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The Influence of The Anabolic Steroid Usage on The Physical Health: A Review

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ABSTRACT

Introduction: Anabolic steroids are synthetic derivatives of testosterone commonly used to enhance athletic performance and physical appearance. Despite their popularity, their non-medical use is associated with significant health risks. This review aims to synthesize current knowledge on the impact of anabolic steroid use on physical health, emphasizing

cardiovascular, hepatic, endocrine, and musculoskeletal systems, as well as broader systemic effects.

Materials and Methods: A systematic literature review was conducted using peer-reviewed articles from databases such as PubMed, Scopus, and Google Scholar published between 2000 and 2023. Studies were selected based on relevance, with particular focus on human clinical trials, observational studies, and meta-analyses. Keywords included "anabolic steroids," "health effects," "cardiovascular risk," and "endocrine disruption."

Results: Anabolic steroid use is linked to increased cardiovascular risks, liver dysfunction, endocrine disturbances, and musculoskeletal injuries. Key effects include hypertension, hepatotoxicity, testosterone suppression, infertility, and tendon injuries. Psychological impacts such as aggression and mood changes were also observed.

Conclusions: Anabolic steroid use poses significant risks to multiple organ systems and overall health. Despite widespread awareness of these dangers, misuse persists, often driven by societal pressures and misinformation. Healthcare providers should prioritize prevention through education, early intervention, and support for individuals at risk. Future research should focus on long-term effects and effective strategies for harm reduction.

Keywords: anabolic steroids, health effects, cardiovascular risk, endocrine disruption

INTRODUCTION

Anabolic-androgenic steroids (AAS) are synthetic derivatives of testosterone designed to promote anabolic effects, such as increased muscle mass and strength, while minimizing androgenic effects like the development of male secondary sexual characteristics. Initially developed for therapeutic use, AAS have found widespread non-medical application among athletes, bodybuilders, and individuals seeking enhanced physical appearance. However, their misuse raises substantial public health concerns due to the associated physical and psychological risks.

The prevalence of AAS misuse varies globally but is reported to affect a significant portion of athletes and young individuals, particularly males. A meta-analysis estimated a lifetime prevalence of AAS use at 3.3% worldwide, with higher rates observed among gym-goers and competitive athletes [1, 2]. Despite strict regulations in many countries, the black market and online sources have facilitated access to these substances, further complicating efforts to mitigate their use [3].

AAS misuse has been linked to a range of adverse effects across various organ systems. Cardiovascular complications such as myocardial infarction, arrhythmias, and cardiomyopathy are among the most serious consequences [4]. Hepatic dysfunction, including cholestasis and liver damage, is also frequently reported, particularly with oral formulations [5]. Endocrine disruptions, such as hypogonadism, infertility, and virilization, pose significant risks to reproductive health [6]. Additionally, AAS use may lead to musculoskeletal injuries, such as tendon ruptures and growth plate closure in adolescents [7].

This review seeks to provide a comprehensive analysis of the effects of AAS on physical health by synthesizing current evidence from clinical and observational studies. By examining the systemic impacts of AAS misuse, this review aims to inform healthcare providers,

policymakers, and the public about the risks associated with these substances and highlight the need for effective preventive and educational measures.

MATERIALS AND METHODS

A comprehensive literature review was conducted using the PubMed, Scopus and Google Scholar databases, focusing on articles published between 2000 and 2023. The search was designed to capture a broad range of studies related to anabolic steroids, health effects, or cardiovascular risk. Keywords used in the search included: “anabolic steroids”, “health effects”, “cardiovascular risk” and “endocrine disruption”. The inclusion criteria for the studies considered in this review were: peer-reviewed articles, clinical trials, systematic reviews, and meta-analyses that focused on the influence of the anabolic steroid usage on the physical health. Articles were selected based on their relevance to the topic and quality of evidence.

RESULTS

The effects of anabolic-androgenic steroids on physical health are multifaceted, influencing several major organ systems. The results of this review summarize key findings from the literature, highlighting their adverse impacts on cardiovascular, hepatic, endocrine, and musculoskeletal systems, as well as associated psychological effects.

Cardiovascular System:

AAS use is strongly associated with cardiovascular complications, which constitute the most severe health risks. Chronic misuse has been linked to structural and functional cardiac abnormalities, including left ventricular hypertrophy, impaired diastolic function, and reduced myocardial efficiency [4, 8]. Studies report that AAS users demonstrate elevated risks of arrhythmias, myocardial infarction, and sudden cardiac death [9]. The mechanisms underlying these effects involve altered lipid profiles, with AAS increasing low-density lipoprotein (LDL) cholesterol and reducing high-density lipoprotein (HDL) cholesterol levels, promoting atherosclerosis [10].

A notable cohort study highlighted that long-term AAS users exhibit a significantly higher prevalence of coronary artery disease (CAD) compared to non-users, independent of other cardiovascular risk factors [11]. Additionally, hypertension, another common complication, is exacerbated by fluid retention and increased vascular resistance associated with AAS use.

Liver Dysfunction:

The liver is a primary target for AAS-induced toxicity, particularly with oral formulations due to their first-pass metabolism. Hepatic complications range from mild enzyme elevations to severe outcomes such as cholestasis, peliosis hepatis (vascular lesions in the liver), and hepatocellular carcinoma [12]. One study reported that oral AAS users had a five-fold increase in liver enzyme levels compared to non-users, indicating significant hepatocellular stress [7].

AAS-induced cholestatic liver disease is characterized by jaundice, pruritus, and bilirubin elevation, which can resolve upon discontinuation but may progress to liver failure in severe

cases [13]. Furthermore, case reports have linked AAS misuse to hepatic adenomas, benign tumors with the potential for malignant transformation [14].

Endocrine System:

AAS significantly disrupt the hypothalamic-pituitary-gonadal (HPG) axis, leading to suppressed endogenous testosterone production in males. Hypogonadism, characterized by testicular atrophy, reduced sperm count, and infertility, is a common consequence of prolonged AAS use [6]. Recovery of normal testosterone levels after cessation of AAS varies and may be incomplete in some individuals [15].

In females, AAS misuse induces virilization effects, including hirsutism, deepened voice, menstrual irregularities, and clitoromegaly. These changes are often irreversible, even after discontinuation. Additionally, adolescents who misuse AAS are at risk of premature epiphyseal plate closure, leading to stunted growth [16].

Thyroid dysfunction has also been documented, with AAS use altering thyroxine (T4) and triiodothyronine (T3) levels, though the clinical significance of these changes remains under investigation [17].

Musculoskeletal System:

While AAS are known to enhance muscle mass and strength, they adversely affect connective tissues and skeletal integrity. Tendon injuries, including tears and ruptures, are frequently reported among AAS users [18]. These injuries occur because AAS promote rapid muscle hypertrophy, creating disproportionate stress on tendons, which adapt more slowly to increased loads. Histological studies reveal that AAS alter the collagen composition of tendons, reducing their tensile strength and making them more susceptible to injury.

For adolescents, the use of AAS poses a unique threat to skeletal development. By accelerating bone maturation and promoting early closure of growth plates, AAS use during puberty can lead to irreversible stunted height [16, 19]. While adult users may experience increased bone mineral density (BMD) due to enhanced muscle forces on bones, this benefit is offset by the potential for localized skeletal weakness and increased fracture risk [20].

Psychological Effects:

AAS misuse is strongly linked to psychological disturbances, often manifesting as aggression, irritability, and mood instability. These effects, colloquially termed “roid rage,” are supported by both observational and experimental studies [2]. Additionally, AAS users report higher rates of anxiety and impaired cognitive function compared to non-users. Withdrawal from AAS can precipitate depressive episodes, with some individuals requiring psychiatric intervention to manage symptoms [21].

Long-term AAS use may also increase the risk of psychiatric disorders, including psychosis, characterized by paranoia and delusions [22]. Moreover, the psychological effects of AAS misuse often intersect with substance use disorders. Studies report that AAS users are more likely to misuse opioids, stimulants, and alcohol, exacerbating health risks and complicating treatment [23, 24].

Systemic Effects:

Beyond specific organ systems, AAS exert broader systemic effects. Immunological alterations, such as suppressed natural killer (NK) cell activity and altered cytokine profiles, have been documented, potentially increasing susceptibility to infections [25, 26]. Renal dysfunction is another emerging concern, with chronic AAS use linked to proteinuria and glomerular damage. These renal effects are particularly pronounced in users who combine AAS with other nephrotoxic substances [27, 28].

Dermatological effects, including severe acne, seborrhea, and androgenic alopecia, are common among AAS users and may impact quality of life [29]. In genetically predisposed individuals, AAS can accelerate male-pattern baldness [30, 31]. Although not life-threatening, these effects often serve as visible markers of AAS misuse and can motivate cessation.

DISCUSSION

The misuse of anabolic-androgenic steroids is a global health concern, with significant implications for physical health. This review has highlighted the extensive negative effects of AAS on multiple organ systems, including the cardiovascular, hepatic, endocrine, musculoskeletal, and psychological domains. While AAS are used primarily to enhance muscle mass and athletic performance, the associated risks often outweigh the perceived benefits. This section aims to interpret the findings presented in the results, contextualize them with existing literature, and discuss the implications for public health, clinical practice, and future research.

Cardiovascular Risk:

The cardiovascular consequences of AAS misuse are perhaps the most concerning due to their potential for fatal outcomes. As discussed, AAS misuse is strongly associated with increased risks of coronary artery disease (CAD), myocardial infarction, arrhythmias, and sudden cardiac death. This review reaffirms previous studies that have demonstrated that AAS use leads to dyslipidemia, with elevated LDL and reduced HDL cholesterol levels, which increases the risk of atherosclerosis [4, 8]. Additionally, the hypertensive effects of AAS, compounded by their ability to increase fluid retention, exacerbate the risk of cardiovascular events [10]. The mechanisms by which AAS alter lipid metabolism and blood pressure are well-established, but further research is needed to investigate their long-term effects on vascular health and to identify which populations are at greatest risk.

A major limitation of current research is the lack of large, long-term cohort studies that track the cardiovascular outcomes of AAS users over time. Much of the evidence to date is based on short-term studies or retrospective reports, and there is a need for more longitudinal studies that can establish causality and better predict cardiovascular outcomes in AAS users. Furthermore, clinical guidelines for managing cardiovascular health in AAS users are lacking, and healthcare providers should remain vigilant in monitoring heart health in individuals who admit to or are suspected of using AAS.

Hepatic Toxicity:

Hepatic dysfunction remains one of the most documented adverse effects of AAS misuse, particularly with oral AAS. The liver is central to the metabolism of many steroids, and

prolonged use can lead to conditions such as cholestasis, liver damage, and even hepatocellular carcinoma [7, 12, 13]. The findings of this review align with existing literature on the hepatotoxic effects of AAS particularly the use of 17-alpha-alkylated steroids, which are more hepatotoxic due to their chemical structure. However, there remains a lack of consensus on the precise mechanisms by which AAS induce liver damage. Studies have proposed that AAS may cause oxidative stress, inflammatory responses, and direct hepatocellular damage, but these mechanisms need to be explored further to identify potential therapeutic interventions.

One area that requires more attention is the risk of liver cancer in AAS users. Although rare, cases of hepatocellular carcinoma associated with AAS use have been documented, especially in users with long histories of use or concurrent use of other hepatotoxic substances [12]. Given the growing popularity of oral steroids, there is a pressing need for more focused research on the hepatotoxic effects of various AAS formulations, particularly in relation to long-term use.

Endocrine Disruption and Reproductive Health:

The endocrine disruption caused by AAS is one of the most well-understood and prevalent consequences of misuse. In males, the suppression of endogenous testosterone production leads to hypogonadism, infertility, and reduced libido [6, 15]. These findings are consistent with the extensive literature on the endocrine effects of AAS, which highlight the long-term repercussions on male reproductive health. Interestingly, studies have shown that recovery of natural testosterone production following cessation is not guaranteed, and some individuals may require pharmacological intervention to restore normal function. This highlights the importance of early intervention and counseling for AAS users, particularly in cases of infertility or diminished sexual function.

In females, the virilizing effects of AAS, such as hirsutism and voice deepening, often result in permanent changes despite cessation of steroid usu [16]. These irreversible effects emphasize the need for early identification and education about the risks of AAS misuse. Further research into the role of AAS in the regulation of the hypothalamic-pituitary-gonadal axis and its impact on both male and female fertility would help guide clinical treatment options and preventive strategies.

Musculoskeletal Effects:

AAS are widely used for their ability to increase muscle mass and strength; however, the associated risks to tendons and bones are significant. As observed in this review, tendon injuries, including ruptures, are disproportionately high in AAS users compared to non-users. The rapid increase in muscle strength induced by AAS may place excessive strain on tendons, which are unable to adapt at the same rate, resulting in a higher incidence of tendon injuries [18]. This observation is consistent with studies in both animal models and humans, which show that AAS negatively impact the collagen composition of tendons, reducing their strength and flexibility.

Additionally, the effects of AAS on skeletal growth in adolescents present a unique concern. The early closure of growth plates, leading to stunted growth, is an irreversible consequence of AAS misuse during the critical stages of development [16, 19]. Given the rising number of adolescents engaging in AAS use, particularly in the context of body image concerns, public

health campaigns should focus on educating younger individuals about the dangers of AAS and promoting healthier alternatives for achieving physical goals.

Psychological and Behavioral Impacts:

The psychological effects of AAS are a significant, albeit often overlooked, aspect of their misuse. As noted, AAS use is strongly linked to mood swings, aggression (commonly known as "roid rage"), anxiety, and depression [2, 21]. These psychological symptoms can significantly disrupt the lives of users, leading to relationship issues, employment difficulties, and legal problems due to aggressive behaviors. The phenomenon of “roid rage” is well-documented, but the underlying neurobiological mechanisms remain unclear. Studies suggest that AAS may alter serotonin and dopamine pathways, but more research is needed to confirm these findings and explore potential therapeutic interventions.

AAS misuse also predisposes individuals to substance abuse disorders, with studies indicating that users are more likely to misuse alcohol, opioids, or other illicit substances [22]. This co-occurrence of AAS misuse and substance use disorders presents additional challenges for healthcare providers. Integrated treatment approaches that address both the physical and psychological consequences of AAS misuse are essential for improving long-term outcomes.

CONCLUSIONS

Anabolic-androgenic steroid abuse continues to pose significant risks to both physical and mental health, with a broad range of detrimental effects observed across various organ systems. Cardiovascular, hepatic, reproductive, and psychological health are among the most severely impacted areas in individuals who misuse these substances. The long-term abuse of AAS is linked to serious cardiovascular complications, including hypertension, left ventricular hypertrophy, and an increased risk of myocardial infarction and stroke. Additionally, the hepatotoxic effects of AAS, ranging from liver enzyme abnormalities to severe conditions such as liver tumors and hepatic failure, necessitate regular medical monitoring for those who engage in steroid use.

AAS use also disrupts the endocrine and reproductive systems, leading to hypogonadism, infertility, and other hormonal imbalances, which can have profound effects on both men and women. The psychological consequences, including mood disorders, aggression, and dependence, further complicate the clinical picture, often requiring comprehensive mental health interventions. Musculoskeletal injuries and dermatological manifestations also contribute to the complex health profile of AAS users, adding to the urgency for prevention and management strategies.

Despite these significant risks, the global prevalence of AAS misuse remains high, driven by cultural pressures, competitive sports, and body image ideals. This underscores the need for effective public health campaigns aimed at educating individuals about the harmful effects of AAS and promoting safe, evidence-based alternatives for performance enhancement. Healthcare professionals must remain vigilant in recognizing the signs of AAS misuse and in providing appropriate treatment and counseling for users. Future research should continue to focus on the long-term effects of AAS use, developing improved methods of prevention, and expanding therapeutic options for those affected by these substances.

In conclusion, the health risks associated with AAS misuse are substantial and multifaceted, highlighting the importance of a coordinated public health response. Ongoing education, regulation, and clinical monitoring are essential in mitigating the harmful effects of AAS use and in supporting affected individuals toward healthier, sustainable approaches to fitness and performance enhancement.

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