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Consequences of Anabolic Androgenic Steroids Abuse in Males, Sexual Hepatic and Metabolic Perspective

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Abstract

Anabolic-androgenic steroids represent a group of synthetic derivatives of testosterone and its analogues, they play an important role in clinical treatment. These groups of drugs are widely abused among the general public to increase lean body weight and improve athletic performance. The use of anabolic-androgenic steroids (AAS) is a growing worldwide public health concern. However, studies assessing its effects on health are properly limited, especially in developing countries, including Iraq. This community-based cross-sectional study was conducted to assess the level of physiological parameters among male gym users in relation to use AAS. It has been reported that AAS use can cause many physiological changes, the current study was to review the effect of AAS on serum levels of LH, FSH, prolactin, free testosterone, ALT, AST, T3, T4, TSH, haemoglobin, and platelet in bodybuilders using these hormones and compare the results with a control group. The study took place in Baghdad city, sample collection lasted for 3 months, a group of 50 male bodybuilders aged 18_48 years who went to the gym on regular basis and were using AASs for at least 2 months were interviewed and blood samples were collected to measure certain biochemical and hormones level, and see the effects of AAS on these parameters and compare results with 31 male control group who used the gym on regular basis but never use AAS before. The levels of eight parameters were significantly different according to the participating groups (AAS user's vs control): LH, FSH, Prolactin, ALT, T3, TSH, haemoglobin, and platelets. Five of the measured parameters were significantly p <0.05 lower in the group of AAS users compared to the control (non-user) group: LH, FSH, T3, TSH, and platelets. In contrast, the other three parameters prolactin, ALT, and haemoglobin were significantly higher in the AAS user group compared to the control group also LH and FSH were significantly different according to the types of used AAS. The participants who used testosterone propionate had significantly higher levels of FSH compared to those who used testosterone enanthate and the levels of liver enzyme ALT and LH levels were significantly different according to the duration of AAS use. The study concluded that many biochemical and hormonal levels were adversely affected by anabolic androgenic steroids.

Keywords: Anabolic androgenic steroids, Athletes, bodybuilding, Gym users, Testosterone.

تبعات الاستخدام المفرط للستيرويدات الاندروجينية الابتنائية جنسيا و الكبد والعمليات الايضية في الذكور

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الخلاصة

تمثل الستيرويدات الابتنائية الاندروجينية مجموعة من مشتقات التستوستيرون الاصطناعية وما يماثلها ، وتلعب دورًا مهمًا في العلاج السريري. يتم إساءة استخدام هذه المجموعة من الأدوية على نطاق واسع بين عامة الناس لزيادة وزن الجسم وتحسين الأداء الرياضي.ان استخدام المنشطات الابتنائية اندروجيني في تزايد مستمر في جميع أنحاء العالم ويسبب القلق للصحة العامة. ومع ذلك ، فإن الدراسات التي تقيم آثارها على الصحة محدودة بشكل واضح ، خاصة في البلدان النامية ، بما في ذلك العراق. أجريت هذه الدراسة المقطعية المجتمعية لتقييم مستوى المعلمات الفسيولوجية بين مستخدمي الصالة الرياضية الذكور فيما يتعلق بالستيرويدات الأندروجينية. تهدف الدراسة مراجعة التأثير على مستويات هرمونات الغدة النخامية ، هرمونات الفدة الدرقية، الهيموجلوبين والصفائح الدموية في الجسممقارنة النتائج مع مجموعة التحكم. أجريت الدراسة في مدينة بغداد واستمرت لمدة ٣ أشهر، وتمت مقابلة مجموعة من ٥٠ من لاعبي كمال الأجسام الذكور الذين تتراوح أعمارهم بين ١٨ _ ٤٨ سنة والذين ذهبوا إلى صالة الألعاب الرياضية بشكل منتظم وكانوا يستخدمون الهرمونات الاندروجينية منذ شهرين على الأقل وتم جمع عينات الدم لتحليلها و قياس مستوى هرمونات معينة، ومعرفة تأثيرات هذه الهرمونات على هذه المعلمات ومقارنة النتائج مع ٣١ من الذكور الذين استخدموا صالة الألعاب الرياضية بشكل منتظم ولكن لم يستخدموا الهرمونات الاندروجينية من قبل. كانت مستويات ثمانية معلمات طبية حيوية مختلفة بشكل كبير (قيمة p <0.05) وفقًا للمجموعات المشاركة (مستخدمو AAS مقابل مجموعة التحكم): LH و FSH و Prolactin و ALT و T3 و TSH والهيموجلوبين والصفائح الدموية. كانت خمسة من المعلمات المقاسة أقل بشكل ملحوظ في مجموعة مستخدمي AAS مقارنة بمجموعة التحكم (غير المستخدم): LH و FSH و T3 و TSH والصفائح الدموية. في المقابل ، كانت المعلمات الثلاثة الأخرى (البرولاكتين ، ALT والهيموغلوبين) أعلى بشكل ملحوظ في مجموعة مستخدمي AAS مقارنة بمجموعة التحكم ايضًا كان LH و FSH مختلفين اختلافًا كبيرًا وفقًا لأنواع AAS المستخدمة. كان لدى المشاركين الذين استخدموا تيستوستيرون البروبيونات مستوى أعلى بكثير من FSH مقارنة بأولئك الذين استخدموا تيستوستيرون إينونثات وكانت مستويات إنزيم الكبد . ALT و LH مختلفة بشكل كبير وفقًا لمدة استخدام AAS. أظهرت الدراسةان هناك تأثير ضار لاستخدام الستيرويدات الاندروجينية على الاختبارات الكيميائية الحياتية ومستويات الهورمونات في الجسم.

الكلمات المفتاحية : الهرمونات الاندروجينية الابتنائية ,الرياضيين ,بناء الاجسام, الصالة الرياضية, هرمون التستوستيرون.

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Introduction

Anabolic androgenic steroids (AASs) are a family of compounds that encompass the male sex hormones like testosterone and its synthetic analogues, AASs increase protein synthesis and decrease protein catabolism (anabolic effect) and they are responsible for the development and maintenance of primary and secondary sex characteristics of the male [(1)].

The first time athletes used an exogenous substance to improve their performance was over 3000 years ago[(2)].

Anabolic androgenic steroids (AASs) are most often used intermittently, i.e. in cycles, and the user's knowledge is obtained from associates, trainers, or online sources [(3)].

Users cycles vary greatly concerning to length, dosage, as well as the number of different AASs used simultaneously or consecutively[(4)]. An earlier report showed that in about 50% of illegally obtained AASs, the contents do not match the description of the label [(5)]. Therefore, it is so difficult to attribute side effects to specific AAS or specific doses.

The AASs have a great affinity for the androgenic receptor (AR), which is widely expressed in central and peripheral tissue However, Aromatase mainly converts androgens into estrogens by aromatization[(6)]. The side effects related to AASs may be intermediated by multiple receptors acting on e.g. the hypothalamic pituitary adrenal axis (HPA), pituitary signalling to thyroid, adipose tissue, and other endocrine processes where steroid hormones may be estimated to have a regulatory role[(7)].

Common patterns for misusing steroids include cycling (Using one or more AAS for a fixed period, ranging anywhere from 6 to 16 weeks, and then stopping for approximately a similar duration of time), stacking (This could involve mixing oral and injectable types or taking compounds intended for veterinary use), pyramiding (Gradually maximizing the dosage of an AAS and then gradually minimizing the dosage of the same drug to zero over a predefined amount of time), plateauing (When a drug becomes ineffective at its current dose. Suggestive of the need to increase calorie intake, increase the drug dose, or stop the drug), however, there is no empirical evidence that one of these practices minimize the drugs' adverse effects[(2)].

The study was done

- To assess the effect of anabolic androgenic steroids on serum levels of LH, FSH, Prolactin, free testosterone, ALT, AST, T3, T4, TSH, hemoglobin, and platelet in bodybuilders using these hormones.
- Compare the results of serum levels of LH, FSH, Prolactin, free testosterone, ALT, AST, T3, T4, TSH, hemoglobin, and platelet between healthy people who never used anabolic androgenic steroids and those who are the current user of anabolic androgenic steroids.
- To detect the effect of alcohol on liver enzymes and testosterone level

Subjects and Methods

This cross-sectional study included fifty male bodybuilders' age range 18_48 years old with average age 33 years ±6.6. The current study was carried out in two gyms in Baghdad Al-Russafa and the samples were collected conveniently in February, March, and April 2022. Health-related questions were asked of bodybuilders involved (chronic diseases, chronic medications, type of androgen, duration of AAS use, duration of training, smoking, and alcoholic status) an blood was collected to measure the effect of AAS on serum levels of LH, FSH, prolactin, free testosterone, ALT, AST, T3, T4, TSH, haemoglobin, and platelet. However, time and vigorous exercises could be confounders' factor to some parameters.

Inclusion criteria were male ≥18 years of age, healthy bodybuilders were using the gym, participants were taking anabolic steroidal hormones for at least 2 months, and the agreement of all the participants in the study.

Exclusion criteria included female, age <18 years, liver, and kidney disorders.

A 31 healthy males who were using the gym regularly but never used AASs in their lifetime were collected as a control group.

Anabolic androgenic steroid abusers were selected conveniently from two gyms in Baghdad selected if they were currently using IM injections of AAS. A sample of 50 bodybuilders were interviewed and requested to participate, and 31 gym users were collected as control, however, 14 persons reject to participate in the study and denied using AAS and some of them asked for fees to participate in the study.

Subject's weight and height were measured using a balance beam and a vertical ruler. Blood samples were collected by venipuncture, hematology analyzer and spectrophotometer were used to obtain the required results in a private laboratory.

Ethical concerns

- The study was approved by the scientific committee of the college of pharmacy/university of Baghdad (no. of approval 3000, date 12/4/2022)
- All of the participants' oral approval to participate in the study has been taken before starting the sample collection.
- Anabolic Androgenic Steroids using bodybuilders were advised against substance abuse and also they were given full information about the adverse effects. Unfortunately almost all of them continued to consume steroids afterward.

The Statistical Package for the Social Science (SPSS, version 22, IBM, New York USA)

was used to conduct statistical analyses. Descriptive statistics (means, standers deviations, frequencies, and percentage) were measured. One-way ANOVA or Independent T-test was used to measure the difference in means of biomarkers (hormones and enzymes) according to the types of androgenic anabolic steroids (AAS) and dosing types. Post Hoc Test (Dunnett T3) was used to measure the pairwise comparisons among the four groups when the ANOVA results were significant regarding the biomarker levels. One-way ANOVA was also used to measure the differences in hormonal levels according to the frequency of training.

Results

The participants were young men with an average age of 33.0 (standard deviation ±6.6) years, BMI of 27.2 (standard deviation ±3.5), and without chronic diseases (98.8%). The vast majority of the participants had a college education (81.5%) in non-medical specialties (91.4%). Approximately 26% of the participants were alcoholics and 43% were smokers (Table 1).

Table 1. The sociodemographic characteristics of the participants

Character	Subcategories	Frequency (N)	%
Group	Control	31	38.3
	AAS users	50	61.7
	Total	81	100
Smoking	smoker	35	43.2
Alcoholic	Alcoholic	21	25.9
Marital status	Single	49	60.5
	Married	32	39.5
Education degree	High-school	12	14.8
	College	66	81.5
	Higher education	3	3.7
Working in the medical field	No	74	91.4
	Yes	7	8.6
Having chronic disease	No	80	98.8
	Yes	1	1.2
Taking chronic medication	No	80	98.8
	Chronic	1	1.2
	Range	**Mean**	**Std. Deviation**
Age (years)	18-48	33.96	6.59
BMI	20.2-37.5	27.15	3.51

The majority of participants (76.2%) were going to the gym five to six times weekly for a duration of one hour (96.3%) daily. The participants were doing four main different exercises for three main reasons: health, social and personal. More than three-quarters (82%) of the user group were taking AAS for non-continuous periods (Table 2).

Table 2. The training characteristics of the participants

Character	Subcategories	Frequency (N)	%
Frequency of training weekly	3	2	2.5
	4	14	17.3
	5	36	44.4
	6	29	35.8
Duration of training (hours/day)	1	78	96.3
	2	3	3.7
Reasons for going to the gym	Health	23	28.4
	Social	19	23.5
	Personal	39	48.1
Exercise type (inside & outside the gym)	Walking	47	58.0
	Running	65	80.2
	Swimming	20	24.7
	Playing soccer	54	66.7
Anabolic steroid dosing	Non-continuous dosing	41	82.0
	Continuous dosing	9	18.0
	Total	50	100.0

The levels of eight biomedical parameters were significantly p <0.05 different according to the participating groups (AAS user vs control): LH, FSH, Prolactin, ALT, T3, TSH, hemoglobin, and platelets. Five of the measured parameters were significantly p <0.05 lower in the group of AAS users compared to the control (non-user) group: LH, FSH, T3, TSH, and platelets. In contrast, the other three parameters (prolactin, ALT, and hemoglobin) were significantly p <0.05 higher in the AAS user group compared to the control group (Table 3).

Table 3. The differences in the biomedical parameters according to the participating groups

Parameter	Study groups	N	Mean	Std. Deviation	*P*-value
LH	Control	31	4.60	1.86	.000*
	AAS users	50	1.82	2.21	
FSH	Control	31	5.05	2.76	.000*
	AAS users	50	1.96	2.15	
Prolactin	Control	31	12.78	6.23	.030*
	AAS users	50	17.05	9.53	
Testosterone	Control	31	5.40	1.95	.661
	AAS users	50	5.72	4.55	
ALT	Control	31	7.23	2.54	.016*
	AAS users	50	9.58	5.96	
AST	Control	31	7.16	2.62	.093
	AAS users	50	8.62	5.08	
T3	Control	31	2.16	0.54	.033*
	AAS users	50	1.92	0.39	
T4	Control	31	94.06	29.79	.396
	AAS users	50	88.87	20.08	
TSH	Control	31	2.53	1.06	.003*
	AAS users	50	1.75	1.11	
Hemoglobin	Control	31	14.06	1.59	.042*
	AAS users	50	15.59	3.94	
Platelets	Control	31	258.32	75.84	.031*
	AAS users	50	223.82	63.89	

*Significant (P-value< 0.05) according to Independent T-test. Control=non-AAS user group. AST=aspartate transaminase; ALT=alanine transaminase; FSH=follicle stimulating hormone; LH=luteinizing hormone. TSH=thyroid stimulating hormone.

There were no significant differences in the liver enzyme (ALT &AST) and testosterone levels between alcoholic and non-alcoholic gym users (Table 4).

Table 4. The effect of alcohol drinking on liver enzymes and testosterone level T-Test

	Alcoholic	N	Mean	Std. Deviation	*P*-value
Testosterone	No	60	5.84	3.31	.334
	Yes	21	4.91	4.85	
ALT	No	60	8.72	5.25	.910
	Yes	21	8.57	4.52	
AST	No	60	7.87	4.22	.498
	Yes	21	8.62	4.75	

The levels of two hormones (LH and FSH) were significantly different according to the types of used AAS. The participants who used propionate had a significantly higher levels of FSH compared to those who used enanthate (Table 5).

Table 5-A. The difference in hormonal levels according to the type of used anabolic steroid.

Hormone	AAS types	N	Mean	Std. Deviation	*P*-value
LH	TC	5	1.50	1.62	.039*
	TE	25	1.41	2.15	
	TP	10	3.59	2.40	
	Sustanon TP+TPH+TI+TD	10	1.23	1.72	
	Total	50	1.82	2.21	
FSH	TC	5	2.14	2.02	.028*
	TE	25	1.41	1.81	
	TP	10	3.71	2.08	
	Sustanon TP+TPH+TI+TD	10	1.50	2.41	
	Total	50	1.96	2.15	
prolactin	TC	5	26.84	14.18	.060
	TE	25	17.03	8.47	
	TP	10	16.36	8.61	
	Sustanon TP+TPH+TI+TD	10	12.90	8.20	
	Total	50	17.05	9.53	
testosterone	TC	5	5.93	3.65	.818
	TE	25	5.47	4.23	
	TP	10	5.07	4.29	
	Sustanon TP+TPH+TI+TD	10	6.90	6.20	
	Total	50	5.72	4.55	
ALT	TC	5	10.60	6.80	.706
	TE	25	10.28	6.25	
	TP	10	9.10	6.69	
	Sustanon TP+TPH+TI+TD	10	7.80	4.24	
	Total	50	9.58	5.96	
AST	TC	5	10.20	6.87	.896
	TE	25	8.64	5.22	
	TP	10	8.10	3.73	
	Sustanon TP+TPH+TI+TD	10	8.30	5.58	
	Total	50	8.62	5.08	
T3	TC	5	2.02	0.58	.660
	TE	25	1.88	0.33	
	TP	10	1.85	0.43	
	Sustanon TP+TPH+TI+TD	10	2.03	0.43	
	Total	50	1.92	0.39	
T4	TC	5	88.18	25.25	.970
	TE	25	88.42	15.30	
	TP	10	87.55	23.69	
	Sustanon TP+TPH+TI+TD	10	91.66	26.75	
	Total	50	88.87	20.08	
TSH	TC	5	1.86	1.02	.920
	TE	25	1.80	1.15	
	TP	10	1.53	1.03	
	Sustanon TP+TPH+TI+TD	10	1.80	1.24	
	Total	50	1.75	1.11	

Continued table (5- A)

Hormone	AAS types	N	Mean	Std. Deviation	*P*-value
Hemoglobin	TC	5	14.16	1.24	.407
	TE	25	15.26	1.25	
	TP	10	15.36	1.19	
	Sustanon TP+TPH+TI+TD	10	17.39	8.54	
	Total	50	15.59	3.94	
Platelets	TC	5	195.60	61.67	.274
	TE	25	240.72	71.74	
	TP	10	216.70	47.36	
	Sustanon TP+TPH+TI+TD	10	202.80	52.77	
	Total	50	223.82	63.89	

TC= testosterone cypionate, TP= testosterone propionate, TE= testosterone enanthate, TPH=testosterone phenylpropionate, TI= testosterone isocaproate, TD= testosterone decanoat

Table 5-B. The difference in LH, and FSH levels according to the type of used anabolic steroid using Post Hoc Tests.

Dependent Variable	(I) AAS_Medication_types	(J) AAS_Medication_types	Mean Difference (I-J)	Std. Error	*P*-value
LH	Cypionate	Enanthate	0.09	0.84	1.000
		Propionate	-2.09	1.05	.321
		Sustanon	0.27	0.91	1.000
	Enanthate	Cypionate	-0.09	0.84	1.000
		Propionate	-2.18	0.87	.129
		Sustanon	0.18	0.69	1.000
	Propionate	Cypionate	2.09	1.05	.321
		Enanthate	2.18	0.87	.129
		Sustanon	2.36	0.93	.118
	Sustanon	Cypionate	-0.27	0.91	1.000
		Enanthate	-0.18	0.69	1.000
		Propionate	-2.36	0.93	.118
FSH	Cypionate	Enanthate	0.73	0.97	.960
		Propionate	-1.57	1.12	.661
		Sustanon	0.64	1.18	.993
	Enanthate	Cypionate	-0.73	0.97	.960
		Propionate	-2.30	0.75	**.044***
		Sustanon	-0.09	0.85	1.000
	Propionate	Cypionate	1.57	1.12	.661
		Enanthate	2.30	0.75	**.044***
		Sustanon	2.21	1.01	.211
	Sustanon	Cypionate	-0.64	1.18	.993
		Enanthate	0.09	0.85	1.000
		Propionate	-2.21	1.01	.211

* The mean difference is significant at the 0.05 level. Post Hoc Tests. Multiple Comparisons: Dunnett T3

The levels of liver enzyme (ALT) and LH levels were significantly $p < 0.05$ different according to the duration of AAS use (≤ 3 months vs ≥ 4 months). The level of ALT has significantly $p < 0.05$ increased with longer AAS use while LH level has significantly decreased with longer AAS use.

Table 6. The differences in the hormonal levels according to the duration of anabolic steroid use

Hormone	Steroid use duration	N	Mean	Std. Deviation	*P*-value
Testosterone	≤ 3 months	33	5.78	4.97	.890
	≥ 4 months	17	5.59	3.74	
ALT	≤ 3 months	33	7.79	5.20	.002*
	≥ 4 months	17	13.06	5.93	
AST	≤ 3 months	33	8.33	4.53	.620
	≥ 4 months	17	9.18	6.13	
LH	≤ 3 months	33	2.26	2.44	.020*
	≥ 4 months	17	0.96	1.37	
FSH	≤ 3 months	33	2.16	2.32	.383
	≥ 4 months	17	1.59	1.79	
prolactin	≤ 3 months	33	15.55	8.36	.122
	≥ 4 months	17	19.96	11.18	
T3	≤ 3 months	33	1.92	0.35	.987
	≥ 4 months	17	1.92	0.48	
T4	≤ 3 months	33	85.66	15.25	.191
	≥ 4 months	17	95.09	26.61	
TSH	≤ 3 months	33	1.82	1.21	.531
	≥ 4 months	17	1.61	0.88	
Hemoglobin	≤ 3 months	33	15.89	4.76	.468
	≥ 4 months	17	15.02	1.23	
Platelets	≤ 3 months	33	219.45	65.46	.507
	≥ 4 months	17	232.29	61.77	

Discussion

The abuse of anabolic substances for performance persists as a prominent issue in athletic demographics[8]. Individuals have historically utilized AAS in an attempt to enhance their exercise training performance outcomes and subsequent recovery [9]. Since the initial speculation of Soviet Doping in the 1952 Olympic Games and the subsequent synthesis of methandrostenalone, several AAS With varying effects, elimination of half-lives, and contraindications, all androgens have a history of abuse when used with the intent of improving strength and body composition [10].

Most of the participants were going to the gym 5 to 6 times a week (76.2%) also the majority of them were going for one hour daily (96.3%), The participants were performing four main different exercises for three chief reasons: health to improve health status also some of them followed physician instructions about using the gym, social reasons due to the community effect about the body shape standards this make people in continuous working to reach perfection even if that required using illegal or dangerous ways and nearly half of the participant were going to the gym for personal reasons. Most of the participants (82%) were using AAS in non-continuous dosing which means they were taking AAS for a certain period of time and then free AAS time to restore the normal physiological body function according to coaches' convictions but this way does not ensure avoidance of long term adverse effects, however, there is no empirical evidence that these practices minimize the drugs' adverse effects[2].

In the current study, Table 3 shows the significantly the lower of the level of LH and FSH between the group who was taking AAS and the control group the results of LH and FSH matches with another study done in the College of Sciences, Mustansiriyah University also showed a significant effect of AAS on LH and FSH[11], but different results were obtained about testosterone levels, the current study did not get significant changes between control and AAS users group this different results could be due to the differences in numbers of participants or duration, type and administration of AAS.

There is a study mentioned that the time of suppression for LH, FSH, and testosterone levels depends on the duration of usage, type of ASS, dosage, and age[12]. However, others indicated those who specified the cause of abnormalities in LH, FSH and testosterone are only the mode of transmission and the type of ASS that was taken by the bodybuilders [13]. It is worth noting that other studies indicated that younger men with lower dosages, shorter periods, and more testosterone have faster recovery of HPG axis function after AAS use[14] so that's why no significant effect on testosterone level

has been shown in the current study because of younger ages of participants and short periods of time.

Exogenous testosterone was aromatized to oestradiol, which then directly stimulated the lactotroph cells of the anterior pituitary to secrete PRL also testosterone can act directly on the hypothalamus to modulate the release of PRL from the anterior pituitary[15]

Significantly higher prolactin levels between AAS users and the control group in the current study in Table 3 and this result is in the same way with a Libyan study about male bodybuilders who were using AAS showed that AAS-using bodybuilders had significantly higher (*p* value <.05) of prolactin than control group[16] this close results could be due to using same types of AASs and nearly same duration of AAS use in both studies.

The current study showed a significant increase in ALT level (*p* value=.016), the same result in a study in the College of Pharmacy/University of Baghdad about the effect of Anadrol (type of AAS) on liver enzymes in rats showed a significant increase (*p* value<.05) on ALT level but opposite results obtained about AST level[17], no significant increase in AST level (*p* value=.093) in the current study but significant effect of Anadrol on AST in rats. These different results could be due to different steroid types or differences between rats and humans.

Effect of AAS on thyroid functions test showed a significantly lower level T3 and TSH between athletes androgens users and control group table 3, the obtained results are in agreement with a study done in Diyala that showed a significant change in T3 but no significant changes in TSH [18], in both of the studies no significant effects shown in T4 level.

AASs induced side effects are the increase of hematocrit and erythrocytosis[19]. significant haematological changes were noticed in haemoglobin and platelets between the AAS user group and the control group shown in Table 3, these results are similar to another study in Baghdad city that showed a highly significant increase in haemoglobin level but it showed maintenance in normal levels of platelet count[11]. This effect on haemoglobin level could be urged by smoking also as nearly half of the participants were smokers.

Serum liver enzymes are the most commonly used and sensitive biochemical markers for the assessment of liver disease, alcohol is a toxin that is harmful to the liver causing alcoholic liver disease and it is one of the leading causes of alcohol-related death[20].

The current study showed no significant effects of alcohol on liver enzymes and no significant effect of alcohol on testosterone levels, this result could change if a higher number of alcoholic athletes were involved in the study. It required a long time and large quantities of drinking alcohol to exert its effect on the body especially in the liver to cause marked changes in the liver enzymes until reach liver cirrhosis, however, most of the participants in the study is young ages so alcoholic effects on liver enzymes may not appear yet.

There were significant differences in hormones level LH and FSH according to the type of AASs used, however no significant effects were noticed in other biomedical parameters in the current study.

To detect the effect of different types of AASs used on LH and FSH levels a post Hoc test (more conservative test) was done and found no significant effect of different types of AASs used on LH levels but a significant effect was found between different types of AASs on FSH level, propionate has a higher effect in reduction of FSH level than enanthate.

Preparations of IM testosterone have been used since the 1950s. Natural testosterone has an approximate half-life of 10 minutes when injected. Current formulations have a longer half-life through the esterification of the 17β carbon of natural testosterone. Esterification increases the solubility of testosterone in oil, which allows for slower release after injection into the muscles. Testosterone esters are not biologically active until the ester group is cleaved off[21].

Testosterone propionate has a short half-life requiring frequent injections, a high risk of aromatization, and the side effects of high estrogen levels; unlike Testosterone Cypionate or Enanthate which are similar, long-acting with a longer half-life, safer with minimal, manageable side effects[21]

All participants have been using AAS for 2-6 months, Table 6 showed the relationship between the duration of AAS taking and the change in hormones level, only LH showed a significant decrease and ALT showed a significant increase. All other parameters are not affected by the duration of taking AAS, the current study is in agreement with the study done in Mosul city, Iraq which also showed a significant decrease in LH levels but Mosul study also found a significant decrease in FSH and testosterone levels [22] which was not found in the current study, these differences in results could be due to more duration of use of AAS at the time of the study and different type of AAS used. Intermittent taking of AAS which means leaving a free AASs time or using AASs for a short period of time has no huge effects on body parameters.

Conclusion

In conclusion, AAS abuse lowered serum concentrations of pituitary gonadotropins, LH and FSH, and testosterone. Increased levels of prolactin were also established, with mildly elevated liver

enzymes, in addition to lowering thyroid hormones and increasing levels of haemoglobin and platelets.

Conflict of interest

The authors declare no conflict of interest

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Ethics Statements

Oral agreements have been taken from the participants. The researcher gave sufficient information about the aim and method of the study. The participation in the study was optional.

Author contribution

Sura Mohammed Challab participated in collecting the sample, sending blood samples to the lab for analysing them, analysing data, writing and reviewing the manuscript. Zinah M. Anwer participated in the study designing, and reviewing the manuscript. Both authors have read and approved the final version of the manuscript.

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