

ANABOLIC STEROID USE: A GROWING WORLDWIDE SUBSTANCE USE DISORDER

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Introduction: Millions of individuals use anabolic-androgenic steroids (AAS), including testosterone and its synthetic relatives, to gain muscle. However, most AAS users in the general population began use after the 1980s, and thus the oldest of these individuals are only now reaching middle age.

Method / Approach: Studies from my laboratory and others assessing long-term adverse effects of AAS.

Key Findings: *Cardiovascular disease:* a large recent study from my laboratory, together with earlier smaller studies, has demonstrated that AAS frequently cause cardiomyopathy. Additionally, AAS users display premature atherosclerotic disease, probably attributable to AAS-induced dyslipidemia, and may experience early-onset heart attacks or strokes.

Neuroendocrine effects: AAS suppress the hypothalamic-pituitary-testicular axis in males, causing users to develop AAS-withdrawal hypogonadism after stopping a course of AAS. Emerging evidence indicates that AAS-withdrawal hypogonadism persists for months or years in many individuals and may occasionally become irreversible.

Psychiatric effects: Some AAS users develop hypomanic or manic episodes while taking AAS, and major depressive episodes during AAS withdrawal. However, only a minority of AAS users develop such effects, and the reasons for these idiosyncratic reactions remain unknown.

Neurotoxic effects: Animal and laboratory studies suggest that *both* supraphysiologic androgen levels (experienced by AAS users when on-drug) *and* hypogonadal androgen levels (experienced during AAS withdrawal) cause neurotoxic effects. Preliminary human data suggest that long-term AAS users exhibit cognitive deficits and abnormalities on neuroimaging.

Discussions and Conclusions: Adverse effects of long-term AAS exposure may create a growing public-health problem as increasing numbers of users reach middle age and beyond.

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