The Prevalence of Anabolic-Androgenic Steroid Misuse in Iranian Athletes: A Systematic Review and Meta-Analysis

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Abstract

Background: Due to widespread abuse of anabolic-androgenic steroids among professional athletes and amateur sportsmen and their health-related problems, determining the prevalence and the pattern of anabolic-androgenic steroid misuse at the national level seems to be vital for designing efficient preventive and educational measures.

Methods: This systematic review and meta-analysis was conducted via comprehensive searches of the electronic databases including PubMed, MedLine, Scopus, Google Scholar and National Persian Databases including SID, Magiran, IranDoc (between 1980 and Dec 2019 in English and Persian languages) and also from citations in the selected papers. Overall, 39 articles met the criteria and were included in qualitative and quantitative synthesis.

Results: The overall prevalence rate of anabolic-androgenic steroid misuse in the Iranian athletic population was 36.2% (95% confidence interval (CI), 29-43) with significant heterogeneity between studies (I^2=99.0%, P<0.001). Prevalence rate of anabolic-androgenic steroid misuse among elite, male and younger athletes was higher (P<0.05). Moreover, prevalence rate of anabolic-androgenic steroid misuse among body-building athletes (36.3%) was higher compared to other athletes (30.9%), (P<0.001).

Conclusion: Due to the higher prevalence of anabolic-androgenic steroids misuse in Iran compared to global statistics and the potential for serious adverse effects, preventive strategies and policies should be regarded as a real concern for public health.

Keywords: Anabolic-androgenic steroid; Athletes; Public health; Doping; Prevalence

Introduction

Anabolic-androgenic steroids (AAS) refer to testosterone and a set of its synthetic derivatives, administered in the treatment of some health problems. However, AAS are mainly used as a doping agent for aesthetic purposes to gain muscle and lose body fat, improving muscle strength, increasing athletic performance, as well as for enhancing psychological well-being (1).

AAS misuse is associated with debilitating complications and increased mortality (2, 3). Unfortunately, many athletes have not proper

knowledge, attitude and behavior regarding banned drugs and their side effects (4, 5).

To minimize this major public health problem, different preventive policies and interventions have been recommended to motivate behavior change. These measures attempt to reduce the AAS misuse through targeting several behavioral risks and protective factors, such as focusing on ethics and values, harms, healthy alternatives, body image, peer expectations, drug refusal role play and social norms. They are provided in the form of educational or media programs, and expert consultations (6, 7). A study conducted in Iran showed the beneficial effects of educational programs using the theory of planned behavior in prevention and reduction of AAS misuse among young male gym users (8). Due to the widespread misuse of AAS among different athletic populations and their major health-related problems especially the young population, determining the prevalence and the pattern of misuse at the national level seems to be vital for designing of efficient preventive and educational measures (9).

Despite the sporadic studies evaluating the prevalence of AAS misuse, no quantitative meta-analysis has been conducted on this domain in Iran. A meta-analysis in this domain is of great value because it can also be used to identify moderators of the prevalence rate. Therefore, we aimed to conduct a meta-analysis on the prevalence of AAS in Iranian athletes and compare prevalence rates across different genders, sport disciplines, professional levels and regions.

Methods

We accomplished a systematic review and meta-analysis according to the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines (10). The study was registered in PROSPERO registry (code: 165323).

Search strategy and inclusion criteria

Relevant articles were identified through systematic and comprehensive searches of the electronic databases including PubMed, Medline, Scopus, Google Scholar and National Persian Databases of SID, Magiran, Irandoc (between 1980 and Dec 2019 in English and Persian language) and also from citations in the selected papers. The following keywords: "Anabolic Agents"[Mesh] OR "Anabolic steroid" OR "steroid" OR "doping" were used in combination with "preval*" OR "epidem*," OR "incidence" AND Iran AND English [Language] for the search.

Other relevant studies (including theses and conference proceedings) were identified by scanning through reference lists of selected articles and reviews.

Inclusion criteria were (a) studies including exact data on the prevalence rate of AAS misuse; (b) participants were athletes.

Data extraction

Two authors (F.H. & M.S.) separately extracted data applying a standardized data extraction form. Any controversies between two reviewers were discussed and more detailed evaluation of the studies were conducted until agreement was achieved.

Assessment of methodological quality

Risk of bias, quality and methodology of the anabolic-androgenic steroid misuse prevalence studies were assessed, applying the Joanna Briggs Institute (JBI) critical appraisal checklist (11) (Table 1).

Level of evidence and The Strength-of-Recommendation Taxonomy (SORT)

Studies were assessed for their level of evidence and consistency according to the Strength of Recommendations Taxonomy (SORT) by each reviewer (12). Based on SORT, I to III levels of evidence classification, and A to C classification for the recommendations will be provided.

Table 1: Critical appraisal tool for quality assessment of the study (11)

Q1. Was the sample frame appropriate to address the target population?

Q2. Were study participants sampled in an appropriate way?

Q3. Was the sample size adequate?

Q4. Were the study subjects and the setting described in detail?

Q5. Was the data analysis conducted with sufficient coverage of the identified sample?

Q6. Were valid methods used for the identification of the condition?

Q7. Was the condition measured in a standard, reliable way for all participants?

Q8. Was there appropriate statistical analysis?

Q9. Was the response rate adequate, and if not, was the low response rate managed appropriately?
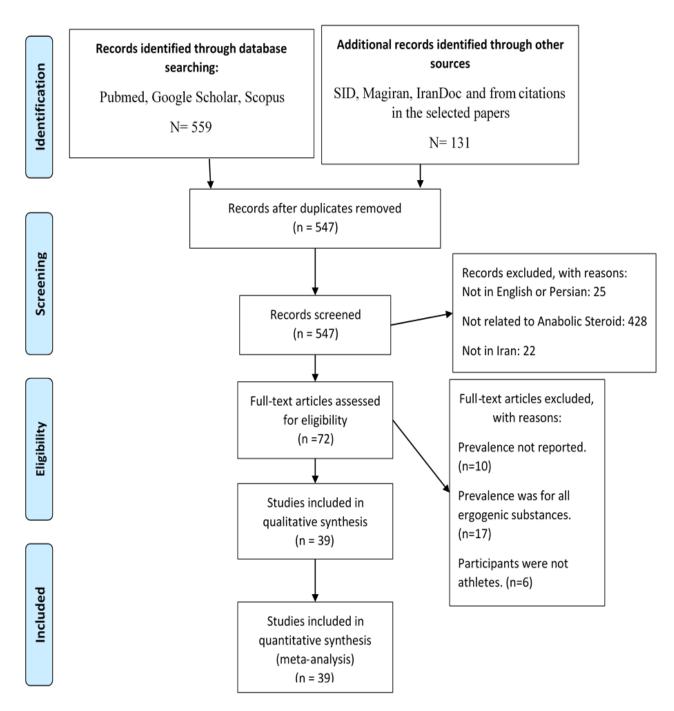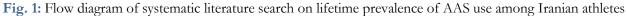

Statistical analysis

A meta-analysis was conducted to estimate the lifetime prevalence rate of AAS consumption in Iran. We used a random-effects model (Dersimonian Liard method) was applied in the calculation of prevalence rates and corresponding 95% confidence interval (CI)s (13).

Evaluation of the heterogeneity was done by calculating the Q-statistic and the I-squared tests. Subgroup analyses was conducted for all moderator variables including age range, gender, type of sport disciplines, professional level and province. Egger's test was applied to evaluate the publication bias of studies by Stata software. Egger's test results with p values less than 0.05 indicated publication bias in this study. If publication bias exists, the evaluation will be completed using trim and fill. The meta-analysis was conducted using Stata (release 12.0, College Station, Texas, USA). *P*-values <0.05 were considered as significant.

Results

A systematic search was conducted for published studies. Overall, 39 articles were identified that studied prevalence of AAS misuse among 13853 athletes (Fig. 1).

Fig. 1: Flow diagram of systematic literature search on lifetime prevalence of AAS use among Iranian athletes

Description of studies

The study characteristics are presented in Table 2. Table 3 presents the prevalence rate of AAS misuse in overall athletic population. The prevalence rate of AAS misuse in overall athletic population was reported 36.2% (95% CI, 29-43) with significant heterogeneity between studies (I^2=99.0%, *P*<0.001) (Fig. 2). The prevalance rate of each study is illustrated compared to the global cumulative estimate (the lower diamond).

Table 2: Characteristics of studies on the lifetime prevalence of AAS use among Iranian athletes

No.	Study (Reference)	Number of Participants	Gender	Age Mean± SD [Range]	Sport discipline	Professional level	Province	Lifetime prevalence (%)
1	Aghili M (14)	425	M	32.3±9.95	Body-building	Recreational	Tehran	60.8
2	Aliabadi S (15)	174	M	26	Body-building	Recreational	Kordestan	11
3	Alidoost E (16)	793	B	NR	Body-building	Recreational	Tehran	27.4
4	Allahverdipour H (17)	253	M	22.2[15-28]	Body-building	Recreational	Hamedan	37.5
5	Angoorani H (18)	289	F	26.3±6.3 [15-52]	Body-building	Recreational	Tehran	24.2
6	Angoorani H (19)	906	M	25.7±7.1 [14-56]	Body-building	Recreational	Tehran	16.6
7	Arazi H (20)	204	M	24.5±5.1	Body-building	Recreational	Alborz	62.7
8	Arazi H (21) (2014)	227	M	22.7 [15-38]	Body-building	Recreational	Qazvin	40.1
9	Arazi H (22)	223	M	23.8±5.4	Body-building	Recreational	Gilan	67
10	Bahrami S (23)	389	M	27.1±5.6	Body-building	Recreational	Kermanshah	32.1
11	Bijeh N (24)	282	M	24.6±5.2	Body-building	Recreational	Khorasan Razavi	64
12	Eskandarion M (25)	200	M	26.2±6.8 [16-46]	Body-building	Recreational	Semnan	59.5
13	Fakhari Rad F (26)	148	B	25.62±6.58	Body-building	Recreational	Tehran	47.5
14	Fijan A (27)	246	M	20.1±7.8	Body-building	Recreational	Fars	39
15	Ghaderi H (28)	192	M	26.6±5.7	NR	Both	Chaharmahal	32.8
16	Haerinejad MJ (29)	453	M	27±6 [16-59]	Body-building	Both	Bushehr	41
17	Hazavehei MM (30)	370	M	NR	Body-building	Recreational	Hamedan	19.2
18	Hoseini Kakhak AR (31)	100	M	NR	Body-building	Elite	NR	97
19	Jalilian F (8)	120	M	23.7±4.5 [15-43]	Body-building	Recreational	Hamedan	20
20	Khabiri A (32)	109	NR	NR	All sports	Elite	East Azarbaijan	46.8
21	Madani A (33)	277	M	27.9 [13-55]	Body-building	Recreational	Hormozgan	44.4
22	Mahdavi M (34)	780	M	NR	Body-building	Recreational	Alborz	5.6
23	Malek M (35)	337	M	NR	Body-building	Recreational	Semnan	14.2
24	Minasian V (36)	169	F	22.8±4	All sports	Elite	Tehran	15.4

25	Nakhaee MR (37)	298	M	25.9±8.4	Body-building	Recreational	Kerman	24.5
26	Nojoomi M (38)	403	M	22.6±8	Body-building	Recreational	Alborz	26
27	Pasharavesh L (39)	839	M	NR	Body-building	Recreational	Kermanshah	38.3
28	Rahimi M (40)	369	M	23±7	Body-building	Recreational	Kermanshah	50.1
29	Rashid Lamir A (41)	286	M	25.6	Body-building	Recreational	Khorasan Razavi	24
30	Razavi Z (42)	250	M	25.52 [15-45]	Body-building	Recreational	Hamedan	28.8
31	Rezaei SMA (43)	214	B	25	NR	Recreational	Kohgiluyeh & Boyer-Ahmad	31.3
32	Saeidinejat S (44) (2018)	920	M	NR	Body-building	Recreational	NR	22.9
33	Sepehri G (45)	202	M	24.89±6.79	Body-building	Recreational	Kerman	18.8
34	Shahsavani AR (46)	373	M	25	Body-building	Recreational	Sistan & Baluchestan	36.2
35	Sharifirad G (47)	245	B	22.4	Body-building	Recreational	Khorasan Razavi	22.4
36	Shojaee A (48)	368	M	NR	Body-building	Recreational	Tehran	62.3
37	Sobhanian S (49)	299	M	25.02±8.08	NR	Recreational	Fars	51.5
38	Taghavi SMR (50)	400	B	NR	Body-building	Recreational	Sistan & Baluchestan	14.2
39	Zakeri A(51)	721	M	NR	Body-building	Recreational	Tehran	36.2

Abbreviations: F: female, M: male, B: Both, NR: not registered

Table 3: Prevalence rates of AAS use among Iranian athletes, confidence intervals, and heterogeneity statistics for the overall athletic population, male athletes, and female athletes, prevalence of AAS use among Iranian athletes

Variable	N	Prevalence (%)	95% CI	Q	df (53)	I^2
Overall	39	36.2	29- 43	3921.61	38	99.0%
Male	31	38.2	30 -46	3770.92	30	99.2%
Female	2	19.9	11- 28	5.51	1	81.8%
Both	5	28.1	19- 37	74.25	4	94.6%

N=number of studies; Q=heterogeneity statistic; df (53) =Q's degrees of freedom; I^2 =heterogeneity index.

According to the subgroup analysis by gender, heterogeneity in prevalence rate of AAS misuse in overall athletic population was not attributable to gender (Table 3). The prevalence rate of AAS misuse in male athletes (38.2%) was higher than in female athletes (19.9%) (*P*<0.001).
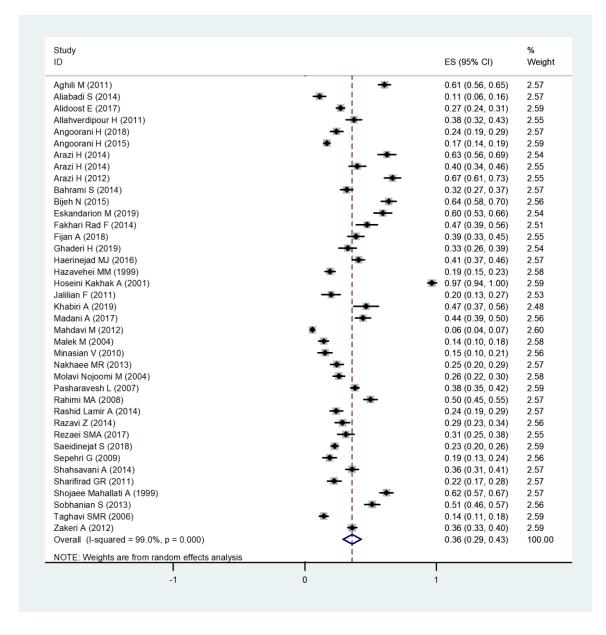
Fig. 2: Forest plot of prevalence rates of anabolic-androgenic steroid in overall athletic population.
ES: prevalence

According to subgroup analysis presented in Table 4, heterogenisity in prevalence rate of AAS misuse in overall athletic population was not attributable to age, sport disciplines and professional level. Prevalence rate of AAS misuse in athletes younger than 25 old (38.6%), was higher compared to athletes aged 25 and older (35.3%) (*P*<0.001). Moreover, prevalence rate of AAS misuse among body-building athletes (36.3%) was higher compared to other athletes, (30.9%) (*P*<0.001). Prevalence rate of AAS consumption among elite athletes (53.1%) was higher compared to recreational athletes (34.6%) (*P*<0.001) (Table 4). According to subgroup analysis, there was significant differences in prevalence rate of AAS misuse in the provinces of Iran (*P*<0.001).

Table 4: Prevalence rates of AAS use among Iranian athletes, 95% CIs, and heterogeneity statistics for age range, type of sport disciplines, professional level

Variable	N	Prevalence (%)	95% CI	Q	df (53)	I^2
Age (yr)						
20-24.9	12	38.6	28- 49	445.83	11	97.5
25-35	16	35.3	28- 43	565.08	15	97.3
Not regis-tered	11	34.9	19- 51	2758.09	10	99.6
Type of sport discipline						
Body-building	34	36.3	29- 44	3821.70	33	99.1
All sports	2	30.9	0.1- 62	32.27	1	96.9
Not regis-tered	3	38.6	25- 52	27.84	2	92.8
Professional level						
Recreational	34	34.6	29- 40	2197.83	33	98.5
Elite	3	53.1	-5 – 110.9	658.09	2	99.7
Both	2	37.3	29- 45	4.04	1	75.2

N= number of studies; Q = heterogeneity statistic; df (53) = Q's degrees of freedom; I^2 = heterogeneity index.

Quality assessment, level of evidence, the strength-of-recommendation taxonomy (SORT) and publication bias

Quality assessment of the studies via the Joanna Briggs Institute (JBI) critical appraisal checklist are presented in Table 5 (11). The results of the level of evidence assessment based on SORT is illustrated in Table 6 (12). Based on Egger's test, publication bias was reported as *P*-value=0.002. Since the *P*-value was significant, we did further analysis to test how many small studies were there that did not publish using trim and fill. If 17 unpublished studies could exist and could reduce the prevalence rate to 20%, not desired.

Table 5: Critical appraisal of studies on prevalence rates of AAS use among Iranian athletes

Study (Reference)	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
Aghili M (14)	No	No	Unclear	Yes	*	Yes	Unclear	Unclear	Unclear
Aliabadi S (15)	No	No	No	Yes	*	Yes	Unclear	No	Unclear
Alidoost E (16)	No	Yes	Yes	Yes	*	Yes	Unclear	No	Unclear
Allahverdipour H (17)	No	Yes	Unclear	Yes	*	Yes	Unclear	No	Yes
Angoorani H (18)	No	Yes	Yes	Yes	*	Yes	Unclear	No	Unclear
Angoorani H (19)	No	Yes	Yes	Yes	*	Yes	Yes	No	Yes
Arazi H (20)	No	Yes	Unclear	Yes	*	Yes	Yes	No	Yes
Arazi H (21) (2014)	No	Yes	Unclear	Yes	*	Yes	Yes	No	Yes
Arazi H (22)	No	Yes	Unclear	Yes	*	Yes	Yes	No	Yes
Bahrami S (23)	No	Yes	Yes	Yes	*	Yes	Yes	No	Yes
Bijeh N (24)	No	Yes	Unclear	Yes	*	Yes	Unclear	No	Yes

Eskandarion M (25)	No	Yes	Unclear	Yes	*	Yes	Unclear	No	Unclear
Fakhari Rad F (26)	No	Yes	Unclear	Yes	*	Yes	Unclear	No	Yes
Fijan A (27)	No	Yes	Yes	Yes	*	Yes	Yes	No	Unclear
Ghaderi H (28)	No	Yes	Unclear	Yes	*	Yes	Yes	No	Unclear
Haerinejad MJ (29)	No	Yes	Unclear	Yes	*	Yes	Unclear	No	Unclear
Hazavehei MM (30)	No	No	Unclear	Yes	*	Unclear	Unclear	No	Unclear
Hoseini Kakhak AR (31)	No	Yes	Yes	Yes	*	Yes	Unclear	Unclear	Unclear
Jalilian F (8)	No	Yes	Unclear	Yes	*	Yes	Unclear	Unclear	Unclear
Khabiri A (32)	Yes	Yes	Yes	Yes	*	Yes	Unclear	No	Unclear
Madani A (33)	No	Yes	Yes	Yes	*	Yes	Unclear	No	Unclear
Mahdavi M (34)	No	Yes	Yes	Yes	*	Yes	Unclear	Unclear	Unclear
Malek M (35)	No	Yes	Yes	Yes	*	Yes	Unclear	Yes	Unclear
Minasian V (36)	Yes	No	Yes	Yes	*	Yes	Yes	No	Unclear
Nakhaee MR (37)	No	Yes	Yes	Yes	*	Yes	Yes	No	Unclear
Nojoomi M (38)	No	Yes	Unclear	Yes	*	Yes	Yes	No	Unclear
Pasharavesh L (39)	No	Yes	Yes	Yes	*	Yes	Yes	No	Unclear
Rahimi M (40)	No	No	Yes	Yes	*	Yes	Yes	No	Yes
Rashid Lamir A (41)	No	Yes	Unclear	Yes	*	Yes	Yes	No	Yes
Razavi Z (42)	No	Yes	Yes	Yes	*	Yes	Unclear	No	Unclear
Rezaei SMA (43)	Yes	Yes	Yes	Yes	*	Yes	Unclear	No	Unclear
Saeidinejat S (44) (2018)	No	Yes	Yes	Yes	*	Yes	Unclear	No	Yes
Sepehri G (45)	No	Yes	Yes	Yes	*	Yes	Unclear	No	Yes
Shahsavani AR (46)	No	Yes	Unclear	Yes	*	Yes	Unclear	No	Unclear
Sharifirad G (47)	No	No	Unclear	Yes	*	Yes	Yes	No	Unclear
Shojaee A (48)	No	No	Yes	Yes	*	Yes	No	No	Unclear
Sobhanian S (49)	No	Yes	Yes	Yes	*	Yes	Yes	No	Unclear
Taghavi SMR (50)	No	Unclear	Unclear	Yes	*	Yes	Unclear	No	Unclear
Zakeri A(51)	No	Unclear	Unclear	Yes	*	Yes	Unclear	No	Unclear

*Not applicable

Table 6: Level of evidence and the strength-of-recommendation taxonomy (SORT) of studies on the lifetime prevalence of AAS use among Iranian athletes

Variable	Strength of recommendation	Consistency across studies	Quality of Evidence
Prevalence rates	C	Consistent	Level 3
Gender	C	Consistent	Level 3
Age range	C	Consistent	Level 3
Type of sport disciplines	C	Consistent	Level 3
Professional level	C	Consistent	Level 3

Discussion

The results of this meta-analysis indicated that the overall prevalence rate of AAS misuse in the Iranian athletic population was as high as 36.2%. Prevalence rate of AAS misuse among elite, male and younger athletes was higher. Moreover, prevalence rate of AAS misuse among body building athletes (36.3%) was higher compared to other athletes.

Conclusive data on the prevalence of drug misuse in athletes are challenging to attain because the athletes who misuse drugs will generally deny or hide their socially and morally improper practice. However, the existing evidence indicates that the use of performance-enhancing drugs including anabolic steroids is now widespread in sportsmen (3).

Evidence regarding the prevalence of steroid misuse may be as diverse as statistics on positive doping tests from accredited laboratories, results of surveys of athletes on their self-reporting or perceptions of drug misuse through to anecdotal reports, and speculation by the media. These sources of evidence are widely variable, leading to estimation of prevalence with a wide range.

There have been many survey-based studies published on the prevalence of drug misuse, however, a few of them have been conducted in athletes and even fewer in elite athletes. Most of published studies are roughly divided into those that investigate the self-report of drug misuse and those that addressed for perceived use of them by other athletes. Results from the former study tend to underestimate the real prevalence, while

those on perceived use usually produce overstated claims (52).

The overall prevalence rate of AAS misuse in the Iranian athletic population (elite and recreational) was 36.2%, according to the studies conducted in Iran. Surveys that recorded the self-report of drug misuse usually underestimate the real prevalence. Therefore, as all of our data was extracted from self-report studies, the real prevalence maybe even higher. Then, due to this high prevalence and potential of serious adverse effects, it should be regarded as a real concern for public health.

The estimated prevalence in our study is much higher than what was reported in a meta-analysis on lifetime prevalence rate of AAS misuse among athletes, recreational sportspeople and general population equal to 3.3% (2). In another systematic review and meta-analysis, the overall lifetime prevalence was 2.1% among athletes, recreational sportspeople and general population in the five Nordic countries (53). In our study, prevalence rate of AAS misuse among elite athletes (53.1%) was much higher compared to recreational athletes (34.6). The overall prevalence rate of AAS misuse among recreational sportspeople and all athletes was 18.4% and 3.4%, respectively (2). Prevalence rate of AAS misuse among gymnasts was reported 24.5% in the western province of Riyadh, Saudi Arabia (54). Prevalence rate of AAS consumption was reported 5.45% among athletes in Nigeria (55). Moreover, in a study on Swedish male professional power sport athletes (wrestling, Olympic lifting, powerlifting and the throwing events in track and field), prevalence rate of 21% was reported (56). The inconsistency may be due to the strict supervision and educa-

tional programs for elite athletes worldwide which highlights the need for developing preventive strategies in this domain in Iran.

The prevalence rate of AAS misuse among recreational athletes in Iranian recreational athletes in our study (34.6%), is comparable to the results of a systematic review in Brazil (57). Results of this review among recreational athletes and regular physical activity practitioners indicated that prevalence rate among recreational athletes varied between 2.1% and 31.6%, based on the participants' characteristics and the region (57). Higher prevalence rate of AAS misuse in Iran, in comparison to world and neighborhood countries, mandates major activities and policy making in this domain. According to the subgroup analysis, our study showed that prevalence rate for male athletes (38.2%) was higher than female athletes (19.9%). It is in accordance with results of global prevalence rate which reported the higher prevalence in male (6.4%) compared to female individuals (1.6%) (2). Other studies in this domain supports the gender differences in this domain (53, 58-60). The proportion of men that used non-medical AAS was significantly higher than the rate for females (2, 53).

Furthermore, the misuse rate in junior and young athletes (38.6%) was significantly higher than more experienced and senior athletes (35.3%). This finding is consistent with another study that showed a lower prevalence of AAS misuse in more experienced athletes (19). This may be explained by the higher knowledge and awareness of the experienced athletes to the adverse effects as well as their expertise to use more effective alternatives to AAS misuse. Moreover, prevalence rate was higher among body-building athletes (36.3%). This finding is compatible with the annual reports of World Anti-Doping Agency (WADA) that show the highest rate of positive doping tests for AAS in bodybuilding and power-lifting disciplines (61). This result is quite expected because the main claims for benefits of these drugs are based on their positive effects on the muscle bulk and strength that are critically important for strength and power athletes.

Finally, prevalence rate among elite athletes (53.1%) was higher than recreational athletes (34.6%). Our findings are consistent with another systematic review which showed higher prevalence of AAS misuse among elite athletes (53). The higher level of competition, increased media or peer pressure and greater stress and training loads may convince the elite athletes to seek ergogenic drugs. In contrast, many recreational athletes do not take part in competitions and are more concerned regarding their health and consequently, they are more resistant to misuse.

One of the main limitations of this meta-analysis was the heterogeneous nature of included studies and the different study populations, questionnaires and sampling methods. Furthermore, we had no original studies in some provinces to assess prevalence rate of that region. Another limitation of the study was existing publication bias. On the other hand, collecting all documents including studies, conference proceedings and theses available in this field is a notable point in developing this study.

Misuse of AAS among elite and recreational athletes is a key global health issue. This study is the first systematic review and meta-analysis assessing the prevalence rate of AAS consumption in Iranian athletes. Results extracted from this study could be a valuable guide and baseline information for design of efficient strategies and developing next steps (including educational measures) for preventive policy-making and promoting awareness and knowledge about risks and complications of AAS misuse among elite and recreational athletes is mandated.

Conclusion

According to the higher prevalence of AAS misuse in Iranian athletic population compared to global statics and potential of serious adverse effects, preventive strategies and policies should be considered as a real concern for public health.

Ethical considerations

Acknowledgements

Conflict of interest

The authors declare that there is no conflict of interest.

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