

Anabolic-Androgenic Steroids and Cardiotoxicity

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Short Editorial referring to the article: *Systolic Subclinical Dysfunction in Anabolic Steroid Users: A Real Life Study*

Anabolic-androgenic steroids (AAS) are a class of natural and synthetic hormones, which owe their name to their chemical structure (steroid nucleus) and their biological, anabolic, and androgenic effects.¹ Misuse of AAS for aesthetic and performance purposes has become widespread, as they provide increases in muscle mass and strength.¹ It is estimated that approximately 3.5% of the world's population uses AAS.

Use of AAS dates back to ancient Greece, followed by the Second World War. They were detected in sports competitions in 1954 and later disseminated among bodybuilders and identified in various sports in the Tokyo 1964 Olympic Games.² Currently, we are witnessing a growing encouragement of AAS use for aesthetic purposes, through “beauty chips” and disguised as hormone replacement therapy. This indiscriminate use culminated in a resolution by the Brazilian Federal Council of Medicine against the prescription of these hormones for aesthetic purposes.³

The literature is rich in demonstrating adverse systemic effects of AAS, which increase the risk of adverse cardiovascular events, as they cause atherosclerosis, by increasing LDL cholesterol and inflammation; vasoconstriction, by action on the renin-angiotensin-aldosterone system; thrombosis, by direct action on prostaglandins, synthesis of procoagulant factors and consequent interference in the coagulation cascade, in addition to stimulating hematopoiesis; and vascular injury⁴ (Figure 1).

It is also possible to demonstrate myocardial repercussions, either by direct action on cardiomyocytes or by collagen deposits, leading to cardiac muscle remodeling, fibrosis, hypertrophy, and/or heart failure.⁴

Advances in noninvasive techniques have allowed better analysis of the impact of AAS on the myocardium and ventricular function. Recent publications have demonstrated the direct cardiotoxicity of these substances, regardless of whether they increase and/or worsen other risk factors for cardiovascular diseases.⁴⁻⁷

Baggish et al., using echocardiography and coronary angiogram, observed greater left ventricular mass

and concentric hypertrophy, reduced systolic and diastolic function, and greater coronary plaque volume in AAS users.⁵

Smit et al., using data from the HAARLEM study (health risks of anabolic androgenic steroid use by male amateur athletes), with echocardiography performed in 3 phases (before the AAS cycle, after the AAS cycle, and 1 year after inclusion), confirmed the data from previous studies. It is worth noting that around 41% developed arterial hypertension, and more than 50% developed erythrocytosis, which was classified as an independent risk factor for adverse cardiovascular events. However, after one year of discontinuation of use, the parameters normalized.⁶

Abdullah et al. used speckle tracking to observe longitudinal, circumferential, radial, and torsional deformations. The authors concluded that AAS users had biventricular systolic and diastolic dysfunction, with 47% having left ventricular ejection fraction lower than 49%.⁷ In this context, this technique can help in the early identification of myocardial pathologies induced by AAS use.

Castro et al. demonstrated the importance of using variables obtained by speckle tracking in the detection of subclinical dysfunction, showing that these variables are still little used in this population.⁸ In a retrospective and observational study, they analyzed the echocardiograms of bodybuilders, comparing the results between two groups: users and non-users of AAS. They added the analysis of myocardial work indexes, which combine the measurement of systolic blood pressure and echocardiographic data of deformation curves. Myocardial work allowed the analysis of left ventricular efficiency, being an effective technique for the evaluation of ventricular performance.⁸

Castro et al. demonstrated that, even with normal conventional echocardiography parameters, AAS users have subclinical systolic dysfunction, which can only be identified using speckle tracking techniques.⁸ All AAS users had left ventricular global longitudinal strain values below normal, with 78% having subclinical systolic dysfunction, despite a normal left ventricular ejection fraction. The changes found with speckle tracking techniques in AAS users confirm ventricular dysfunction related to steroid abuse, being an effective way of detecting this pathology early.⁸

The warning against abusive use of AAS is highlighted by the recent article by Windfeld-Mathiasen et al., who evaluated the incidence of adverse cardiovascular events in AAS users. The authors found a 3-fold increased risk of acute myocardial infarction; a higher risk of arrhythmias, atrial fibrillation being the most prevalent; a 9-fold increased risk of developing dilated cardiomyopathy; and a higher risk of deep vein thrombosis.⁹

AAS use has been widespread among young or middle-aged individuals for aesthetic and/or recreational purposes,

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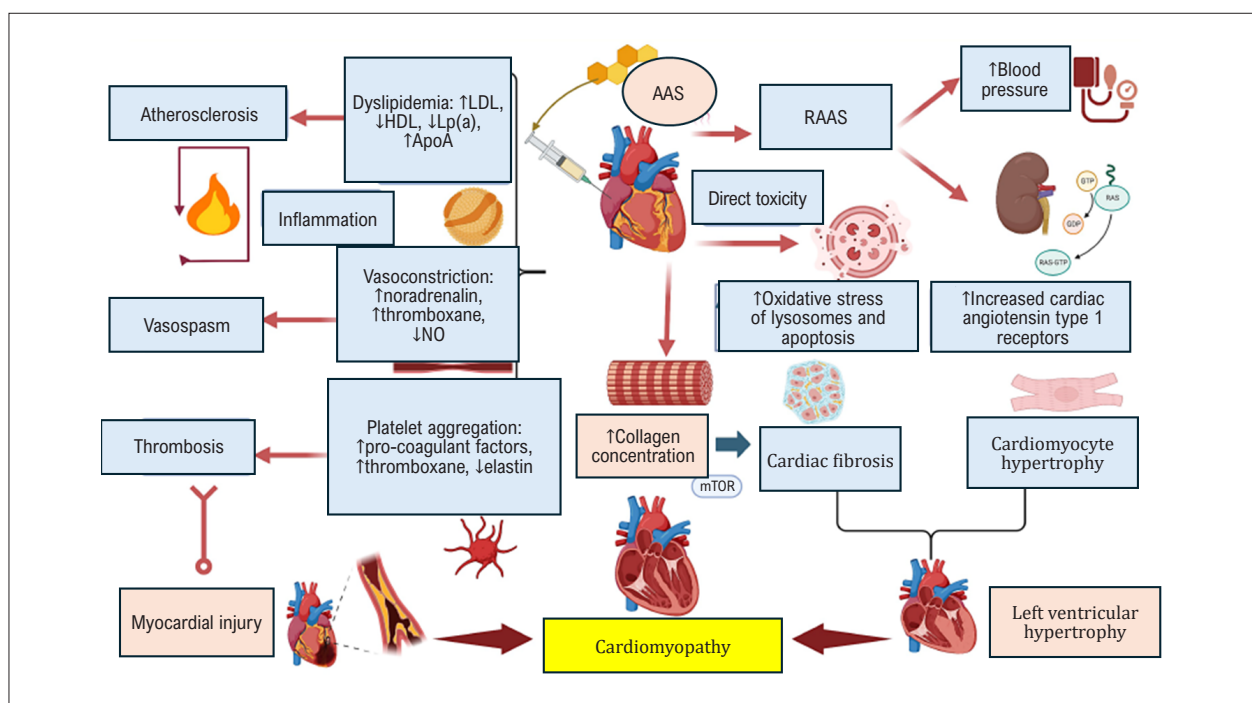


Figure 1 – Mechanisms of cardiovascular injury due to AAS. Adapted from Fadah et al.⁴ AAS: anabolic-androgenic steroids; ApoA: apolipoprotein A; HDL: high-density lipoprotein; LDL: low-density lipoprotein; Lp(a): lipoprotein(a); NO: nitric oxide; RAAS: renin-angiotensin-aldosterone system.

even in those who do not identify as athletes. In this population with evidence of unexplained ventricular dysfunction or premature coronary artery disease, cardiotoxicity due to AAS use should be considered in the differential diagnosis.

AAS abuse should be a public health concern, highlighting the need for longitudinal studies that examine the occurrence of adverse cardiovascular events related to the dose and duration of their use.

References

1. Bond P, Smit DL, de Ronde W. Anabolic-Androgenic Steroids: How do they Work and what are the Risks? *Front Endocrinol.* 2022;13:1059473. doi: 10.3389/fendo.2022.1059473.
2. Roque RF, Rocha FL, Hashimoto N, Alves MJNN, Negrão CE, Oliveira EM. Efeitos do Uso de Esteróide Anabolizantes: Do Atleta ao Paciente. *Rev Soc Cardiol Estado de São Paulo.* 2007;1(Suppl A):21-4.
3. Conselho Federal de Medicina. Resolução CFM nº 2.333/2023. Adota as Normas Éticas para a Prescrição de Terapias Hormonais com Esteróides Androgênicos e Anabolizantes de acordo com as Evidências Científicas Disponíveis sobre os Riscos e Malefícios à Saúde, Contraindicando o Uso com a Finalidade Estética, Ganho de Massa Muscular e Melhora do Desempenho Esportivo. *Diário Oficial da União.* 2023 Apr 11(69 seção 1):226.
4. Fadah K, Gopi G, Lingireddy A, Blumer V, Dewald T, Mentz RJ. Anabolic Androgenic Steroids and Cardiomyopathy: An Update. *Front Cardiovasc Med.* 2023;10:1214374. doi: 10.3389/fcvm.2023.1214374.
5. Baggish AL, Weiner RB, Kanayama G, Hudson JI, Lu MT, Hoffmann U, et al. Cardiovascular Toxicity of Illicit Anabolic-Androgenic Steroid Use. *Circulation.* 2017;135(21):1991-2002. doi: 10.1161/CIRCULATIONAHA.116.026945.
6. Smit DL, Voegel AJ, den Heijer M, de Ronde W. Anabolic Androgenic Steroids Induce Reversible Left Ventricular Hypertrophy and Cardiac Dysfunction. Echocardiography Results of the HAARLEM Study. *Front Reprod Health.* 2021;3:732318. doi: 10.3389/frph.2021.732318.
7. Abdullah R, Bjørnebekk A, Hauger LE, Hullstein IR, Edvardsen T, Haugaa KH, et al. Severe Biventricular Cardiomyopathy in Both Current and Former Long-Term Users of Anabolic-Androgenic Steroids. *Eur J Prev Cardiol.* 2024;31(5):599-608. doi: 10.1093/eurjpc/zwad362.
8. Castro RRT, Campos MB, Mello L, Silveira JG Neto. Systolic Subclinical Dysfunction in Anabolic Steroid Users: A Real Life Study. *Int J Cardiovasc Sci.* 2025;38:e20240193. doi: 10.36660/ijcs.20240193.
9. Windfeld-Mathiasen J, Heerfordt IM, Dalhoff KP, Andersen JT, Andersen MA, Johansson KS, et al. Cardiovascular Disease in Anabolic Androgenic Steroid Users. *Circulation.* 2025;151(12):828-34. doi: 10.1161/CIRCULATIONAHA.124.071117.



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