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ANABOLIC ANDROGENIC STEROIDS: SIDE EFFECTS, POTENTIAL PIPELINES TO USE, AND THE CURRENT STATE OF OPINION AMONG THE YOUTH

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Abstract: *Anabolic-Androgenic steroids (AAS) are a class of drugs primarily used for hormone replacements; however, many athletes take them to elevate performance and physical capabilities. While previously AAS were primarily used by professional athletes, over time adolescent individuals have begun to use these substances despite the slew of negative side effects. In this paper we will discuss the current state of AAS, specifically what they are and their mode of action, side effects of using various AAS, the ease of use, general opinions of high school students and young adults, potential influencing factors that can lead to abusing AAS, ethical considerations regarding AAS-use and their current status, and a discussion reading how to minimize addiction among the American youth.*

In order to gauge public opinion on AAS, we surveyed 111 individuals, ranging from 14 to 22 years of age. We approached public gym-goers and asked them if they wanted to participate in an anonymous survey regarding their opinions on AAS. We collected data from five gyms and three high schools in different parts of Philadelphia, Pa and Boston, Ma. Survey results suggested that sports, especially high-contact sports, can heavily influence a person to use AAS. It was also determined that a large gap in formal education regarding these drugs exists, and a majority of the survey respondents have learned about AAS through social media.

Keywords: *Androgens, glucocorticoids, anabolic-androgenic steroids, performance enhancing drugs, hypothalamic–pituitary–gonadal axism, sex hormone-binding globulin, hypomania.*

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INTRODUCTION

Anabolic-Androgenic steroids (AAS) have been used over the past 40 years by world class athletes and even the general population. AAS were first introduced into the world of sports in the 1950s-1970s where it was predominantly used by weightlifters and bodybuilders to enhance performance. Over time, they were slowly disseminated to the general population in the 1990s. Nowadays, AAS have reached as far as adolescent adults. Whether adolescents are using it for strength and conditioning or for peer approval, the use of AAS has skyrocketed in the 21st century.[38] Through this discussion, we intend to highlight the negative effects steroids could have on the adolescent population, while also focusing on the physiological and psychological side effects AAS-use can cause in adolescent adults. The physiological side effects include both external and internal ones while psychological effects include behavioral and psychiatric side effects.

In order to gauge public opinion on AAS and other performance enhancing drugs (PEDS), we conducted anonymous surveys at various fitness centers. We aimed to understand why the youth is willing to use AAS, how peers perceive the negative and positive consequences of taking them, and factors influencing athletes' and students' inclination towards the drugs.

THE SCIENCES OF ANDROGEN STEROIDS

Among both androgenic and estrogenic steroids, testosterone and estradiol are amongst the highly thought of steroids that play a vital role to regulate reproductive health. These hormones are primarily synthesized in the gonads after puberty and play a crucial role in shaping and maintaining the majority of secondary sex traits; physical features that distinguish males and females after puberty but not directly involved in reproduction. In males, these include facial and body hair, deepening of the voice, and increased muscle mass, while in females they include breast development, widening of the hips, and characteristic fat distribution.

The hypothalamic–pituitary–gonadal (HPG) axis plays a central role in controlling testosterone levels and overall gonadal function.[39] The hypothalamus releases gonadotropin-releasing hormone (GnRH), which stimulates the anterior pituitary to produce two key hormones: luteinizing hormone (LH) and follicle-stimulating hormone (FSH).[39] LH specifically targets the Leydig cells in the testes, signaling them to produce testosterone. When circulating testosterone levels rise too high, a negative feedback mechanism is triggered, this reduces GnRH release from the hypothalamus and decreases the pituitary's sensitivity to GnRH, thereby lowering LH and FSH output and restoring balance.[39]

Most circulating testosterone is bound to plasma proteins, primarily sex hormone-binding globulin (SHBG) and albumin. This protein-bound fraction serves as the body's reservoir of testosterone. Only a small portion remains free (unbound) in the bloodstream, and this biologically active fraction is what acts directly on target tissues such as bone, muscle, and the prostate gland. Within cells, testosterone can be converted by the enzyme 5-alpha-reductase into dihydrotestosterone (DHT), a more potent androgen. Both testosterone and DHT bind to intracellular androgen receptors, where they influence gene transcription and regulate protein synthesis.[39]

THE MISUSE & ADDICTION MECHANISM

Testosterone therapy is widely prescribed for managing specific medical conditions, most notably hypogonadism caused by dysfunction of the hypothalamic–pituitary axis or other pathological disorders. In these cases, replacement therapy becomes essential because the reproductive system is unable to maintain normal androgen-dependent functions on its own.[39] However, administering exogenous testosterone to men with impaired reproductive capacity can markedly suppress the body's natural testosterone production through negative feedback on the endocrine system.[39] This suppression lowers endogenous secretion, which may, in turn, negatively affect tissues that rely on androgens for healthy function.[39] The decreased intratesticular testosterone results in low stimulation of spermatogenesis which can cause male infertility.[34]

In both adults and adolescents, the use of AAS for cosmetic purposes is often mistakenly viewed as a relatively harmless way to enhance muscle growth and achieve a more sculpted physique.[28] However, androgens are potent, and have dose-dependent psychoactive effects on mood, including hypomania in healthy individuals.[28] Exogenous testosterone interacts with androgen receptors in the central nervous system (CNS), where it modulates neurotransmitters including dopamine, serotonin, and endogenous opioids.[28] At moderate to high doses, users experience heightened confidence, euphoria, and irritability, while prolonged exposure is linked to hypomania, aggression, and, in some cases, psychotic symptoms.

The psychoactive properties AAS contribute to the reinforcing potential of them. By stimulating the mesolimbic dopamine pathways, testosterone enhances reward sensitivity, creating a behavioral loop in which users seek to maintain the psychological and physical benefits of use.[48] Over time, tolerance develops, leading individuals to escalate doses, while cessation triggers withdrawal hypogonadism, characterized by fatigue, depressed mood, low libido, and anhedonia.[48]

ADOLESCENT VULNERABILITY

Adolescents are particularly vulnerable to the effects of AAS because of the critical stages of development that occur during puberty. Physiologically, exogenous testosterone can disrupt the normal maturation of the HPG axis, leading to premature closure of growth plates in bones, stunted height, and long-term endocrine dysfunction.[48] At the same time, the adolescent brain is highly plastic, especially in regions involved in impulse control, emotion regulation, and rewards processing.[48] Steroid-induced alteration in neurotransmitter systems, particularly dopamine and serotonin, can therefore have more profound and lasting impacts on mood and behavior in teenagers than in adults. Beyond the physiological standpoint, adolescents face heightened social pressures, from athletics, body image ideals, and social media.[48] These reinforce misuse and increase the risk of dependence. The combination of ongoing physical development, psychological susceptibility, and cultural influences makes AAS-use during adolescence especially harmful and potentially long-lasting in its consequences.[48]

THE SIDE EFFECTS OF ABUSING AAS

Teenagers and young adults who use AAS reportedly do so to help them achieve a leaner, more muscular physique and attain a higher level of strength than they would be able to achieve naturally. These compounds activate the androgen receptor, increasing muscle protein synthesis and stimulating muscle hypertrophy.[35] Simply, AAS are very good at increasing overall muscle mass. However, the health consequences of these substances are often overlooked by users.[24] While some side effects present early in use and are typically ignored by the user, other, more serious adverse effects present insidiously with long-term use.[13]

Additionally, using AAS comes with a host of endocrine, cardiovascular, musculoskeletal, and other miscellaneous harmful health effects. The endocrine effects are a result of androgen excess. Testosterone is the primary androgen in the body. When testosterone is in a surplus, a host of effects including voice deepening, hirsutism, acne, receding hairline, and shrinking testicles in males or clitoromegaly in females may occur. These masculinizing effects explain why females use AAS at a much lower rate than males. Approximately 98% of users of AAS are male.[24] Exogenous testosterone intake also impairs the body's ability to naturally produce its own endogenous testosterone due to suppression of the HPG axis. Excessive exogenous testosterone levels negatively feedback on LH, the hormone released by the pituitary gland responsible for promoting testosterone production, and GnRH, the hypothalamic hormone responsible for promoting release of LH and FSH from the pituitary. Through this mechanism of HPG axis suppression, using AAS decreases the ability of the testes to produce endogenous testosterone and may cause oligospermia, or decreased sperm count. Decreased endogenous testosterone production and oligospermia can ultimately lead to infertility in males. By a similar mechanism of HPG suppression, using AAS can lead to ovarian dysfunction in females.[16]

Androgens like testosterone can also be converted into estrogens like estradiol by the aromatase enzyme through a process called aromatization. This means that using AAS not only leads to androgen excess, but estrogen excess as well. In males, estrogen excess presents classically as gynecomastia, or the development of breast tissue, and mood lability. Fluid and fat
retention as well as decreased libido and erectile dysfunction may also occur. For this reason, many individuals who use AAS simultaneously take compounds that inhibit aromatase in an effort to prevent these unwanted estrogenic effects. While effective at reducing estrogenic effects, aromatase inhibitors create an even greater testosterone surplus, likely intensifying the aforementioned androgenic, masculinizing effects of AAS.[13]

Cardiovascular Side Effects

The cardiovascular effects of using AAS are perhaps the most worrisome, as they present insidiously and are responsible for the majority of deaths associated with long-term use of these compounds. Use of AAS is linked to the development of hypertension and dyslipidemia, two conditions that significantly increase the risk for atherosclerosis, or buildup of plaque within and on artery walls and narrowing of the arterial lumen. Untreated atherosclerosis, in turn, increases risk for life-threatening thrombotic events such as myocardial infarction (MI) and stroke.[46] Because hypertension and dyslipidemia often present without symptoms until late in the disease course when signs of end-organ damage such as visual disturbances, headaches, chest pain, and palpitations

arise, an individual may have significant atherosclerotic disease and be at immediate risk for a thrombotic event by the time they visit a physician. Acute MI in particular has been identified as a cause of death in several post-mortem studies of weight lifters who had a history of using AAS.[43]

Beyond atherosclerotic risk, AAS can also affect the heart muscle itself. It has been proven that AAS have the potential to increase the size of the heart muscle, particularly the left ventricle. The left ventricle houses the majority of the heart's musculature, and its enlargement leads to a condition known as left ventricular hypertrophy (LVH). Unlike the increase in skeletal muscle mass, LVH is in no way beneficial. LVH is a type of pathologic cardiac remodeling that impairs the ability of the heart to pump oxygenated blood throughout the body. An enlarged, stiffened left ventricle may eventually lead to development of diastolic heart failure.[33] Diastolic heart failure is the inability of the left heart to adequately relax and fill with a sufficient amount of blood between ventricular contractions. This is a direct result of concentric hypertrophy of the myocardium of the left ventricle decreasing the ventricular chamber size. The resultant decreased compliance of the left ventricle leads to a backflow of blood into the lungs, which classically presents with symptoms of shortness of breath and fatigue. This can be diagnosed on physical exams as an S4 heart sound and has characteristic electrocardiogram findings.[22]

Musculoskeletal Side Effects

As previously discussed, AAS are effective at increasing muscle hypertrophy, however, the musculoskeletal effects of these compounds are not all beneficial. One significant detrimental effect is an increased incidence of tendon rupture in those who use AAS. A large cohort study consisting of male bodybuilders aged 35 to 55 years old found a statistically significant increase in the relative risk of upper-body tendon rupture, such as rupture of the pectoralis or biceps tendons, in those who use AAS compared to non-users.[32] The prevailing theory behind this finding is that while AAS increase muscle hypertrophy and strength, they do not induce strengthening of the tendons associated with these muscles. Therefore, muscles become stronger than their tendons. In other words, as steroid users are able to increase the amount of weight they lift and the intensity of their workouts as a result of increased strength and endurance granted to their muscles by AAS, their tendons do not keep up, increasing the propensity for tendon rupture. Contrarily, in non-users, tendons are able to gain strength at a rate mirroring that of muscle, decreasing the likelihood for tendon rupture. A non-mutually exclusive hypothesis to possibly explain the increased likelihood of tendon rupture in those who use AAS is that high doses of AAS, when combined with intense muscular exercise, may damage the connective tissue proteins such as collagen, elastin, and proteoglycans that comprise tendons, making tendons stiffer and more prone to rupture. This has been demonstrated in several rat studies.[36]

Additional Physical Side Effects

Usage of AAS is associated with a host of miscellaneous adverse health effects in addition to the aforementioned neurologic, endocrine, cardiovascular, and musculoskeletal effects. For instance, AAS were actually used therapeutically for the treatment of various anemias prior to the advent of epoetin alfa, or recombinant human erythropoietin (EPO). EPO is useful in the treatment of anemia because it stimulates the

bone marrow to create erythrocytes, or red blood cells. AAS increase synthesis of EPO in the kidneys and promote differentiation of erythropoietic stem cells.[6] In the short-term, increased levels of EPO has been proven to be performance-enhancing, particularly in endurance sports, as EPO increases VO2 max, or the maximum amount of oxygen the body can take in and use during exercise, as well as the delivery of oxygen to peripheral tissue. However, long-term increases in EPO will continually increase hemoglobin and hematocrit levels in the blood, potentially inducing erythrocytosis, polycythemia, or sludging, which is increased blood viscosity and potential for clotting.[47]

Hepatotoxicity is another widely recognized adverse effect of using AAS. Hepatotoxicity is particularly of concern when AAS are taken orally, as the liver must metabolize these compounds via the hepatic portal system by way of first-pass metabolism. Because elevated alanine transaminase (ALT) and aspartate transaminase (AST), colloquially known as liver enzymes, are early indicators of hepatotoxicity, people using AAS should see a physician regularly to have these enzyme levels monitored. The hepatotoxic effects of AAS include cholestasis, or reduced flow of bile from the liver through the biliary system; peliosis hepatis, or enlargement and engorgement of liver sinusoids; and development of liver tumors such as hepatic adenoma, focal nodular hyperplasia, or hepatocellular carcinoma.[46] Nephrotoxicity is another potential adverse effect of AAS, particularly when they are injected. Although this association is less established than hepatotoxicity, an association has been identified between the usage of AAS and the development of focal segmental glomerulosclerosis (FSGS), a nephrotic syndrome characterized by damage to glomeruli, the filtering units of the kidney. This association between the usage of AAS and FSGS is likely due to a combination of glomerular changes secondary to increased lean body mass, as well as the direct toxic effects of AAS on podocytes and other cellular components of the glomerulus. This association may actually be underrecognized clinically due to the acceptable rise in serum creatinine that comes with increased lean body mass.[29] Finally, using AAS poses the risk of contraction of bloodborne diseases when users share needles for injection, which is not an uncommon practice in many circles. Additionally, it has been found that adolescents who report using AAS are more likely to report use of other drugs including cocaine, marijuana, alcohol, and tobacco than non-users.[18]

METHODOLOGY

In order to collect data on the public opinion, regarding AAS, of teenagers/young adults aged 14-22, we collected data via an in-person survey at five gyms and three high schools in Pennsylvania, New Jersey, and Massachusetts. We surveyed a total of 111 individuals, 99 males and 12 females, approaching them in public settings. The surveys were 100% anonymous and optional. We asked a range of questions regarding their opinions on using AAS, their inclinations towards using AAS, and their knowledge of the side effects of using AAS while also simultaneously collecting information about their lifestyle, i.e whether they played sports or not, and, if so, how long.

SURVEY RESULTS

Of the 111 participants, 20 (18%) said that they would consider taking AAS and/or other PEDS. Of the 20 individuals who said they would take steroids, 7 (35%) of them would do so in the next 0-4 years, 4 (20%) said they would take steroids in the next 5-9 years, 7 (35%) said they plan on taking steroids 10+ years from now, and two (10%) said they were unsure when they would take steroids but knew they wanted to.

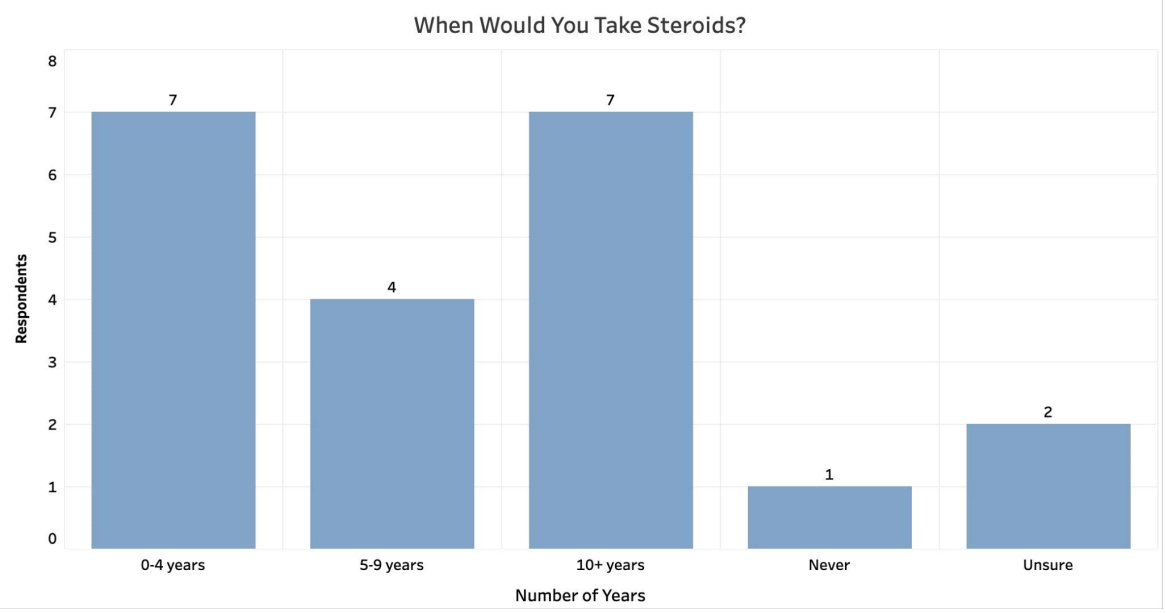

Figure 1: The distribution of respondent's intents to use AAS across how soon they plan to or might consider taking AAS.

Additionally, 13 of the 20 (65%) said that they would take AAS for "fun", while 4 of the 20 (20%) felt inclined to take supplemental testosterone to maintain their health and testosterone levels later in life. This clear divide highlights how, for much of the surveyed population, AAS are not seen as medicines or hard drugs, rather they are perceived as recreational substances with no tangible negatives or downsides. This can be attributed to the lack of formal education on the topic: of the 99 participants familiar with AAS, only 10 (10.10%) learned about them from schools while 81 (81.81%) learned about them from social media.

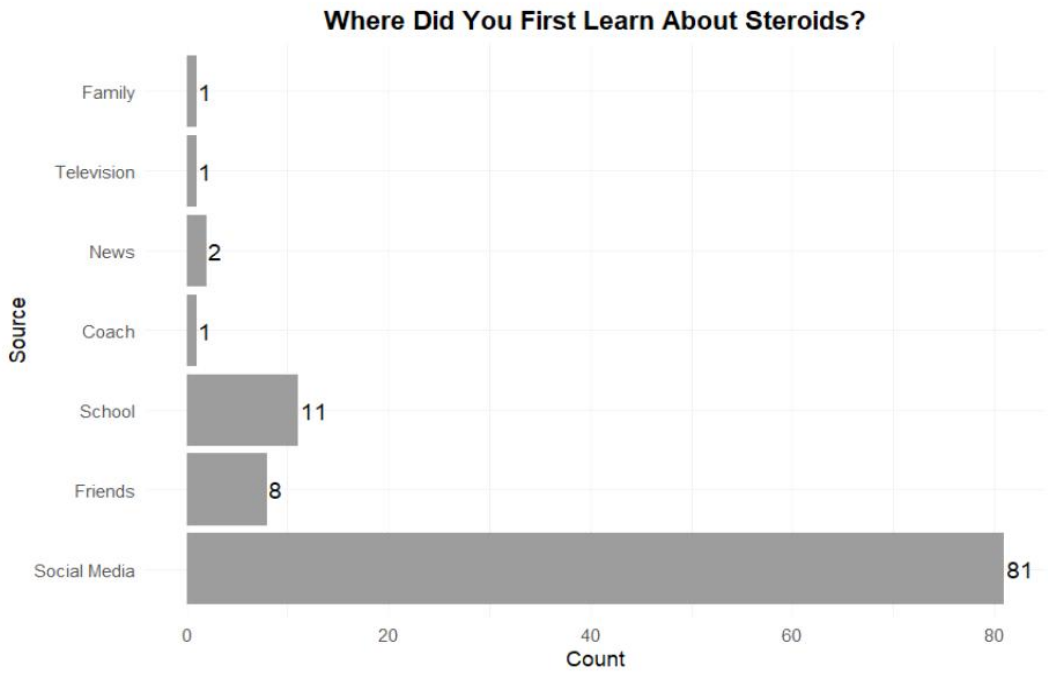

Figure 2: The distribution of information sources that first introduced respondents to AAS across the count of respondents.

Using Pearson's Chi-squared test of independence, it was determined that there is no statistical significance between media exposure and inclination to take steroids, accepting the null hypothesis and stating that the distribution of motivations is independent of the type of media exposure. However, although there is no clear correlation between social media and elevated tendencies to take AAS, a concerning trend is present regarding the prevalence of education provided by unregulated channels on AAS. Social media influencers are able to show the highlights of steroid abuse and hide the dangers of it, potentially influencing public opinion on the topic. This biased portrayal of a lifestyle on AAS can lead people to believe that anabolics can be used for recreation with little-to-no negative health consequences, despite the plethora of dangers and negative effects.

Additionally, involvement in sports has a big influence on a person's willingness to take steroids. After conducting a one-way analysis of variance, it was determined that playing sports had a statistically significant effect on the likelihood of abusing AAS, and certain types of sports had varying levels of influence.

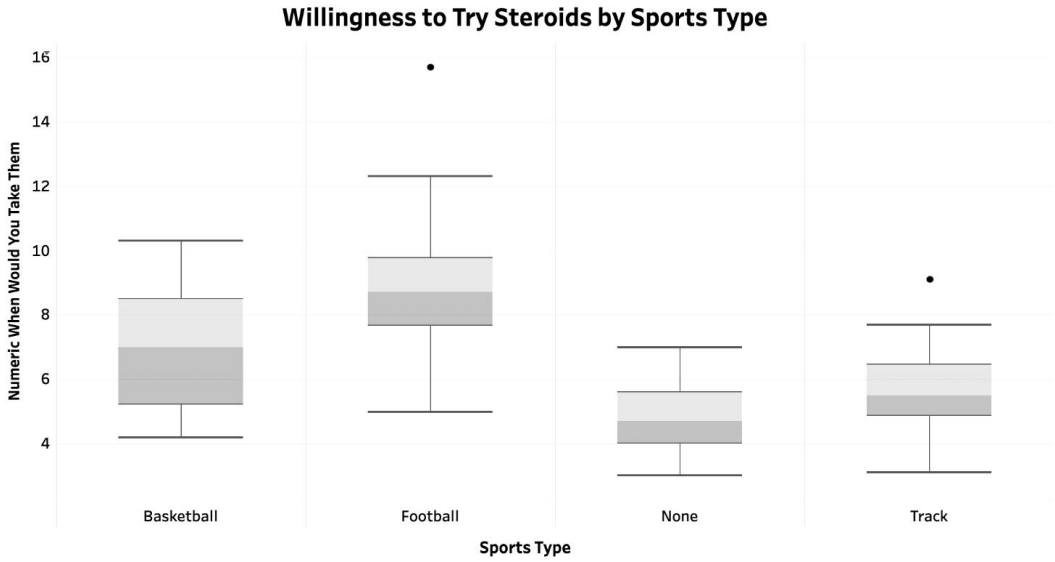

Figure 3: The confidence intervals of sub-samples' mean willingness to use AAS across the contact level of the primary sport of that sub-sample.

We saw that students involved in high contact sports (football) had the highest willingness to abuse AAS, followed by those involved in medium contact sports (basketball), low contact sports (track), and finally those involved in no sports respectively.

DISCUSSION

For many non-professional athletes, AAS can seem like a simple performance booster or supplement, rather than a hard drug. As highlighted, education regarding the true dangers of abusing AAS is informal, unregulated, and led by social media figures who may have financial incentives to coerce their viewers to purchase and use AAS, painting them as fun and helpful rather than being truly transparent. Additionally, the likelihood of abusing AAS does vary among athletes, with adolescents partaking in higher contact sports being, on average, more willing to use them. Finally, adolescents are tending towards using AAS in either a short time frame (0-4 years), or a long time frame (10+ years).

Our findings correspond with other findings relating social media use with elevated willingness to use AAS. Traditional, image-based social media create self-perception issues amongst the youth, increasing their likelihood of taking AAS to validate their own feelings and extinguish their sense of inferiority to those on social media. Additionally, data has shown that web-forums, such as Reddit and Quora, are often frequented to gather information about dangers of specific AAS and advice on what drugs to take (Ganson et al., 2026).

The findings from our study highlight a general lack of formal education regarding AAS and, coupled with the usage of social media for information, an overall unrealistic view of AAS. This fantasized view of AAS has led adolescents to want to use these drugs in a short time frame. Our study indicates that there is a real

willingness to use AAS, especially among high-contact athletes, such as football players. This is especially concerning as

there are no real legal or social consequences of their actions if they are not regularly tested by their league or association. Additionally, among sports players, athletes involved in high contact sports have a higher willingness to abuse AAS than athletes in medium and low contact sports, highlighting how physical demands may influence a student's decision to abuse steroids. A pipeline effect is established, where early introduction into high contact sports may lead students to abuse AAS during their high school and college careers, as they want to be able to continue competing at a high level despite their own physical weaknesses. These findings support the need for more tailored interventions and education for students involved in high contact sports.

The likelihood of this occurring is high, as the cost of purchasing AAS is manageable. Using the American minimum wage, ignoring state specific restrictions, an average high schooler is making $7.25 an hour. Factoring in school and other after school activities, the average high schooler is working 20 hours a week.[30] So, it can be expected for a high school student, working part-time, to make around 145 dollars a week before taxes.

The price of AAS tends to fall between $100 and upwards of $130.[49] Barring the mixing of substances and other expenses, it can be inferred that the average high school student can afford to take AAS on a minimum wage salary working 3-4 hours a day. So, financially speaking, abusing AAS is possible for a majority of high school students. Additionally, this ease of purchase of AAS makes internet glorification an incredibly large issue and danger to the American youth as these harmful substances are within arms reach.

However, in the United States of America, use of exogenous testosterone is limited. Only when the substances are prescribed by a physician can a person take them, and recreational usage is illegal. Additionally, procuring the substance from a non-physician is also illegal as exogenous testosterone and other steroids are Schedule III controlled substances as stated under the Controlled Substance Act.[40]

Still, manufacturers and consumers are able to produce and purchase AAS, respectively. Individuals can purchase these illicit substances through the internet, buying them from foreign countries and having them shipped overseas. Unlike in the United States, AAS are legal for sale and use in countries like Italy and Greece. Due to easy access to the substances, foreign distributors are able to ship vials of the drugs to the United States in relatively small, innocuous envelopes ranging in size from 5-by-6 inches to 6-by-9 inches. Additionally, US Customs and Border Protection (CBP) cannot stop all of these illegal substances from entering the country due to a variety of reasons. The most influential factor is the sheer volume of drugs entering the country. Simply put, there are too many sources and individual shipments of AAS for the CBP to effectively prevent them from entering the country.[49]

As a result, despite their illegal status, AAS are easily purchased through the internet. Once making landfall through international shipping services, law enforcement officials struggle to prevent individuals from abusing these substances, as seizure and detection of shipments is very difficult. As is their Fourth Amendment right, Americans are protected against unreasonable searches and seizures, so while law enforcement may suspect an individual of possessing and abusing AAS, without tangible proof of use they cannot act upon their suspicion. Essentially, if someone purchases AAS from the Internet, and they open the package in a secluded area and use it in the same area, law enforcement cannot arrest them. Unless they find a person in clear, informed possession of the substances, arrest is impossible. Therefore, any teenager with access to the internet can abuse AAS with minimal risk of arrest if they use the substances in secrecy.

In order to prevent the usage of AAS by the youth, we believe that more tailored education should be provided rather than stricter regulations on the drug. As it stands, information about AAS is completely unregulated and non-standardised, allowing for different people to provide different views on the drugs creating potentially false notions in impressionable children. By ensuring that traditional four-year high schools provide adequate education regarding AAS, education similar to current lessons regarding marjuana and opioids, teenagers will have a more scientifically accurate view on the drugs. Similarly, we propose that high school athletics coaches and administrators ensure that their players are not in environments conducive towards AAS abuse. By creating strict anti-doping regulations and implementing regular, unannounced drug tests in high school and collegiate sports, the likelihood of being caught using AAS would increase as the frequency at which players are tested will increase. This would prevent athletes from taking AAS, then ceasing usage to pass a drug test. They ideally would not have enough time to let the drugs fully exit their system before another test, essentially guaranteeing that they are caught.

LIMITATIONS

Due to the survey based nature of our research, there were some notable limitations. First, we couldn't ensure participants were answering honestly. Individuals who may have been taking, or contemplating about taking, AAS would have likely not been honest as by admitting usage they would admit to using illegal substances. We also could not account for gender-based differences, as a larger majority of females were less comfortable participating in the survey than males, potentially creating an underrepresented group in our sample. Additionally, we couldn't gauge public perceptions of people in varying climates/geographical locations. We were confined to Pennsylvania, New Jersey, and Massachusetts, so our findings are only applicable to gym-goers in those areas and may not represent a nationwide consensus. Additionally, we couldn't properly gauge socioeconomic factors as many of the large gyms we visited/worked with were based in higher-income, suburban areas. While a difference between urban gym-goers and their suburban and rural counterparts could be present, we couldn't judge that. Finally, we couldn't obtain substantial input from experienced lifters. Due to our young target population, there were not many individuals that had been working out for decades or more. While our sample displayed an under-informed view on AAS, more experienced lifters could have more substantiated knowledge on the topic.

ETHICAL ANALYSIS OF ABUSING AAS

Use of AAS among young people raises ethical issues involving autonomy, beneficence, non-maleficence, and justice.[7] This analysis will address those issues concerning the responsibility of various stakeholders, including healthcare providers, educational institutions, policymakers, social media platforms, and sporting organizations, in minimizing adverse effects.

The capacity to make informed, voluntary decisions regarding the body constitutes autonomy. Autonomy is hampered in adolescents by neurodevelopmental, psychological, and social constraints.[10] The neuroplasticity of the adolescent brain, particularly its prefrontal areas linked to self-regulation, decision making, and cognitive flexibility, makes assessing the danger of AAS difficult.[12] Endogenous testosterone production is suppressed with small amounts of AAS, leading to physiological alterations in brain structure and behavior, potentially resulting in

maladaptive traits.[19] In our study, 65% of individuals who were prepared to use AAS claimed they would do so "for fun," indicating risk perception and autonomous choice deficits. According to international literature, there are numerous adolescents using AAS that lack awareness of health outcomes, ranging from one-third to one-half of all participants.[3,8,21] For example, in Kuwait, only 18.2% of participants had sufficient side effect awareness[3] ; in Riyadh, 82-83% were inadequately educated[8] ; in Egypt, 30.6% were unaware of side effects.[21]

AAS have a variety of toxicities on multiple organs, including cardiovascular, hepatic, renal, endocrine, neuropsychiatric, and reproductive.[11,23,41,44] In young individuals, the potential dangers of using AAS are greater because of their developmental vulnerability. Premature epiphyseal closure and permanent neurological impacts are two possible risks.[19,50] Additionally, discontinuation of AAS may exacerbate behavioral problems and mood dysregulation, making cessation more difficult.[10,51] This potential harm outlines the principle of non-maleficence, and the ethical obligation of healthcare professionals, healthcare institutions, and caregivers to promote the abstinence from performance enhancing drugs.

There are obstacles to addressing healthcare providers' responsibilities. Some users of AAS avoid professional assistance due to stigmatization or a lack of medical knowledge.[10] A harm reduction strategy should be adopted by physicians, which entails non-judgmental counseling on drug use and cessation, and routine cardiovascular screening.[10,11,23] This allows a framework to exist for healthcare professionals to support adolescents who choose to use AAS against medical advice, to ensure their safety and health. Only 10.1% of users acquired information on AAS through school, implying a duty for evidence based education on AAS and media literacy programs. Combining practice and theory-based approaches, such as ATLAS, has been shown to be effective in reducing intention to abuse AAS.[17] Ultimately, there needs to be a diverse and multifocal outreach approach to the youth regarding the use and abuse of AAS to ensure adequate education and retention of the consequences.

Athletes in contact sports demonstrate the highest intention to use AAS, and are readily available and inexpensive for impoverished young people through internet pharmacies.[2,26] Most users start consuming AAS before turning eighteen, and polysubstance use is widespread.[37,44,51] Social media and influencers disseminate favorable viewpoints on AAS, generating ethical obligations for social media companies to intervene.[25] The widespread use of social media platforms, in combination with young athletes in a school setting, is an environment productive of peer pressure and uninformed choices. School-based substance testing might discourage usage of AAS, although privacy and due process concerns could arise.[15] However, given the risks associated with the use of AAS, conducting drug testing at schools and colleges is proportionally acceptable provided safeguards are present. Harm reduction is a suitable strategy for current users of AAS, but with adolescents, harm prevention and attitude change are prioritized because of their vulnerabilities and the severity of the dangers.[3,10,17]

The study population included individuals aged 14-22 years, and all participants were anonymous. It was a methodological advantage, ethically preserving anonymity but with inherent limitations, including dishonesty, gender equity, regional, and socioeconomic biases. Future research directions may include longitudinal studies of adolescent usage of AAS[44,50], studies on evidence-based interventions for school education regarding AAS[17] , targeted studies focusing on females, minorities, and diverse socio-economic statuses[12,37], and finally in-depth examination of social media's impact on attitudes towards AAS.[25]

Overall, recommendations for improvement in adolescent education and misuse of AAS can have a future in which there is mandated, evidence-based education on AAS in secondary schools with media literacy. On the other side, harm reduction and non-judgmental clinical training regarding use disorder involving AAS can be

emphasized for clinicians and academic professionals. From a policy perspective, prevention targeting high-risk groups, such as athletes, can grow and professional governing bodies can implement anti-doping policies. Regulation of social media and mandatory posting of warning labels can mitigate online purchases and prohibit positive content glorifying AAS targeted at children.

The results obtained in this review highlight autonomy limitations, informational deficiencies, significant dangers, and structural failings in education, regulation, and healthcare sectors. Ethical action must be taken immediately and systematically, including protective measures in adolescents' health and longevity, following the core principles of non-maleficence, beneficence, and justice.

CONCLUSION

AAS constitute a widely undercovered topic in formal education centers, creating the opportunity for teenagers/young adults to be misled regarding the true dangers of them. Social media and other un-regulated sources of information have allowed an unrepresentative view of life on AAS to become common, transforming opinion on the drug from a life-altering hard drug to a "fun way to get stronger". Overall, this study has shown that while certain sports may increase the likelihood of abusing AAS, the fact of the matter is that anyone can be influenced to start "juicing", and anyone can access them. The scrawny kid who used to get bullied could one day jeopardize his longevity and health to look "cooler".

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