

# Cardiovascular manifestations of anabolic steroids in association with demographic variables in body building athletes

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**Background:** The most common drug abuse among athletes is anabolic steroids which lead to the development of cardiovascular diseases and sudden death. Thus, the aim of this study was to evaluate cardiovascular outcomes of anabolic consumption in body building athletes. **Materials and Methods:** Totally, 267 male athletes at the range of 20-45 years old with the regular consumption of anabolic steroids for >2 months with at least once weekly. High-density lipoprotein (HDL), low-density lipoprotein (LDL), triglyceride (TG), and hematocrit (Hct) levels were measured after 10 h of fasting. Data analysis was performed using K2, *t*-test, ANOVA and correlation coefficient through SPSS 17. **Results:** There was a nonsignificant difference between groups regarding HDL, TG, and total cholesterol. There was a significant decrease in the total and categorized LDL and Hct levels in consumers of anabolic steroid versus nonusers ( $P = 0.01$  and  $P = 0.041$ , respectively). Results showed a significant increase in systolic and diastolic blood pressure (SBP and DBP) in anabolic steroid users which associates with duration of abuse ( $P = 0.02$  and  $P = 0.03$ , respectively). No significant electrocardiography changes were found within the follow-up period. **Conclusion:** Increase in SBP or DBP is a common complication of these drugs which can lead serious vascular disorders. The lower LDL cholesterol level might be due to the higher amounts of lipid consumption in these athletes.

**Key words:** Anabolic steroids, body building, cardiovascular, complication, dyslipidemia, hypertension, lipid index

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## INTRODUCTION

Drug abuse and its related side effects are common apprehensions of physician's councils and sport federations. Delivered statistical reports from laboratory of international committees implies that the most common drug abuse among athletes are anabolic steroids which leads to the development of dangerous side effects as cardiovascular diseases (CVD) and sudden death in athletes. Anabolic steroids are a family of hormones derived from testosterone which exert both anabolic and androgen properties which were originally developed in the late 1930s.<sup>[1]</sup> All major professional sports organizations ban the use of anabolic steroids. Almost all side effects of anabolic steroids are related to their androgen properties.<sup>[2-4]</sup> There is a tremendous effort to enhance anabolic to androgen ratio of these steroids as much as possible.

Anabolic steroids are applicable through oral, injection, and dermal routes according to their molecular structure. General side effects of these agents are CVD, testicular atrophy, increased libido, hepatic

disorders, psychological problems, and so on.<sup>[5,6]</sup> Although Cardiovascular side effects are among the most threatening side effects of anabolic steroids which might manifest later in life but The prevalence and underlying mechanisms of Anabolic steroid-induced cardiovascular toxicity remain poorly understood. Electrocardiography (ECG) abnormalities as left ventricular hypertrophy (LVH) and arrhythmia are common in these cases. The risk of coronary thrombosis and myocardial infarction is also noticeable in this population.<sup>[7-10]</sup>

As taking anabolic steroids are common in many body building clubs in our province, and there are no comprehensive data regarding side effects of anabolic steroids this study evaluated the association between occurrence of CVD and anabolic steroid consumption in athletes.

## MATERIALS AND METHODS

This case-control study was performed from 2013 to 2014 and includes 267 male athletes at the range of

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20-45 years old with the regular consumption of anabolic steroids for more than 2 months. This study was performed in Isfahan Legal medicine, Isfahan, Iran. Case group include 219 male bodybuilders using anabolic steroids regularly for more than two months, and control group were 48 age-matched subjects volunteered for this study without consumption of anabolic steroid. Participants were counseled as to the hazardous health effects associated with the use of exogenous androgens and informed that they were free to withdraw from the study at any time. Subjects provided written informed consent. Exclusion criteria include diabetes mellitus, hepatic disorders, abnormally elevated liver enzymes, hyperlipidemia, cigarette smoking, and pre-existing cardiac disorder. All volunteer participants signed informed consent forms. High-density lipoprotein (HDL), low-density lipoprotein (LDL), triglyceride (TG), and hematocrit (Hct) levels were measured. Lipid profile was evaluated after 10 h of fasting. LDL and Hct were evaluated in divided groups as LDL (group 1: LDL <100, group 2: 100 < LDL <160 and group 3: LDL >160) and Hct (group 1: Hct <39, group 2: 40 < Hct <52 and group 3: Hct >52).<sup>[11,12]</sup> ECG was also taken. All participants filled questionnaires. All of these variables were checked out before and after steroid consumption. For assessing blood pressure, after a resting period of 5 min in the supine position, systolic and diastolic blood pressure (SBP and DBP) were measured with a sphygmomanometer.<sup>[13]</sup> Data are expressed as mean  $\pm$  standard deviation data analysis was performed using K2, *t*-test, ANOVA, and correlation coefficient through Statistical Package for the Social Sciences version 17.0 (SPSS Inc, Chicago, IL, USA).

## RESULTS

Participants were matched regarding age and duration of drug abuse. The mean value of age of participants in anabolic positive and negative group was  $28.37 \pm 4.86$  and  $29.65 \pm 7.19$ , respectively, which shows a nonsignificant relationship between groups ( $P > 0.05$ ). Education level of participants in groups shows a nonsignificant difference between groups. The mean value of HDL, LDL, and Hct measures of participants are included in Tables 1, which shows a nonsignificant difference between groups. There was a significant decrease in the total and categorized LDL and Hct levels in consumers of anabolic steroid versus nonusers (0.01 and 0.041, respectively) [Table 2]. There was no correlation between duration of consumption and LDL increase.

Comparing mean SBP and DBP in case and control groups of our study revealed that abusing anabolic steroids may elevate both SBP and DBP significantly (0.02 and 0.001, respectively) and the amount of increase correlates with duration of abuse. Meaning that the much longer anabolic steroid abused, the higher SBP and DBP rises (0.027 and

**Table 1: The mean value of HDL, LDL, TG, and Hct in anabolic positive and negative group**

Parameter	Group (n)	Mean $\pm$ SD	P
HDL	Anabolic + (196)	91.91 $\pm$ 34.38	0.08
	Anabolic - (46)	103.33 $\pm$ 35.43	
LDL	Anabolic + (196)	91.91 $\pm$ 34.38	0.04
	Anabolic - (46)	103.33 $\pm$ 35.43	
Hct	Anabolic + (196)	41.38 $\pm$ 5.60	0.03
	Anabolic - (46)	43.38 $\pm$ 6.78	
TG	Anabolic + (196)	138.84 $\pm$ 67.35	0.64
	Anabolic - (46)	144.00 $\pm$ 67.39	

HDL = High-density lipoprotein; LDL = Low-density lipoprotein; TG = Triglyceride; Hct = Hematocrit; SD = Standard deviation

**Table 2: The mean value of categorized LDL and Hct in anabolic positive and negative group**

Parameter	Group	Group (count [%])		Total	P
		Anabolic + (%)	Anabolic - (%)		
LDL	1.00	123 (62.8)	20 (43.5)	143	0.04
	2.00	39 (19.9)	16 (34.8)	55	
	3.00	34 (17.3)	10 (21.7)	44	
Hct	1.00	59 (30.1)	8 (17.4)	67	0.001
	2.00	108 (55.1)	20 (43.5)	128	
	3.00	29 (14.8)	18 (39.1)	47	
Total		196 (100)	46 (100)	242	

LDL = Low-density lipoprotein; Hct = Hematocrit

**Table 3: The mean value of SBP and DBP in anabolic positive and negative group**

Parameter	Group	Mean $\pm$ SD	P
SBP (mmHg)	Anabolic +	139.08 $\pm$ 15.29	0.022
	Anabolic -	133.39 $\pm$ 13.84	
DBP (mmHg)	Anabolic +	102.70 $\pm$ 16.18	0.034
	Anabolic -	97.71 $\pm$ 13.56	

SBP = Systolic blood pressure; DBP = Diastolic blood pressure; SD = Standard deviation

0.016, respectively) [Table 3]. Furthermore, analyzes showed that among anabolic consumers, 70% of subjects were categorized in hypertensive level (stage 1 and 2), while in the control group 35% suffered from hypertension (data not shown). No ECG changes were found within the follow-up period except occurrence of LVH in one case.

## DISCUSSION

Anabolic androgenic steroids are associated with direct effects such as cardiac muscle hypertrophy and myocardial fibrosis and indirect effects, including dyslipidemia, hypertension, arrhythmia, and myocardial infarction. It is likely that chronic exposure to these agents can result in significant alterations in the cardiovascular system, and their safety has not been fully established.<sup>[14]</sup>

One of the main findings of our investigation was finding an association between steroid consumption and changes in

lipid profile. Steroid abuse was not associated with altered HDL, TG, total cholesterol level and ECG abnormalities. A 20% increase in LDL plasma level and 20-70% decrease in HDL plasma level have been reported using anabolic steroid consumption.<sup>[7,15]</sup> We have found a significant association between anabolic steroid consumption and mean plasma level of LDL. We observed a decrease in mean plasma level of LDL. Interestingly, this finding is in contrast with previously reported findings. This might be due to the higher energy consumption consequent to the higher activity following anabolic steroid consumption. But we have not observed any significant decline in mean HDL plasma level, in which this finding is not in parallel with our finding. No change in TG and total cholesterol has been demonstrated by Hartgens *et al.* using consumption of anabolic steroids.<sup>[16]</sup>

The relation between anabolic steroid abuse and blood pressure is controversial. A link between anabolic steroid abuse and increase in blood pressure has been reported majority of related studies.<sup>[17-20]</sup> Whereas some others have shown no association.<sup>[21-24]</sup> Our results support the first hypothesis, indicating that anabolic steroids increase SBP and DBP and the amount of increase are associated with duration of abuse. The definite mechanism by which anabolic steroid increase blood pressure is not clear, but it has been suggested that overproduction of 11- $\beta$ -deoxycorticosterone by adrenal cortex may be responsible. In addition, androgens may also increase renal renin secretion resulting blood pressure increase.<sup>[25]</sup>

Electrocardiography abnormalities as LVH and arrhythmia were also reported using anabolic steroid consumption,<sup>[7-10]</sup> but surprisingly, no ECG abnormalities have been seen in our survey. An increase in the mean value of Hct with a significant difference between drug users and nonusers is in accordance with previous findings. This polycythemia has been attributed to the androgenic entity of these agents.

In our survey, we did not observe decreased HDL, altered TG/total cholesterol or sudden cardiac death. But we did not follow up cases for development of CVD.

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## AUTHOR'S CONTRIBUTION

FGH contributed in the conception of the work, clinical studies, literature search, data acquisition, conducting the study, and agreed for all aspects of the work. MRPA

contributed in the conception of the work, revising the draft, approval of the final version of the manuscript, and agreed for all aspects of the work. GRM contributed in the conception of the work, agreed for all aspects of the work. MB contributed in the conception of the work, conducting the study, revising the draft, approval of the final version of the manuscript and agreed for all aspects of the work. PP contributed in the conception and design of the work, revising the draft, approval of the final version of the manuscript, conducting the study, data acquisition and agreed for all aspects of the work.

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