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CARDIAC CONSEQUENCES OF ANABOLIC STEROID USE: LITERATURE REVIEW

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Abstract: The popularity of anabolic steroids is growing worldwide, as is the desire for peak physical performance. However, their side effects on the heart have not been discussed, and the general population has been overdosing beyond their physiological capacity, which has a major impact on cardiovascular health. The main objective of this study was to critically analyze the current literature that relates the use of steroids and anabolic steroids to cardiovascular alterations, seeking to understand their effects and impacts. This is a narrative bibliographical study, in which articles from the last 10 years that met the inclusion and exclusion criteria were analyzed, available in full and following the steps for screening the results, such as complete reading and selection of articles that were pertinent and corresponded to the objectives of the study. Analysis of the materials showed that prolonged and sometimes abusive use of steroids is associated with serious cardiovascular alterations, which can compromise the functioning of the heart, generating cardiac hypertrophy, lipid alterations that favor thromboembolic events, myocardial fibrosis, systolic and diastolic dysfunction, as well as lethal arrhythmias. Prolonged use of steroids and anabolic steroids is strongly linked to structural heart disease, often irreversible, which can result in sudden death. The findings reinforce the need to raise awareness about the risks of these compounds and the importance of clinical guidelines for case management and prevention.
Keywords: Anabolic steroids; Steroids; Cardiotoxicity; Ventricular hypertrophy; Arrhythmias

INTRODUCTION

The use of anabolic androgenic steroids (AASs) has been strongly amplified by the media and by celebrities both in and out of the digital environment, especially among professional athletes and gym-goers. With the aim of improving aesthetic appearance and achieving high physical performance, these substances have been increasingly used by the general population without knowledge of the adverse effects [1]

Anabolic steroids are synthetic substances derived from testosterone, widely used by athletes and bodybuilders to increase muscle mass and physical performance [2]. Although there is a therapeutic use, they are often widely used illicitly [3].

Studies show that the use of these substances is associated with a three times greater risk of hospitalizations, as well as an association with cardiovascular diseases [4]. The use of anabolic steroids is linked to serious cardiac pathologies, their abuse is closely associated with numerous toxic and hormonal effects, and identifying these patients to prevent side effects and consequences that can be irreversible is of paramount importance [2].

In view of this, this study aims to review and critically analyze the available literature on the cardiovascular effects of anabolic steroids, especially in athletes and physical activity practitioners.

METHODOLOGY

This study consisted of a narrative literature review, carried out with the aim of gathering and analyzing the available evidence on the Cardiac Consequences of Anabolic Use. The search for scientific articles was conducted in the SciELO and PubMed databases between November 2024 and April 2025.

The inclusion criteria adopted included articles published in the last 10 years (2015-2025), in Portuguese, Spanish and English, which were original articles, case studies, meta-analyses, case reports and systematic reviews, directly related to the central theme. Exclusion criteria were articles whose content was not relevant to the topic, according to an initial assessment of the titles and abstracts.

The search terms used included: "Steroids", "Anabolic steroids", "Cardiomyopathy", "Arrhythmia", "Atherosclerosis". To optimize the results, Boolean operators (*AND*) and filters were used for articles published in the last 10 years, available in full and based on studies in human species, restricting the articles to the conditions previously established in the exclusion criteria.

The selection of studies was carried out in three stages: initially, the titles and abstracts were screened to identify the articles that met the inclusion criteria. The selected papers were then read in full. Finally, only studies that provided information relevant to the study's objectives were included.

RESULTS

The literature review showed that the use of anabolic androgenic steroids (AAS) is associated with a series of serious cardiovascular alterations that affect cardiac structure and function. The main findings are summarized in the Table and detailed below.

DISCUSSION

PATHOPHYSIOLOGY:

Steroids are used orally or intramuscularly and are absorbed and sent to target tissues, where they bind to androgen receptors or undergo biotransformation. Testosterone, for example, can be transformed into dihydrotestosterone by the enzyme 5alpha-reductase, increasing its androgenic power, or into estradiol by aromatase, varying its biological effects [7].

In addition to promoting muscle growth, these mechanisms are involved in a series of adverse effects, especially on the cardiovascular system [7].

Amendment	Description	Data/Evidence	References
Left Ventricular Hypertrophy	Increased thickness of the heart muscle, with fibrosis and necrosis of the tissue.	Myocardial fibrosis was observed in 79% of cases and tissue necrosis in 52%.	[2, 5]
Cardiac dysfunction	Reduced ejection fraction and impaired diastolic relaxation.	LVEF: 52% +/- 11% (users) vs. 63% +/- 8% (non-users; p< 0.001).	[8]
Sudden Cardiac Death	Increased risk of sudden death due to atherosclerosis, thrombosis and myocardial damage.	6 to 20 times greater risk; 1/3 of deaths from cardiovascular disease.	[5, 9]
Lipid changes	Reduced HDL and increased LDL, favoring atherosclerosis and heart attacks.	Reduced HDL and elevated LDL in users of EAAS.	[6]
Arrhythmias	Myocardial hypertrophy and fibrosis create scenarios for lethal arrhythmias.	Increased risk of ventricular tachycardia and atrial fibrillation.	[9]

Source: Authors 2025

CARDIAC HYPERTROPHY AND EJECTION FRACTION:

Hypertrophic cardiomyopathy is an enlargement of the left ventricle that is not directly linked to hypertension or other diseases, but the use of steroids is directly linked to this pathology. A study that analyzed 33 bodybuilders found that 33% of the patients had cardiomegaly and 30% had left ventricular hypertrophy, as well as other manifestations that were detected histologically, such as myocardial fibrosis (79%) and cardiac necrosis at some points (52%) [5]. Another study carried out in Sweden with 87 patients showed that the use of EAAs can lead to hypertrophic cardiomyopathy [2].

Ejection fraction (EF) was also strongly affected compared to non-users, where EF was significantly lower in those who used these substances, indicating systolic dysfunction. In addition, the speed of early relaxation in diastole was lower in users of EAAs, also demonstrating diastolic dysfunction. [8]

A study of 24 athletes who used anabolic steroids and 20 healthy athletes showed that the basal-septal region in users showed depressed myocardial function, compared to genetic hypertrophic cardiomyopathy, with alterations in the septal and apical regions [10].

SUDDEN DEATH

Sudden cardiac death (SCD) is one of the most common medical causes of death in athletes and is regularly correlated with the use of drugs to improve performance. It is estimated that 1 in 200,000 young athletes suffer from SCD [2]. The proposed causes of sudden death in people who use EAAs are atherogenic alterations, thrombosis, vasospasm and direct myocardial injury [5].

Continued long-term use of anabolic steroids is associated with a 6 to 20-fold increase in cardiovascular mortality in recreational athletes, where almost a third of these deaths are attributed to cardiovascular diseases [9]. Studies show that 50% of men who use anabolic steroids have coronary atherosclerosis, a factor that predisposes to a possible acute myocardial infarction [9]

LIPOPROTEIN CHANGES:

Users of anabolic steroids can show significant changes in their lipid profile, with studies showing that this leads to a reduction in plasma levels of HDL (high-density lipoprotein) and an increase in LDL (low-density lipoprotein), as well as a high risk of thrombogenicity due to increased platelet activation [3, 6].

A case of a 43-year-old man who had been using nandrolone and testosterone for more than 20 years showed that his HDL levels were low and his LDL was increased, in addition to

a chronic total occlusion in several coronary arteries that was seen on the coronary angiogram, although he was treated with a coronary artery bypass graft, he had moderate biventricular dysfunction while continuing to use steroids [3].

Another comparative study also between users and non-users showed the same changes in lipid levels, where HDL was low and LDL was increased [6].

ARRHYTHMIAS:

In addition to cardiac arrhythmias being a chronic complication in those who use AAS, the ventricular hypertrophy and myocardial fibrosis that have been observed end up generating a favorable field for the appearance of lethal arrhythmias, multiplying the risk of cardiovascular events [9]. The direct trophic effect of anabolic steroids leads to inadequate hypertrophy, which also contributes to lethal arrhythmias [2].

OTHER CARDIOVASCULAR CHANGES:

In addition to all the cardiovascular alterations and effects, the use of EAAs is linked to other types of alterations, as mentioned in the case of a 60-year-old male bodybuilder, where in addition to presenting a reduced ejection fraction (25% - 30%) and Polycythemia, which generated blood viscosity and a risk of thromboembolic events [11]. In addition, a control study analyzed 50 participants, where those who used steroids showed greater coronary inflammation, assessed by Pericoronary Fat Attenuation (PFA), and increased levels of pro-inflammatory cytokines such as IL-1, IL-6 and IL-10 [6]

CONCLUSION

Based on the results presented, it can be concluded that the use of steroids and androgenic anabolic steroids is linked to serious cardiovascular alterations and can be considered a relevant risk factor. As presented in the case of the 60-year-old bodybuilder, where even after improving with treatment, he remained symptomatic with heart failure [11]. In addition, changes in the lipid profile and functional and structural alterations were also the result of prolonged steroid use, where there was an increase in the thickness of the interventricular septum (12.8 ± 2.1 mm) and a reduction in the ejection fraction (58.2 ± 5.7% vs. 64.9 ± 5.9% in non-users) [6, 8, 10], in addition, cardiac hypertrophy with myocardial fibrosis can be an alarming factor for lethal arrhythmias [2, 5, 9].

The study had some limitations that should be considered when interpreting the results. The main limitation was the small number of long--term studies, as well as the lack of research on humans, with control groups and field research.

Finally, the results obtained reinforce the importance of general knowledge about the cardiotoxic effects of steroids and anabolic steroids, where there is a deficit of information in the population about the pathophysiological mechanisms involved. The evidence found may suggest including the use of anabolic steroids as a risk factor, which could help health professionals make decisions. In addition, the data presented may broaden the discussion on the subject, fostering future research and creating new protocols or guidelines.

In view of the limitations found, it is suggested that future research focus on the long-term context, as well as thoroughly investigating the population that uses androgens, through controlled trials and more robust methodologies. Future research could not only consider the use of precise technologies or instruments, but also interdisciplinary approaches. These initiatives could contribute to the advancement of scientific knowledge.

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