such as maximal muscle strength *(MK)*, speed power *(SK)*, sprint speed *(S)*, and endurance at high speed *(SA)* at different intensities *(I)*. This is a direct photograph of Fig. 21 of the scientific report of Dietrich Nicklas and colleagues of the research institute FKS in Leipzig *[37]*. The German text of the legend translates: "Relationships of the major training means used, performance development and anabolic steroid (AS) administration before and after the year of the first AS application, using the example of a female long jumper and a male decathlete." At the time of the first treatment with a total of 935 mg OT, the long-jumper was still a minor. Her example was presented by these authors to show that in young girls relatively low drug dosages can be effective for top achievements in the jumping events.

Considering the strictly central and tight organization of this program and its control by the Stasi, even in such a totalitarian system, a "black market" for doping drugs existed. Drugs like Oral-Turinabol and other compounds (see next section) were so much in demand that the top-cadre athletes and their coaches often wanted more than the allotted dose, and second-class athletes and coaches of minors in so-called training centers (in some cases this involved 9- to 12-year-old-boys and girls) tried everything to obtain "the stuff" unofficially on the black market. The driving force behind these efforts to obtain doping drugs through illegal sources was the importance attributed to success in sports in the GDR society, which provided increased salaries and privileges such as travel abroad for both the athlete and the coach. The Chief Physician of the DGV *[28–30]* repeatedly complained about the craving of the coaches for more and more steroids.

Testosterone Games: The Scientists' Contribution to Cheating

Testosterone esters played, and still play, a significant role in Olympic sports. Before 1974, such drugs were primarily used as merely another group of anabolic-androgenic steroid preparations. However, after the introduction of in-competition controls, albeit infrequent, in the mid-1970s, testosterone esters suddenly gained special importance as undetectable alternatives to be used for "steroid bridging" (also known as "bridging therapy") in the last weeks before competitions. Consequently, after ceasing administration of the readily detectable synthetic steroids, athletes of both sexes were routinely injected with testosterone esters of various fatty acid chain lengths. This precompetition program of repeated intramuscular injections of testosterone esters had by then become a common procedure in several countries. This is also evident from the analysis by the West German, IOC-approved Doping Control Laboratory in Cologne of the unused aliquots of urine samples ("B samples") taken during the 1980 Olympic Games in Moscow: Even at the games, 7.1% of all female urine samples were still positive for testosterone doping, as revealed by a testosterone:epitestosterone (T:E) ratio >6 *[62]*, including samples from athletes in events such as fencing, in which androgenic doping is uncommon. Only since 1982, when doping tests for testosterone were introduced by the Medical Commission of the IOC for the 1984 Olympic Games (in fact, it had been announced by the International Athletics Association earlier) have T:E values >6 become rare findings.

In the GDR sports system, however, this "bridging" by testosterone injections was used through the late 1980s, as has been documented for hundreds of male and female GDR athletes. Fig. 4, for example, shows the pattern of testosterone bridging in 1981–1984 for athletes in several events. Moreover, several male and female athletes used testosterone ester injections throughout the season, in addition to their Oral-Turinabol and mestanolone tablets. Consequently, virilizing side effects in female GDR athletes were frequent and pronounced. Höppner reported the following to the Stasi on August 30, 1979: "Now as ever before testosterone is injected in irresponsible

amounts, and this even at competitions where it does not matter so much that spectacular records are achieved."

When it became clear in 1981 and 1982 that the IOC would introduce doping tests for exogenous testosterone, Höppner, who was a member of the respective international commissions, reported this threat to GDR success in international sports to the governmental and sports authorities. A symposium to face this problem was held in Leipzig on June 24, 1981, which included six professors and a senior researcher and physician. The protocol and copies of some lectures of this and other similar meetings have been saved *[42]* and published in total elsewhere *[10, 11]*.

At the 1981 meeting, the following was proposed and agreed to:

1) to determine alternatives to the exogenous application of testosterone,
2) to replace testosterone by its precursor, androstenedione, various forms of dihydrotestosterone, dihydroandrostenedione, or dehydroepiandrosterone (DHEA), and
3) to administer testosterone as well as dihydrotestosterone by nasal spray[6], especially in those events in which the psychotropic effects of testosterone, such as increased aggressiveness, are considered important, as well as to evade the doping tests.

In the ensuing years nasal spray preparations containing testosterone or androstenedione were indeed developed in collaboration with VEB Jenapharm, tested, and used in top athletes—some of whom did not like this mode of application (as described by some athletes; see refs. *[11, 12, 32]*).

In subsequent meetings, as well as in letters, other scientists were consulted (e.g., *[31, 32]*). Among the alternative methods were the use of drugs (e.g., hCG) known to increase the endogenous synthesis of testosterone (see, e.g., refs. *[7, 14, 18, 26–28, 30–32, 41]*). Dozens of research projects, all financed under the central program, State Plan Theme 14.25, emerged from these expert interactions, all with only two objectives: to improve athletic performance pharmaceutically and to achieve this aim without detection by international doping controls.

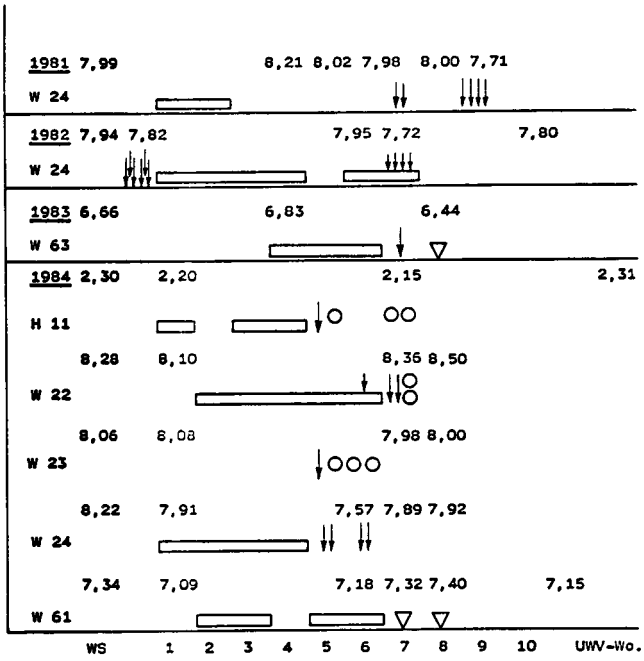

Abb. 8: Anabole und spezielle Vorbereitung auf den Oahres-Wettkampfhöhepunkt im Rahmen der UWV im Olympiazyklus 1980/84 am Beispiel ausgewählter Weitspringer (W) und eines Hochspringers (H) in Verbindung mit den in diesem Zeitraum erreichten Wettkampfleistungen

Fig. 4. Example (from hundreds of evaluations) showing typical administration patterns of orally taken synthetic anabolic-androgenic steroids (Oral-Turinabol, periods of application denoted by *rectangles*) and injections of testosterone esters [*arrows*, 10 mg of testosterone propionate (TP); *triangles*, 25 mg of TP; *circles*, 100 mg of testosterone enanthate plus 1500 IU of hCG], here given to high *(H)* and long (*W*, Weitsprung) jumpers during the last 10 weeks before a major international competition in 1981–1984 [immediate preparation period (UWV), in weeks, is indicated on the *x*-axis; *WS*, competition series preceding the UWV; the competition results (in meters) are shown immediately above the specific drug application symbols].

Document directly taken from the scientific evaluation report of Nicklas et al. *[37]*, Fig. 8. The code numbers represent male long jumpers (W 22, W 23, and W 24), female long jumpers (W 61 and W 63), and a high jumper (H11), identified in refs. *[10–12]*. Note that the synthetic steroid was withdrawn ~3 weeks before major international competition; instead, the athletes were injected with testosterone esters closer to the competition. Numerous analytical tests had shown that this pattern of administration would not be detected in the international doping controls at the competition. The original German legend of this figure translates as follows: "Anabolic and special preparation for the top competition of the year during the immediate preparation period in the Olympic cycle 1980/84, using the example of some selected long jumpers (W) and a high jumper (H) in combination with the results of competitions during this time."

Already in 1982, i.e., before the doping control test for testosterone administration was introduced, the doping scientists of the GDR had a solution. In a study on 241 male and female athletes, Clausnitzer et al. *[14]* showed that short fatty acid esters are preferable and that 3 days after injection of 25 mg of testosterone propionate the T:E ratio would again be <6, i.e., not classifiable as resulting from doping. They also determined that treatments with hCG and clomiphen did not change the T:E ratio. These

[6] Recently, Michael Oettel, who participated in that symposium, regretted his role in doping research. In a personal declaration, completely printed in ref. *[10]* (pp. 462–3), he stated: "I was fully aware that such proposals could be practically applied in high performance sports. I made the proposal to administer testosterone intranasally and I reviewed the literature on the psychotropic actions of steroid hormones . . . We scientists were not informed about the detailed results of the administration of androgenic hormones to athletes, and we have not taken efforts to get such information. Today, however, having read the classified documents, I have to say that this ostrich policy of ignorance can hardly be reconciled with the responsibility of a scientist. The administration of anabolics to minors for athletic performance shows strikingly how far irresponsible and uncontrolled sports medicine can be driven. I have to live with the burden to have served this sports system as a scientific consultant."

and other experimental findings were considered in all further doping and precompetition bridging programs of the GDR (see, e.g., Fig. 4 and refs. *[7, 14, 19–22, 26–32, 34–37]*). The general procedure was that in the last weeks leading up to a drug-controlled competition only testosterone propionate should be injected and that the last injection should be given 4 or 5 days before the competition. More detailed clearance profiles were subsequently defined *[7]*, so that one could predict for the individual athlete by how many hours after injection would the T:E ratio in her or his urine again be <6.

To ensure the success of the deception, T:E ratios were also routinely assessed at the ZDKL laboratory shortly before the athletes were to depart to major international events (Ausreisekontrollen). The predictive safety of the T:E return-to-normal-range curves was so accurate that athletes could risk loading with testosterone up to the last possible day. A departure control series (not shown) completed before the 1989 European Swimming Championships in Bonn showed that urinary test results for four female swimming superstars (together representing 10 Olympic gold medals), were in the doping range, i.e., T:E ratios between 8.8 and 17. Officials, however, were confident that the women's values would be well <6 by the time of competition 2 or 3 days later.

GDR sports medicine had an additional strategy to circumvent the doping test. Since 1983, VEB Jenapharm had produced preparations of epitestosterone propionate, a biologically inactive compound that had no commercial value but was prepared exclusively for the governmental doping system. As Riedel reported in 1983 *[41]*, the sports physicians of the GDR had determined the dosage of epitestosterone necessary to be injected, simultaneously or sequentially, "to bring the T:E ratio back into the normal range." The injection of epitestosterone, alone or together with testosterone, was then frequently incorporated into the program—but only for the top athletes in international competitions. Because this protocol made it possible for female athletes to receive high testosterone dosages, Höppner reported, for the first time, his medical concerns to the Stasi on March 23, 1984 ("Technik," Vol. III, p. 334), immediately after the successful Olympic Winter Games in Sarajevo, where a female athlete excelled.

> [This athlete] was among the selected top athletes who were prepared for their competitions at the Olympic Winter Games with considerable amounts of testosterone and simultaneous counterinjections of epitestosterone. Similar supporting measures were also performed [for her] at the subsequent World championships. With this in mind one has to conclude that [her] extraordinarily positive results . . . will be unique and not reproducible, also not in her own best interest, as already now her facial features have virilized and her voice has changed.

Nevertheless, this most-virilizing procedure of steroid doping with T:E injections was generally used in girls and women since 1983–84 and is particularly mentioned in the reports for swimmers and rowers.

However, the titration of the T:E value by injections of propionate esters of both testosterone and epitestosterone was such a convenient method to beat the doping controls that more and more athletes were anxious to use it, including many *not* among the selected elite of cadre A athletes. Consequently, an illegal black market for epitestosterone formed in the GDR, and Clausnitzer began to observe increased absolute amounts of epitestosterone in urine samples of athletes. On October 19, 1983, he reported this finding to Häcker at the FKS, and the investigators of the FKS and the Stasi reportedly found a "source" of the black market epitestosterone at the producer, VEB Jenapharm (Stasi report, code name "Hans Georgi").

In summary, the physicians responsible for the doping system had a choice of methods for avoiding detection while administering large amounts of testosterone esters. The top coaches were then instructed and thus were, and still are, adept at these procedures.

Finally, however, even when an athlete of the GDR, or another socialist country, was tested at a risky moment, i.e., when her or his urine was expected to still contain metabolites of synthetic steroids or an above-normal T:E ratio, there was no reason to panic. From the written records, it appears that, usually, one of the members of the international doping control committee was able to clear away the sample. For example, the Stasi reports from Höppner, who served many years on control committees, describe when and how he covered up certain drug-positive cases and arranged falsely negative findings, often after consultation with a ZK member; if worst came to worst, he acted directly by carrying out a urine exchange. For example, in his Stasi report of March 23, 1984, he reported that, at an international weightlifting competition in which supposedly still drug-positive GDR athletes participated, he would be personally responsible for the transport of the urine samples and then "when underway break the seals and exchange the urine samples of the GDR weightlifters for clean urines." Shortly thereafter, on April 6, he reported on the fate of the doping control samples of several GDR athletes successful at that competition: "Their urine samples were exchanged by the IMB[7] . . . , resulting in negative analytical findings."

The numerous secret reports and protocols document that, at least after 1978, doping controls were circumvented by the GDR. After the Slupianek case in 1977, none of the numerous athletes loaded with anabolic steroids was ever found positive in any of the numerous international doping control analytical laboratories in any on-

[7] IMB is a special high grade of spy with orders to be in touch with the enemy ("mit Feindberührung"), to which Höppner was promoted after many years of service to the Stasi.

Table 3. Some of the documented damaging side effects observed in male and female GDR athletes during treatment with anabolic-androgenic steroids, notably Oral-Turinabol.

Damaging side effect	% of athletes affected	Dosage category[a]
Side effects observed in athletes of jumping events, heptathlon, and decathlon [7]		
Muscle tightness	65	1, 4, 5
Body weight increase	23	1, 4, 5, 6
Muscle cramps	15	1, 3
Irregular menstruation, including amenorrhea	15	1, 6, 7
Acne and hirsutism	10	7, 8
Alteration of libido, sexual potency, fertility	8	1, 5, 7, 8
Edema	2	1
Diarrheas, constipation	2	1, 6
Functional/structural liver damage	0–1	7, 8, 5
Other damaging side effects reported by "Unofficial Collaborators" in Stasi reports		
Deaths (2 bodybuilders, 1 hammer thrower)		
Gynecomastopathy, with surgical removal of breast tissue (12 documented operations)		
Severe liver damages, necessitating hospitalization		
Excessive hirsutism		
Acne, folliculitis		
Amenorrhea		
Polycystic ovarian syndrome		
Deepening of voice		
Nymphomania		
Loss of libido (in males)		
Arrest of body growth (in adolescents)		

[a] 1 = >15 mg/day; 2 = <5 mg/day; 3 = short treatment intervals, ≤14 days; 4 = long treatment intervals, ≥28 days; 5 = coincident medication with contraceptive steroids; 6 = first-time medication; 7 = high dosage per year (>1000 mg); 8 = long treatment period (several years).

competition and out-of-competition test. In other words, the doping controls were useless.

Damages and Side Effects but the Games Must Go On

First-hand medical information on the negative effects of the doping drugs used in GDR sports, particularly androgenic steroids, is found in the secret doctoral theses, in some of the scientific reports, and most directly and frankly, in the Stasi reports of some sports physicians. Many of the sports physicians of the GDR broke patient confidentiality and professional secrecy in their reports to the security agents. Moreover, in recent years, several courageous former athletes have publicly described the damages resulting from these drugs, and some have sued the responsible persons. The general prosecutor of a special task force "for governmental and unification criminality" (ZERV) in Berlin is currently investigating the cases of >50 victims of the administration of these drugs without medical requirement or justification and usually also without informed consent.[8]

Most of the side effects and damages known from the medical literature to occur with various frequencies upon administration of androgenic steroids or of drugs stimulating testosterone synthesis have also been observed in GDR athletes, and nowhere have the GDR doctors described a novel damaging side effect not mentioned in the Western literature (for reviews see *[1, 2, 5, 52, 54–63]*). As two examples we present, in Table 3, tabular data from the thesis of Riedel *[7]*, which summarizes the negative effects and disorders resulting from the administration of androgenic steroids to 191 male and 174 female athletes (mostly in the jumping events) and a list of damaging side effects reported by "unofficial collaborators" and by some former athletes and victims.

From the records of GDR doping it is also apparent that even "mild" side effects can affect the life of a young athlete. Hirsutism and so-called "steroid acne," notably on the body trunk, can be serious problems, physically and psychologically, for young women, particularly because the effects may be irreversible *[63]*. Take the case of a teenage world record holder who developed a minor gastrointestinal infection and was seen by the team physician, Höppner. When she undressed, he recognized the bizarre side effects of Oral-Turinabol. In his comprehensive Stasi report on the Games, he described his shock when he saw her ("Technik," Vol. II, pp. 193–213):

> The legs including the inner parts of the thighs are strongly hirsute and the pubic hair extends already to the navel. She is forced to shave. I then talked to her several times because according to the approved program she should have been given

[8] Additionally problematic is that the only publication in which medical doctors and researchers of the former GDR have reported on their doping experiments after the German unification is, in important aspects, a demonstrable fake *[64]*: They have selectively left out all data concerning administrations to minors and female athletes and details of damaging side effects.

anabolics only since last year. It became clear, however, that she had been given these supporting means by her coach already since she was 15 years old. Initially this was explained to her as vitamin tablets. When she, however, noticed the changes in her body she recognized that it was anabolic steroids. . . . Because of the circumstances she had already decided to stop participating in high performance sports . . .

Höppner then also learned that the sports club and the special school for sports talents (KJS) had already informed the athlete that she would lose all support and be expelled from the school if she did not continue her sprint career—a not unusual threat. He then took compassion, talked to an official of the GDR Sports Association, and arranged, as an exception, that she could both stop her androgenic sprint career and graduate from school. Androgenic treatment of other girls, however, continued. One year later, one of them noticed the same and other virilizing side effects, including a deepened voice, but was not allowed to stop the androgenic medication. She consequently decided to defect from the GDR to the West under dangerous circumstances. She was the first to report the truth about the systematic and forceful androgenization of young athletes in GDR sports and to bring, as evidence, her "vitamin pills," which were identified in a West German laboratory as Oral-Turinabol. Although her report, and a few others, were widely publicized, the sports authorities of the world, including the IOC, remained silent, a reaction that pleased the GDR officials.

The classified records of GDR sports medicine contain numerous cases of virilization, gynecological disorders, and other problems. Courageously, some of these women who have finished their careers, such as the swimmers Rica Reinisch, three-time gold medal winner in the 1980 Olympic Games, Christiane Knacke, once world record holder and winner of an Olympic bronze medal in 1980, and Karen König, 1985 world record holder in the 4 × 100-m freestyle relay, have presented their drug history on German and international television.

Höppner was especially concerned that some of the women experiencing deepening of their voice would sue the GDR sports authorities for damages. He repeatedly mentioned to the Stasi the case of a double gold medal winner who, because of her now-deepened voice, could not work in her profession as an interpreter. Androgen-induced amenorrhea and more severe changes such as ovarian cyst formation with recurrent inflammation were also frequent.

The doping physicians of the GDR systematically recorded the damaging effects of the administration of androgens to female athletes. In 1977 Höppner summarized these problems in a report to the Stasi ("Technik," Vol. II, pp. 143–5):

In numerous women the prevailing administration of anabolic hormones has resulted in irreversible damages, in particular in the swimming events, for example signs of virilization such as an increased growth of bodily hair (hirsutism), voice changes and disturbances in libido. The effect on the sexual drive was relatively strong in some women. This resulted in special problems, particularly in training camps where the "official" male partners of these women were not present.

The increase of libido was so severe and unbearable for some women that they requested cessation of the hormone treatment and release from participation in elite sports. In November 1990 Höppner publicly admitted this in the German weekly magazine *Stern*, when he described a case of a young woman "who had noticed as a side effect that she was sexually over-stimulated by these pills" and was finally allowed to stop medication.

When pregnancies occurred in women taking the androgenic hormones, the teratogenic risk of the drug was as much a problem as the loss of a top athlete from international competitions. In 1977 Höppner ("Technik," Vol. II, pp. 143–5) informed the Stasi: "As the administration of anabolic hormones in early pregnancy could result in malformations of the fetus, the simultaneous use of contraceptive drugs has been recommended. In cases of a pregnancy despite contraception an abortion was ordered in each case" (". . . wurde in jedem Fall eine Schwangerschaftsunterbrechung angeordnet").

However, simultaneous intake of a 17-alkylated androgenic steroid such as Oral-Turinabol or mestanolone with contraceptive steroid preparations increased the risk of liver dysfunctions and damages. Höppner on December 17, 1984, reported in another Stasi report:

. . . 10 elite athletes were referred for hospitalization and admitted for extensive diagnostic tests. The test results indicated that because of the increasing alcohol consumption by certain top athletes in combination with the intake of anabolic steroids, liver damages had appeared, including considerable increases in the size of the organ (hepatomegaly). In female athletes these damaging effects are additionally promoted by contraceptive pills. In two of the athletes tested, liver damages were diagnosed in such an advanced stage that one could not take the responsibility to let them continue with high performance sport.

Höppner also named two world-class athletes, a weightlifter and a hammer thrower. In August 1992, GDR hammer thrower Detlef Gerstenberg (personal best in 1984: 80.50 m, finalist in the 1980 Olympic Games and in the 1982 European Championships), age 35, was hospitalized because of extensive liver and obstructive bile duct damage; he died in 1993 from postoperative complications. In front of Gerstenberg's grave, another GDR top hammer thrower admitted publicly that he also had been suffering for some time from "liver problems."

The problem of life-threatening liver damage was noted by Höppner in April 1977 when he reported the case of a shot-putter to the Stasi:

Last week the athlete . . . was admitted as an emergency case to the hospital Erlabrunn because of an indication of hepatitis. The physicians at the hospital where he then was already in a hepatic coma concluded that the liver damage resulted from the intake of anabolic steroids. [He] had confirmed that he had been

taking anabolics since January and he reported the exact dosage. His wife, who works as a pharmacist, informed the district pharmacy officer, who classified the administration of anabolic steroids a crime. This case was brought as very important news to the attention of [a leading member of the ZK]. Meanwhile all medical records with the diagnostic tests were confiscated and [the athlete] was admitted to the neuropsychological hospital . . .

The athlete survived and was released after almost a year of hospitalization in a "closed hospital" behind a fence. He was forced to remain silent and only after the political changes, 17 years later in 1994, did he dare to talk for the first time about his case.

A particularly bizarre and relatively frequent damaging side effect of androgenic steroids or withdrawal therefrom was the development of breast enlargement (gynecomastia) in men, often even with enlarged nipples. In 12 weightlifters, this abnormal tissue growth was so massive and apparent that the tissue was removed by surgery, mostly performed at the cancer hospital in Berlin-Buch. One of these former athletes, Roland Schmidt, who had been given Oral-Turinabol when he was a minor and without information about such risks, has recently brought his case before the German courts.

The Stasi files also contain a number of reports on damages to minors, from cases of growth arrest and long-term amenorrhea in 15-year-old girls participating in canoeing and kayaking, to severe acne in several boys and girls. In 1991 one of the young kayakers, a relative of one of us (B.B.), described on television how she was hormone-doped as a 16-year-old girl and was forced to stop participating in elite sports because of severe gynecological disorders.

Pharmacological Manipulation in GDR Sports—Paradigm and Legacy

Although the documents of the secret doping system in the GDR have been published in great detail since 1991 and although the doping documents have been accepted as evidence in several court cases, the international sports officials and politicians have reacted essentially with silence. In track-and-field events alone, the use of androgenic hormones has been documented for some 230 athletes, including numerous medal winners and record holders *[10–12]*; see also Table 2). Similarly impressive numbers of doping protocols have been published for athletes in other events, from weightlifting to swimming. However, all the numerous drug-based records are still recognized, and no medals have been stripped.

This passive response of sports and governmental officials to these revelations also pertains to their relationships with the coaches, physicians, and functionaries known to be involved in hormonal doping, including the treatment of minors and the androgenization of young girls. Many of them are still—or again—working in the same or similar functions in Germany or elsewhere, and the researchers who laid the basis for the development and application of the illegal UM have not been penalized.[8] Descriptions of the post-1990 careers of several proven dopers and doping researchers of the former GDR have been presented elsewhere (e.g., *[11]*).

The legacy of the GDR doping system is the know-how and recognition of what can be achieved by UM and the application of scientific methods to avoid detection by controls. This knowledge has spread to other countries, as indicated by recent findings. For example, the popular GDR steroid mestanolone (STS 646, Table 1) was detected in 1993 at the World Athletic Championships in the urine of a medal winner from the US; he was banned and stripped of his medal. A former GDR long jumper now living in the US was found positive in spring 1995 for doping with Oral-Turinabol and was banned. Interestingly, a coach was implicated in two doping control affairs when his athletes tested positive for clenbuterol; he confessed publicly that he had obtained the nearly 500 tablets on the black market. While the athletes were banned, the coach was not penalized, as German drug laws do not allow prosecution for the distribution of prescription drugs without receipt of money.

In spring 1996, a Japanese champion was found positive for methyltestosterone and banned, a rare finding in Japan. The press then reported that he was training in a gym run by a former GDR coach. Furthermore, the repeated administrations of low-dose testosterone esters as originally proposed and applied by the SMD of the GDR *[7, 14]*, has been expanded to include an oral preparation of the undecanoate ester (Andriol), as apparent from the positive case of a German athlete who in 1993 admitted to using the drug and was banned for 2 years.

The system of pharmacological support for performance enhancement in the GDR may have been unique in certain aspects, such as the direct and all-pervasive governmental organization and control, particularly in the selection of talented children, the concentration of young talent in special schools (KJS), and their treatment with androgenic hormones without informed consent. But it is also fair to say that the GDR doping was in essence a paradigm and just an extreme variant of the underlying wish to manipulate other human individuals, the younger the better, for the profit of a group, a community, a nation, or a political system. In the GDR the primary motivation was apparently the state's international prestige and the demonstration of the superiority of Socialism in medal counts at international athletic events during the Cold War. This motivation since 1992 seems less pervasive but still may be dominant in certain countries successful in Olympic sports such as China, as indicated by a relatively high number of positive urine tests in recent athletes. But similarly strong forces may exist in the Western world, in which personal ego, money, and again nationalism are incentives for doping athletes and hormonal manipulations of minors. This is shown by the numerous cases of positive test results in the Western world and in interna-

tional sport—where only the extent and the pattern of organization differ essentially from the government-supported system so efficiently organized in the GDR.

Doping in "capitalistic" countries in general is organized in small clandestine and conspiratory circles, usually around a specific coach or sports doctor who also serves as a "guru" providing the justifying philosophy (see references below). The government does not play a direct role in these treatments, which in most countries represent violations of drug laws. In some countries, however, a supportive role of the government cannot be overlooked (for reviews on the pattern of doping drug distribution and organization in Western countries see, e.g., *[2, 52–59, 61, 63]*). In West Germany, the modes of distribution and administration of doping drugs became most obvious when they were investigated by prosecutors in legal proceedings, who uncovered a bizarre scenario of drug connections (for details see also *[11]*). The following examples illustrate some of the contemporary German scenario of elite sports:

1. The 1984 Olympic weightlifting champion, Karl-Heinz Radschinsky, was found guilty of large-scale trafficking of prescription drugs, notably, 220 000 tablets of anabolic steroids, and sentenced to prison with probation.
2. Jochen Spilker, lawyer and national coach for the 200-m and 400-m woman sprints was convicted in 1994 for use of Anavar (oxandrolone) for his athletes. This conviction, however, did not inhibit his career in the German sports system: He was later elected as a law officer to the Board of Directors of the State Sport Association of Thuringia.
3. In the same year, a court found that the national coach for the discus throw, Karlheinz Steinmetz, not only was involved in steroid doping but, in a doping control, had also submitted his clean urine under the name of one of his throwers who was taking steroids. Steinmetz was sentenced for perjury.
4. The German shot-put champion, Kalman Konya, was sentenced to prison, with probation, for perjury concerning his consumption of anabolic steroids. Another shot-putter was also convicted of perjury concerning steroid doping.
5. A prosecutor reported that another national coach had distributed androgenic steroids by mail to his doping clients, a charge that at the time of investigation was held invalid under the statutes of limitations.
6. A number of incorrect prescriptions with the signature of a sports medicine "guru" were used for many years by athletes to buy androgenic steroids, including an athlete who died from a toxic multidrug situation after developing painful steroid-induced muscle cramps (see Table 3).
7. In an academic report found at university of Heidelberg, the main body of the thesis (for a master's degree) was public, but a secret appendix describing the true "Materials and Methods" of that study and documenting the androgenic steroid doping of three shot-put athletes was stored as classified material in the professor's office.

Similar diversified drug scenarios have been reported from other countries, particularly in the US, where the frequency of illegal users among high school students is astonishingly high (for reviews see refs. *[2, 52–55]*). There even exist medical protocols proving the implementation of specific drug programs, such as the famous diary of the Californian physician Robert Kerr, which includes "many world class athletes, movie stars, politicians and other celebrities" *[53]*. Kerr, who in the court room claimed to have prescribed androgenic steroids to 20 medal winners of the 1984 Olympic Games in Los Angeles, treated female sprinters not only with androgenic steroids but also with human growth hormone and hCG (testimony of Diane Williams, 10.86-s sprinter and bronze medal winner at the 1983 World Championships *[52]*). The crucial difference now is that the world is aware of the protocols of the GDR doctors but does not know the protocols of the sports doctors of the Western countries such as Kerr.

Even the androgenization of young girls has been, and remains, a documented practice in the sport system of countries outside the GDR and the socialist system. Although doping tests of minors are relatively rare, the revelations that androgenic steroids had been administered to teenage athletes from several countries suggest that such treatments may take place without the knowledge of the subject. In fact, parents around the world should know what can happen to their talented daughters in schools and clubs and be critical and suspicious.

That the treatment of young women with androgenic steroids is not merely a matter of history and also includes endurance events has also become clear from the results of testing before and at the 1996 Olympic Games in Atlanta and recent long-distance running championships.

Thus, the broad and efficient organization of the hormonal doping program in the GDR should not lead to the conclusion that the ethical standards of the doctors, officials, and athletes in the GDR were lower than those in the West. Rather, analysis of numerous cases and comments by politicians and sports officials in the Western world rather show that many of them would have liked to use the same drugs and be similarly successful but just could not risk a scandal. In a historical analysis of the reunification of German sports medicine, John Hoberman *[65]* concluded: "We must recognize that the prospect of effecting such hormonal manipulation of athletes has fascinated a significant number of West German scientists as much as it did their East German colleagues, even if the former were constrained by political circumstances that precluded the large-scale experimentation with steroids that took place in East Germany." In June 1992 Harm

Beyer, a judge by profession and president of the German Swimming Association for 10 years, Secretary General of the European Swimming Association, and Member of the Board of Directors of the World Swimming Association, proposed the use of doping substances in swimming and, with respect to the GDR doping system, said in a published interview (*Junge Welt,* June 27, 1992), to Volker Kluge, sports writer and former member of the GDR and German National Olympic Committees: "My only reproach to the GDR is that they used all these possibilities but lied to us as they claimed the opposite." Obviously, the use of the possibilities to dope and manipulate young talents is a barely hidden wish of some sports officials around the world, and nothing can stop these forces but enhanced laws and the refusal of parents and athletes.

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