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Anabolic-androgenic Steroid Use in Saudi Arabia and its Impact on Sexual and Reproductive Health: A Systematic Review

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Abstract **Objectives:** Despite severe side effects, anabolic steroids are widely used to enhance appearance and performance, raising global health concerns as unsupervised use persists. We aimed to assess Anabolic-androgenic Steroid (AAS) prevalence and risk factors in Saudi Arabia. **Methods:** Systematic Medline/PubMed and Google Scholar searches were performed to identify articles of interest related to AAS use in Saudi Arabia from the database's inception until August 2024. Following the PRISMA checklist, the following were included in the search: “Anabolic Steroids and Misuse” and “Anabolic Steroids and Saudi Arabia”. Inclusion and exclusion criteria were used to screen literature and extract data. The Ottawa scale was used for quality evaluation and assessment of nonrandomized studies. We identified 15 articles that reported AAS misuse variables between 2016 and 2024. All studies had a cross-sectional design. We synthesized our results by identifying similarities, highlighting differences between studies and making recommendations based on our findings. **Results:** Our systematic review revealed that 5303 individuals in Saudi Arabia were reported to have misused AAS based on 15 review articles that have been evaluated in this systematic review. The AAS was predominantly sourced from the internet, friends and gym trainers and the Central Province in Saudi Arabia exhibited the highest instances of AAS misuse. Gym members had a higher prevalence of AAS use. The mean age across the studies ranged from 18 to 49 years. The majority of AAS misusers were males. Most users were either single or not in committed relationships. The prevalence of AAS misuse in Saudi Arabia ranged from 4.7%-32%. The preferred route of AAS administration was oral intake. The most commonly misused AAS types reported in our review were testosterone and deca-durabolin, frequently noted in several studies. Metandienone and oxandrolone have been popular oral AAS choices in multiple studies. The most frequent reports of adverse effects among AAS misusers were liver and kidney damage and psychiatric problems such as depression, breast hypertrophy and hypertension. Sexual dysfunction was reported in 10.6% and 13% of the patients, respectively. Infertility was reported to be 24.5% among users. **Conclusion:** Our review shows high AAS misuse among Saudi gym members, highlighting the need for public health education and preventive measures, especially for teens.

Key Words Abuse, anabolic steroids, bodybuilders, gym, misuse, Saudi Arabia

INTRODUCTION

Anabolic-androgenic Steroids (AAS) are synthetic derivatives of testosterone. They have two significant effects: Anabolic and androgenic. The anabolic effects reduce body fat, enhance bone density and skeletal muscle mass and stimulate erythropoiesis [1].

Androgenic effects are associated with the development of male sexual characteristics. They are used because they affect athletic performance and muscle development [1].

There are several side effects associated with high levels of AAS; among these, some are life-threatening, such as multiple organ failure, myocardial infarction [2],

atherosclerosis, cardiac hypertrophy, hepatic tumors, affected sperm count, testicular atrophy and prostate cancer [1]. Moreover, behavioral problems among athletes, such as sharing steroid injections, could be a severe risk factor for HIV infection [2].

Many bodybuilders use steroids to increase muscle growth, strength and efficiency with minimal effort over a shorter period rather than relying on physical exercise and a healthy diet alone [1]. A global systematic review published in 2014 reported that the use of AAS for recreational purposes was "a serious widespread public health problem" [3].

Data show that AAS abuse is more common in Brazil, Western countries and the Middle East and less prevalent in Asia and Africa [1]. A 2005 study conducted in the UK found that daily AAS use was common among gym users, with 70% reporting AAS use and 65.8% reporting still using it [1]. Among Brazilian bodybuilders, the frequency of AAS use was 20.6%; 98.1% were young men and 49.5% had been trained for more than four years [1]. In the UAE, a study published in 2008 reported an AAS use prevalence of 22% among gym users, which was significantly higher among weightlifters and bodybuilders. Another study in Kuwait reported a similar prevalence of 22.7% for AAS users [3]. In Saudi Arabia, a recent study in the western province of Riyadh reported 24.5% of AAS users among 400 male gym attendees from ten different fitness centers [3].

The level of awareness regarding AAS was also low among the study participants. However, AAS use is relatively common in the Middle East and data on their prevalence and risk factors are still lacking in Saudi Arabia [3]. Other factors associated with AAS use include lower levels of education, a history of illegal drug abuse and body insecurities [3]. This systematic review explored the status of AAS misuse in Saudi Arabia.

MATERIALS AND METHODS

A comprehensive exploration of AAS use in Saudi Arabia requires a meticulous methodology for gathering relevant and valuable insights using the PRISMA checklist.

Information Sources

The approach involved a systematic search strategy utilizing the extensive Medline/PubMed and Google Scholar databases. The primary objective of this study was to identify articles that specifically address AAS misuse, focusing on athletes and gym users in Saudi Arabia. The search criteria were selected strategically to ensure the inclusion of articles on the misuse of anabolic steroids in the Saudi Arabian population. Two key search phrases, "anabolic steroids and misuse" and "anabolic steroids and Saudi Arabia," were employed to cast a wide net and capture a spectrum of research studies, reviews and other relevant literature. This dual-pronged approach aimed to cover both the broader aspects of AAS misuse and the specific nuances within the context of Saudi Arabia. We searched for articles from the selected databases from inception until August 2024. Two senior academics (M.A.A and R.M) evaluated the review process. After executing the search (Figure 1) using the PRISMA flow diagram, 360 articles were identified.

The initial step involved screening the titles and abstracts of the retrieved articles to determine their relevance to the focus of the study. This screening process was pivotal in eliminating articles that did not align with the research objectives and streamlining the dataset to include only those that directly addressed AAS use and misuse in Saudi Arabia.

Eligibility Criteria

The subsequent step involved thoroughly examining the full texts of the selected articles. A rigorous evaluation of the selected articles was imperative to extract nuanced information, methodological details and substantive findings. This meticulous approach ensured the inclusion of studies that provided in-depth insights into the prevalence, patterns, motivations and consequences of AAS use in Saudi Arabia. Inclusion and exclusion criteria were applied judiciously to maintain the integrity and relevance of the dataset. Studies that did not specifically address AAS use or were not conducted in the context of Saudi Arabia, nonrelevant articles and duplicated articles were excluded from upholding the precision and relevance of the study (Figure 1).

Risk of Bias

The quality of literature was evaluated using the Newcastle-Ottawa Scale, which was used to evaluate and assess nonrandomized studies, which revealed a good quality scoring of selected articles: four stars in the selection domain, one star in the comparability domain and two stars in the outcome/exposure domain.

Synthesis of Results

Finally, 15 studies that met the inclusion criteria were selected for the review. These were reviewed and the results were categorized based on their characteristics.

We synthesized our results by identifying similarities, highlighting differences between studies and making recommendations based on our findings.

RESULT

Study Selection

The outcomes of the database search are systematically delineated in (Table 1) and visually represented in (Figure 1). The database search yielded 1588 papers; after removing duplicates and non-relevant articles, 360 publications were reviewed by titles/abstracts and 299 were eliminated. After that, 61 of these papers were reviewed in full text. Following a stringent eligibility assessment, 21 full-text articles emerged as fitting the criteria for inclusion in this study and 6 were excluded, yielding 15 included publications (Figure 1).

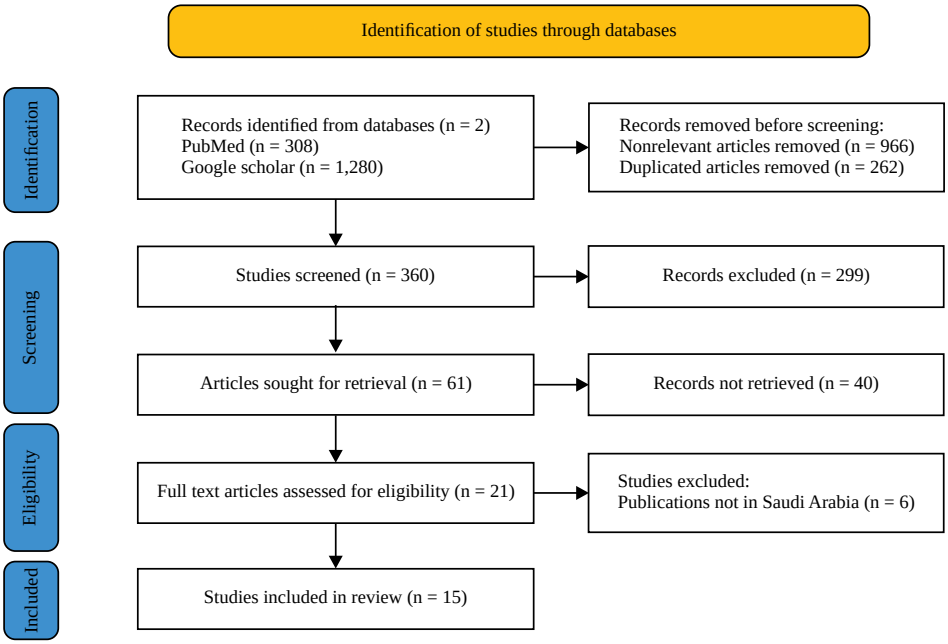

Figure 1: PRISMA flow diagram for search

Characteristics of Studies and Populations

The review included 15 papers and 5303 individuals were involved in the included studies (Table 1). All selected studies were cross-sectional studies [1-15].

Studies Reported AAS Misuse

This study reviewed data from several cross-sectional surveys on AAS administration among diverse populations in Saudi Arabia. The studies involved 5303 participants, with different samples from each study area, as listed in Table 1.

Prevalence of AAS Use

All the studies were cross-sectional and gathered data from gym-goers, indicating a high prevalence of AAS use in fitness environments (Table 1). The overall prevalence of AAS use ranged from 4.7 to 32% among the studies. The highest reported prevalence was 32%, observed by Alrehaili *et al.* [4] in Al Madina Al Munawara, whereas the lowest prevalence was 4.7%, noted by Ahmed *et al.* [9] in Jeddah. The prevalence among males was consistently higher than that among females, with studies by Abumunaser *et al.* [5] reporting a male prevalence of 68.8% (Table 2, 3).

Socio-demographic Characteristics

The age of the AAS users varied across the studies, with the mean age ranging from 18 to over 49 years. Males comprised the majority of AAS users, accounting for over 90% of the cases in most studies. Most users held at least a bachelor's degree, as observed in studies such as Albaker *et al.* [1] and Al-Harbi *et al.* [3], where over 60% of the participants had higher education (Table 2, 3).

Types of AAS Used and Routes of Administration

A wide range of AAS types has been reported, with oral and injectable forms being the most common. The most frequently used steroids included testosterone and its derivatives, such as testosterone enanthate and testosterone cypionate and deca-durabolin (nandrolone, decanoate), frequently noted in several studies. In many studies, Methandienone (Dianabol) and oxandrolone (Anavar) were popular oral AAS choices. The routes of administration varied, with some users opting for oral AAS (ranging from 27 to 56.1%) and others using injectable forms (between 22 and 64.7%). For instance, in a study by Abumunaser *et al.* [5], 64.7% of users preferred a combination of oral and injectable AAS (Table 3).

Adverse Effects

Common adverse effects reported by AAS users included liver complications, sexual dysfunction, cardiovascular disorders and kidney damage (Table 3). Alrehaili *et al.* [4] reported a wide range of side effects, including kidney damage (18.4%), liver complications (14%) and sexual dysfunction (13%). Psychological effects, such as increased aggression (6.1%) and depression, have also been reported. Long-term exposure to AAS has been linked to aggressive behaviors and reported ranges between 27 to 55% of AAS users reported by Bahri *et al.* [12] and Alharbi *et al.* [8].

Albaker *et al.* [1] reported sexual dysfunction in 10.6% of patients. Alharbi *et al.* (2019) found that 54.6 and 59.6% of the participants had knowledge and awareness of the adverse effects of AAS on sexual function and fertility, respectively [8].

Sources and Cost of AAS

The AAS was predominantly sourced from the internet, friends and gym trainers. For instance, Alrehaili *et al.* [4] reported that 30.7% of users obtained AAS online, whereas 30% relied on coaches. In contrast, Althobaiti *et al.* [6] highlighted that 43.3% of users cited gym trainers as their source of AAS, with 39.7% using online websites. At the same time, Al Bishi and Afify [11] reported AAS users use Online shopping 45% and Gym coach 22.5% as source for AAS (Table 3). As detailed in the table, the cost of using AAS varies significantly among users. Specifically, Almohammadi *et al.* [2] reported that most users (87.5%) incurred no costs, likely reflecting those who obtained AAS informally. The reported cost of AAS was as follows: 1.67% spent less than 500 SAR (approximately $133), 3.33% spent between 500-999 SAR (around $133-266), 4.17% spent between 1,000-2,999 SAR (about $266-798) and 3.33% spent over 3,000 SAR (more than $798) (Table 3).

Knowledge and Awareness

The knowledge level and awareness of AAS's adverse effects of AASs varied significantly among users (Table 3). Some studies, such as Abumunaser *et al.* [5], reported a high level of knowledge, with 72.5% of participants showing good awareness of risks. However, in other studies like Al Bishi and Afify [11], inadequate knowledge was prevalent, with over 80% of users displaying a limited understanding of AAS-related risks (Table 3). The AAS users in studies such as that by Althobaiti *et al.* [6] showed limited awareness of long-term risks. Albaker *et al.* [1] reported that AAS nonusers expressed more knowledge of infertility as a side effect (48.69%) than users (23.9%).

Factors Influenced Participants' Selection of AAS

Various factors influenced participants' selection of AAS (Table 3). The majority chose products based on price and cost, advice from a trainer, friends, online availability, or pharmacist recommendation. Most users (87.5%) incurred no costs [2], advice from coaches or trainers (5.9, 11.4, 14.17, 22.5, 30.0, 38.5, 38.8 and 43.3%), respectively [2,4-6,8,9,11,13], or from friends (13.33, 17.6, 27.9, 35.7 and 50.7%), respectively [4,5,8,13]. One study reported that trainers and friends are major sources (75.20%) for obtaining AAS [1]. Larger proportions cited online availability of AAS (19.17, 29.4, 30.7, 39.7 and 45%), respectively [2,4,5,10,11]. And smaller proportions cited recommendations from pharmacists (6.3 and 17%) [4,10].

For reasons of AAS use, most of the obtained AAS were for muscle or bodybuilding (47.1%) [5], aerobics (45.5%) [3], or weightlifting (45.5%) [3]. Also, users reported the use of AAS for participating in sports contests (29.4%) [5] and walking-related exercise (33.7%) running-related exercise (15.5%), swimming-related exercise (21%) and soccer-related exercise (29.8%) [10].

Table 1: Study characteristics of studies reported anabolic-androgenic steroid users (n = 5303)

Author/Year/Reference	Study design	Sample size (n)	Province	City	Data collection location
Alrehaili *et al.* [4]	Cross-sectional	121	Western	Al Madina Al Munawara	Gyms
Abumunaser *et al.* [5]	Cross-sectional	269	Western	Jeddah	Gyms
Althobaiti *et al.* [6]	Cross-sectional	520	Western	Makkah	Gyms
Almohammadi *et al.* [2]	Cross-sectional	120	Western	Taif, Jeddah and Makkah	Gyms
Albaker *et al.* [1]	Cross-sectional	541	Eastern	Al-Hufof, Ad-Dammam, Al-Khobar, Al-Qatif, Al-Jubail and Saihat	Gyms
Al-Harbi *et al.* [3]	Cross-sectional	482	Central	Riyadh	Gyms
Almaiman *et al.* [7]	Cross-sectional	16	Central	Qassim, Unaizah	Gyms
Alharbi *et al.* [8]	Cross-sectional	482	Central	Riyadh	Gyms
Ahmed *et al.* [9]	Cross-sectional	300	Western	Jeddah	Gyms
Althobiti *et al.* [10]	Cross-sectional	474	Western, Central, Eastern, Southern, Northern	NR	Gyms
Al Bishi and Afify [11]	Cross-sectional	363	Central	Riyadh	Gyms
Bahri *et al.* [12]	Cross-sectional	465	Southern	Sabya, Samtah, Abu Arish, Jazan, Baish and Ahad AL-Masarailah	Gyms
Al Nozha and Elshatarat [13]	Cross-sectional	316	Western	Madinah	Gyms
Alshammari *et al.* [14]	Cross-sectional	457	Central	Riyadh	Gyms
Jabari *et al.* [15]	Cross-sectional	600	Central	Riyadh	Gyms

NR: Not reported, AAS: Anabolic-androgenic steroid

Table 2: Socio-demographic characteristics of studies reported anabolic-androgenic steroid users (n = 5303)

Author/Year/Reference	Sample size (n)	Age	Gender n (%)	Marital status n (%)	Education n (%)
Alrehaili *et al.* [4]	121	18- over 40	Males 121 (100)	Single: 96 (79.3) Married: 23 (19.0) Divorced: 2 (1.7)	School: 39 (32.2) Bachelor: 73 (60.3) Postgraduate: 9 (7.4)
Abumunaser *et al.* [5]	269	Mean±SD: 29.5±12.9	Male 185 (68.8) Female: 84 (31.2)	Single: 136 (50.6) Married: 133 (49.4)	Secondary/below: 52 (19.3) University graduate: 185 (68.8) Post-graduate: 32 (11.9)
Althobaiti *et al.* [6]	520	Mean±SD: 27.49 (9.09)	Male 226 (43.46) Female 294 (56.54)	NR	NR
Almohammadi *et al.* [2]	120	Mean±SD: 27.78±6.82	Male 120 (100)	NR	High school: 39 (32.5) Diploma: 22 (18.33) Bachelor: 56 (46.67) Postgraduate: 3 (2.5)
Albaker *et al.* [1]	541	Range: 18–35	Male 541 (100)	Single: 330 (61) Married: 211 (39)	Intermediate or Lower: 23 (4.3) High School: 155 (28.7) Higher Education: 363 (67.1)
Al-Harbi *et al.* [3]	482	Mean±SD: 27.2±6.9	Male 482 (100)	Single: 294 (61) Married: 182 (37.8) Divorced: 6 (1.2)	Intermediate or lower: 23 (4.7) Secondary: 136 (28.2) Degree or diploma: 302 (62.7) Higher education: (Master or PhD): 21 (4.4)
Almaiman, 2019 [7]	16	Average: 34	Male 16 (100)	Single: 2 (12.5) Married: 9 (56.25) Married: with children 5 (31.25)	Diploma: 2 (12.5) Bachelor: 14 (87.5)
Alharbi *et al.* [8]	482	Mean±SD: 27.2±6.9	Male 482 (100)	Single: 294 (61) Married: 182 (37.8) Divorced: 6 (1.2)	Literate: 6 (1.2) Intermediate: 11 (2.3) Secondary: 136 (28.2) Bachelor or Diploma: 302 (62.7) Higher education(Master or PhD): 21 (4.4)
Ahmed *et al.* [9]	300	Mean±SD: 30.66±9.2	Male:121(40.3) Female: 179(59.7)	Single: 152 (50.7) Married: 148 (49.3)	Student: 113 (39.6)
Althobiti *et al.* [10]	474	Mean±SD: 28.6 + 6.2	Male: 474(100)	Single: (53.6) Married: (46.4)	High school or lower: (27.6)
Al Bishi and Afify [11]	363	Range: 18–49	Male: 363(100)	Single: 203 (55.9) Married: 139 (38.2) Divorced: 18 (4.9) Widow: 3 (0.8)	Intermediate or lower: 17 Secondary: 233 Degree or Diploma: 93 Higher education(master or PhD): 20
Bahri *et al.* [12]	465	15- over 34	Male: 465(100)	NR	Basic education: 205 (44.1) Higher education: 260 (55.9)
Al Nozha and Elshatarat [13]	316	18-38	Male:316(100)	NR	NR
Alshammari *et al.* [14]	457	Range: 18-40	NR	NR	Intermediate: 7 (1.5) High school: 126 (27.6) Bachelor: 293 (64.1) Masters: 25 (5.5) Above: 6 (1.3)
Jabari *et al.* [15]	600	Range: 15–49	Male: 600(100)	NR	NR

NR: Not reported

Table 3: Anabolic-androgenic steroid users characteristics (n = 5303)

Author/ Year / Reference	Sample size (n)	Type of sport/training Users Source of AAS n (%)	Use of AAS n (%)	The overall prevalence of AAS use (%)	Types of AAS used n (%)	Route n (%)	Cost n (%)	Adverse events n (%)	Overall knowledge and Awareness of AEs n (%)
Alrehaili *et al.* [4]	121	NR Internet (30.7) Coaches (30) Friends (27.9) Pharmacies (6.3) Hospitals (5)	User: 39 (32) Non-user: 82 (68)	32%	NR	NR	NR	Kidney damage (18.4) Liver complications (14) Sexual dysfunction (13) Cardiovascular disorders (8.4) Prostate enlargement (7.9) Voice deepening (7.5) Increased body hair (7.3) Premature baldness (6.9) Increased aggression (6.1) Gynecomastia (5.9) Acne (1.5) Others (3.1)	Mean knowledge score: 4.14±2.47 Information about AAS: social media (23.8) Physician consultations (20.6) Friends (20.6) Internet (12.1) Books (10.3) Coaches (10.3) Commercial advertisements (1.9) Pharmacists' consultations (0.5)
Abumunaser *et al.* [5]	269	Muscle building (47.1) Participating in contests (29.4) Other reasons (23.5) Internet: 5 (29.4) Friends: 3 (17.6) Coach: 1 (5.9) Others: 8 (47.1)	Current user: 17 (6.3) Non-user: 31 (12.3)	6.3%	Oral: Anavar: 8 (47.1) Proviron: 8 (47.1) Anadrol: 7 (41.2) Winstrol: 7 (41.2) Dianabol: 4 (23.5) Turinabol: 3 (17.6) Injectable: Deca-durabolin: 9 (52.9) Sustanon: 7 (41.2) Primobolan: 6 (35.3) Depot: 6 (35.3) Others: 10 (58.8)	Oral: 5 (29.4) Injectable: 1 (5.9) Both of them: 11 (64.7)	NR	NR	Good knowledge level 195(72.5%) Poor knowledge level 74 (27.5%)
Althobaiti *et al.* [6]	520	NR	Current user 39 (7.50) Previous use 68 (13.08) Non-user413 (79.42)	NR	NR	NR	NR	Muscle or joint pain	NR

Table 3: Continued

Almohammadi *et al.* [2]	120	Resistance-trained (strength training or weight training) Internet (19.17) Coach (14.17) Friends (13.33)	Current 24 (20) Non-user 96 (80)	20%	Decadurabolin: 5 (4.17) Dianabol: 6 (5) Testeronecypionate: 2 (1.67) Decadurabolin+testeronecypionate: 1 (0.83) Used all these products: 1 (0.83)	No: 24 (20) Injection: 3 (2.50) Oral: 80 (66.67) Injection+oral: 13 (10.83)	No cost: 105 (87.5)* <500 (<$133.14): 2 (1.67)* 500-999 ($133.14-$266.02): 4 (3.33)* 1000-2999 ($266.29-$798.60): 5 (4.17)* >3000 (>$798.87): 4 (3.33)*	Weakness: 5 (4.17) Headache: 4 (3.33) Increase hair: 2 (1.67) No reported AEs: 109 (90.83)	Not at all: 24 (20) Low knowledge: 53 (44.17) High knowledge: 43 (35.83)
Albaker *et al.* [1]	541	NR Trainers and friends (75.20)	Current user: 113 (20.9) Non-user: 428 (79.1)	(21.3)	Anavar (61.9%) Dianabol (46%) DecaDurabolin (45.1%)	NR	NR	Acne: 28(32.7) Hair loss: 12(14.2) Breast Enlargement: 8(9.7) Psychiatric Problems: 41(47) Sexual Dysfunction: 9(10.6) Chest pain: 2(2.7) No reported AEs: 26 (23)	Users knowledge: Acne 38(33.6) Heart problem 19 (16.8) Hair loss 39(34.5) Increased blood pressure 43(38.1) Infertility 27(23.9) Liver Problems 27(25.7) No harm 7(6.2) No knowledge 24(21.2) Nonusers knowledge: Acne 86(20.1) Heart problem 100(23.4) Hair loss 86(20.1) Increased blood pressure 106 (24.8) Infertility 208(48.6) Liver Problems 113(31.1) No harm (0) No knowledge 160(37.4)
Al-Harbi *et al.* [3]	482	Aerobics: 61(45.5) Weightlifting: 61(45.5) Other: 12(9) NR	Current user: 141(29.3) Non-user: 341(70.7)	29.3%	NR	NR	NR	NR	NR
Almaiman *et al.* [7]	16	Bodybuilding and energy NR	Current user:12 Non-user:4	NR	Testosterone enathate Dianabol Decadurabolin Tamoxifen citrate Clomiphene citrate	IV Oral	NR	NR	Not trust 2(16.6) Doubt 2(16.7) as low knowledge Trust 8(66.7) as high knowledge

Table 3: Continued

Alharbi *et al.* [8]	482	Bodybuilding Aerobics Weight-lifting Coaches: (38.8) Friends: (35.7)	Current user: (29.3) Non-user: (70.7)	29.3%	NR	NR	NR	NR	Lack of knowledge of AE Acne (66.5%), behavioral changes (55%), blood pressure changes (59.9%), cancers (71.8%), cholesterol level (66.8%), stunt growth (56.2%), breast development (51.1%), heart diseases (59.2%), liver diseases (55.2%), affect fertility (59.6%) Affect sexual function (54.6%)
Ahmed *et al.* [9]	300	Previous personal experiences (37.2) Coach's advice (11.4)	Current user: 14(4.7) Non-user: 286(95.3)	4.7%	NR	NR	NR	NR	Low knowledge: 133(44.3) Moderate knowledge: 88(29.3) High knowledge: 79(26.3)
Althobiti *et al.* [10]	474	Walking-related exercise (33.7) Running-related exercise (15.5) Swimming-related exercise (21.0) Soccer-related exercise (29.8) Gym prints 41.5% Gym trainer 43.3% Online sites 39.7% Local drug stores 17%	Current user:474 (9.8) Non-user: 4386 (90.2)	9.8%	Testosterone enanthate: (31) Dianabol: (30.8) Decadurablin: (28.6) Sustanon: (20) Winstrol: (16.7) Other types: (37.3) Unknown: (24.8)	Oral: (43.6) Injection: (22) Both: (34.4)	NR	Depression: (52.5) Muscle wasting: (59.3) Fitness decrease: (54.4) Infertility: (24.5)	Users knowledge Acne (48.5) Hair loss (38.4) Infertility (39.5) Cardiovascular disease risk(33.5) Non-users knowledge Acne (37.9) Hair loss(31.8) Infertility (59.2) Cardiovascular disease risk (46.3)
Al Bishi and Afify [11]	363	Bodybuilding Fitness Wight loss Online shopping 45% Gym coach 22.5%	Current user:89(24.5) Non-user:274(75.5)	24.5%	Testosterone: (34.8) Metandrostenolone: (14.6) Stanozolol: (11.2) Nandrolone: (10.1) Boldenone: (10.1) Oxandrolone:(7.8). Dorsatanolone(4.5) 19-Norandrostendione: (3.3) Norandrostendlone: (1.1)Trenbolone: (1.1) Metonolone: (1.1)	Oral: (43.9) Injection: (56.1)	NR	NR	Users inadequate knowledge (82) Appropriate knowledge (2.2) Non-users inadequate knowledge (83) Appropriate knowledge (7.6)

Table 3: Continued

Bahri *et al.* [12]	465	Body building Fitness NR	Current user:144 Non-user:321	31%	Decadurabolin: 83(57.6) Testosterone:75(52) Anvar:38(26.3) Testosterone enanthate:54(37.5) Winstrol:25(17.3) Primobolan:24(16.6)	Oral: (27) Injection: (38) Both: (35)	NR	Depression and aggressive behavior: (27) Hypertension: (36)	NR
Al Nozha and Elshatarat [13]	316	NR Gym trainers 38.5% Friends 50.7%	Current user:70 Non-user:246	NR	Testosterone 36 (11.4)	NR	NR	NR	Believed that AAS cause harm (66.8) Had knowledge of AEs (78.8) Knowledge that testosterone hormone in males may lead to: Disruption of puberty (52.8%) Breast tissue development (51.3%) Male pattern baldness (50.9%)
Alshammari *et al.* [14]	457	NR	NR	NR	NR	Oral: (51.4)	NR	Hypertension Diabetes Weight gain Vision problems Psychiatric Prostatic problems Hyperplasia testicular breast hypotrophy enlargement Increased RBC	Did not know (average 53.14) Had knowledge (average 29.32)
Jabari *et al.* [15]	600	Bodybuilding NR	Current user: (30.5) Non-user: (69.5)	30.5%	NR	NR	NR	NR	Users knowledge: Complete knowledge (0) Reproductive disorder (44.8) Psychiatric problem (55.2) Non-users knowledge: (40%) (age group of 20–24 years) Complete knowledge (40) Liver damage (23.5) Hormonal disorder (27.3)

*Financial cost of anabolic hormones and dietary supplements, NR; not reported, AEs: Adverse events

DISCUSSION

This review explored AAS misuse in Saudi Arabia. The sample sizes ranged from 16 to 600 participants, with a total of 5303 participants that have been reported in Saudi Arabia misusing AAS. The highest concentration of AAS misuse was in the Western and Central provinces, especially in cities such as Riyadh, Jeddah and Makkah. The consistency of cross-sectional studies indicates the need for longitudinal research to understand long-term impacts and trends. Additionally, most studies lack diversity in data collection environments as they are confined to gyms, potentially missing other AAS user populations. These results highlight both the scope of AAS use in fitness settings and gaps in research methods that should be addressed in future studies (Table 1). In the US alone, at least 2 million people use or have used AASs and epidemiological statistics imply that there are millions of more AAS users worldwide, such as from the UK to Sweden, other European countries, Canada, Australia and Brazil [16]. The data in Table 2 provide the sociodemographic profile of AAS users in Saudi Arabia based on various studies. Key findings indicate that AAS use is prevalent primarily among young males, with most participants falling within the age range of 18-49 years old. A significant portion of the sample population was single, although there were variations across studies, with some samples showing almost equal proportions of single and married individuals. Education levels among AAS users also varied, although a substantial number hold bachelor's degrees or higher. For instance, in the study by Abumunaser *et al.* [5], 68.8% of the participants were university graduates, while similar educational trends were evident in other studies. AAS usage is no longer limited to athletes, bodybuilders, or weightlifters. Still, it is now extending to the general public, including young people, most likely due to the extremely competitive character of high school and college varsity sports [17-20].

The gender distribution across studies demonstrates a male-dominated sample, with a few studies including female participants, as reported by Ahmed *et al.* [9] and Abumunaser *et al.* [5], where females represented 59.7 and 31.2% of the participants, respectively. The limited female representation in other studies highlights a potential area for further research, as data on female AAS users remain sparse. Even if AAS use increases in women, the prevalence will remain far higher in male populations [21].

Overall, the demographic data point toward a largely educated, young male population as the primary users of AAS in Saudi Arabia (Table 2). This demographic insight is critical for developing targeted educational and preventive programs that focus on the high-risk groups identified in this research. In addition, exploring AAS use across diverse social groups, including women and older age categories, would provide a more comprehensive understanding of the dynamics of AAS use in Saudi Arabia.

Demographic characteristics such as age, gender, health status and ethnicity all significantly impact how AAS is tolerated or controlled. However, demographic studies are limited; most studies focus on young male athletes, leaving women, older persons and other populations unexplored.The AAS are increasingly used by athletes. According to many studies, short-term supplementation with anabolic steroids has a wide effect in Saudi Arabia, specifically on gems (Table 1). In 2013, the World Anti-Doping Agency (WADA), which works for the International Olympic Committee (IOC), published a list of prohibited substances both in and out of competition. It has about more than 60 AAS agents, both synthetic and natural [22]. The most commonly used AAS in Saudi Arabia are testosterone and its derivatives, such as testosterone enanthate, testosterone cypionate and deca-durabolin (Nandrolone, Decanoate), which are frequently noted in several studies. Metandienone (dianabol) and oxandrolone (anavar) have been popular oral AAS choices in multiple studies (Table 3). This is listed among the prohibited substances based on the latest updated WADA report.

The Economic costs of AAS vary, as reported in the last two decades, with annual per capita expenses for AASs ranging from $90 to 6780 [21]. In our review, the average cost was relatively low, ranging from $133 to 798 (Table 3]. These costs highlight a diverse spending range, indicating that while some users obtain AAS at low or no cost, others incur considerable expenses, potentially influenced by easy availability, access and sourcing channels .

Impact of AAS on Sexual and Reproductive Health

Testosterone plays a crucial role in promoting muscle strength and growth. AAS has been used as a performance-enhancing drug to improve physical performance in competitive sports [23].

The use of AAS has significant, long-lasting consequences on both the reproductive health of athletes and recreational users, as well as on fertility [24]. A recent systematic review and meta-analysis revealed that after discontinuing AAS use, most users showed signs of hypogonadism, with consistently low gonadotropin and testosterone levels [24].

It has been reported in a recent review that AAS-induced infertility and sexual dysfunction [25]. In men, AAS can cause a decreased sperm count, azoospermia, testicular atrophy, infertility, gynecomastia, baldness and prostate and breast cancers. In women, it can cause voice changes, increased facial hair, male pattern baldness, amenorrhea and clitoral enlargement [16,26]. A recent meta-analysis of the consequences of AAS misuse on sexual parameters indicated that up to 44% of the patients reported lower testicular volume, 31% had decreased libido and 19% had erectile dysfunction [27]. Oligozoospermia, severe oligospermia and azoospermia are common conditions among AAS users [25].

In our review, sexual dysfunction was reported in 10.6 and 13% of patients, respectively. Infertility was reported to be 24.5% among users (Table 3). According to a recent systematic review and meta-analysis [24], most AAS users experience hypogonadism, which is characterized by chronically low gonadotropin and testosterone levels that last for several weeks to months after AAS discontinuation.

Withdrawing anabolic steroids is the first-line treatment for oligospermia or azoospermia caused by their misuse [28]. A previous meta-analysis documented that gonadotropin levels recovered 13-24 weeks after AAS withdrawal, whereas serum endogenous T levels remained low at 16 weeks [24]. Data from a retrospective matched cohort study primarily examined the link between AAS use and male fertility outcomes [29] and showed that AAS use negatively affects male fertility rates. Specifically, the research highlights that long-term AAS users experienced a 26% lower fertility rate compared to non-users. However, after a period of cessation (post-doping sanction), some recovery in fertility rates was observed, suggesting that the adverse effects on fertility may be partially reversed by discontinuing AAS. This finding underscores the potential reproductive risks associated with AAS and the importance of awareness and interventions for individuals using these substances. Potential treatment and recovery strategies for AAS-induced fertility and sexual dysfunction have been reported, emphasizing that while some individuals may recover after discontinuing AAS, others may face long-term sexual and reproductive issues [27].

Medically, AAS, including testosterone and its derivatives, is commonly used to treat male hypogonadism, but medical guidelines strictly control dosages. Admissibility is evaluated by clinical need and monitored through blood tests (e.g., hematocrit, liver enzymes, PSA levels) to avoid complications such as polycythemia or cardiovascular strain.

Recommendation and Future Direction

Our analysis showed that the use of AAS is common among gym-goers in Saudi Arabia. Healthcare professionals should be aware of individuals who may be at risk of abusing AAS because of the serious negative effects that can result from their overuse [30]. In fact, new data from a large cohort study in the physically active Danish population have shown that all-cause mortality is about two times greater (hazard ratio of 2.81) in AAS abusers than in controls [31].

Ignoring the harmful consequences may lead to adverse outcomes. Public health education and awareness efforts are essential. Educating people about adverse events and the sequence of AAS misuse is a crucial step in improving awareness, either directly from gyms or via social media. It is critical to identify anabolic steroid abuse as soon as possible and refer individuals to suitable treatments [30]. We urge healthcare policymakers to create programs and preventive measures to prevent AAS abuse, specifically among teenagers. We emphasize the importance of preventive measures, such as public health education, proper doping screening and legislative actions, to mitigate AAS misuse.

There is no doubt that AAS have therapeutic benefits for individuals with HIV, liver illness, renal failure, some cancers, symptomatic hypogonadism and burns. However, currently, the major challenge with these agents is AAS misuse.

Administering AAS lowers the hypothalamic-pituitary testicular axis, especially when administered in large doses and over extended periods of time and reduces testosterone production. Men who stop using AAS for an extended length of time are at risk of developing hypogonadism; while this is usually transient and resolves on its own, it might last for a long time and necessitate medical intervention. People who are dependent on AAS may be experiencing withdrawal symptoms due to hypogonadism. These negative experiences have been found as a determining factor in users' decisions to continue or resume AAS use. The limited evidence presented here suggests that positive outcomes are regularly reported in the treatment of males suffering from neuroendocrine problems following AAS [32]. Despite restrictions limiting the empirical prescription and dispensing of these medicines, many people, particularly athletes, continue to misuse them. Several approaches to reduce the frequency of anabolic steroid abuse have been proposed, including [33]:

- Increased awareness of anabolic steroids among vulnerable patient groups, healthcare professionals, educators, school administrators and nurses, personal trainers, non-governmental organizations, social workers, behavioral health workers and law enforcement
- Increased and stricter preventive measures in gyms and athletic training facilities
- Legislative reforms should be undertaken to enable for easier steroid usage testing and federal laws should be made to allow for the inspection of suspect shipped items

CONCLUSION

According to our systemic review, the misuse of AAS is extremely widespread among Saudi gyms. Misuse of anabolic steroids can have serious and long-term consequences. Healthcare practitioners should be aware of the risk of AAS abuse in patients. Educating people about adverse outcomes and the sequence of AAS use is critical in improving awareness. Therefore, it is critical to identify anabolic steroid abuse as soon as possible and refer individuals to suitable treatment. Healthcare policymakers should develop programs and preventive measures to reduce AAS abuse, particularly among teenagers.

Limitations

This study has several limitations. First, The challenges of the cross-sectional approach are recognized as the inability to

discriminate between a presumed cause and its potential impact. The prevalence of adverse events is usually calculated using remote or in-person questionnaires, which may result in bias if participants overestimate their sexual performance or fail to recognize specific sexual and fertility difficulties. Furthermore, prevalence estimates for sexual dysfunction and infertility may be incorrect when solely based on questionnaires rather than clinical confirmation. We used an adapted version of the Newcastle-Ottawa Scale as a quality appraisal instrument for observational studies, which provided an easy and convenient tool for the quality assessment of nonrandomized studies to be used in a systematic review [34]. To our knowledge, this is the first systemic review exploring AAS misuse in Saudi Arabia.

Medical professionals should be fully aware that these medications are frequently abused and that close monitoring is required. Proper therapeutic usage and dealing with unlawful abuse of AAS necessitate an interprofessional team effort.

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