SYSTEMATIC REVIEW STUDY (BASED ON THE PRISMA METHOD) ON THE HARM CAUSED BY THE USE OF ANABOLIC STEROIDS

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ABSTRACT

Beauty standards and the search for a perfect body today have led to the use of substances that can facilitate the acquisition of bulky muscles and decrease body fat. Thus, many individuals have sought the use of Anabolic Androgen Steroids (AAS), since these substances play an anabolic role, about the synthesis of contractile proteins (increases muscle volume and strength) and catabolic, in relation to lipid metabolism (stimulates lipolysis). In sports, AAS have been widely used, since they develop greater strength capacity in the athlete and, therefore, bring improvement in speed, power and also cardiorespiratory capacity, since they can lead to a better recovery, thus influencing sports performance. However, the responses are not always beneficial, and can trigger considerable problems in users of AEAs, both at the physical level such as cardiovascular, metabolic and endocrine changes, and at the psychological and social level, through changes in mood, cognition and behavior. Therefore, seeking, compiling and understanding the possible harms triggered by the indiscriminate use of AAS is of great importance for the academic community and society as a whole. Thus, the objective of the present systematic review was to search, through the PRISMA method, for primary studies that present the harm caused by the use of AAS. Results: After applying the exclusion and inclusion criteria, eleven articles were found relating various harms in AAS users in the last 5 years. Among the harms, physiological changes were found such as increased blood pressure, cardiac arrhythmias and increased shear rate, heart diseases, atrial fibrillation, cardiac depolarization problems, thrombi, infertility, decreased testosterone and erectile dysfunction; metabolic factors such as an increase in low-density lipoproteins (LDL) and very low-density lipoproteins (VLDL), creatinine, urea, liver enzymes in the blood; such as suicidal ideation, increased verbal and non-verbal aggressiveness, cognitive and memory impairments. Conclusion: Therefore, it was possible to conclude, through the present systematic review, that the use of anabolic steroids can trigger harm involving the physiology, metabolism, behavior and social life of users.

Keywords: Anabolic steroids. Injuries. Diseases.

INTRODUCTION

Beauty standards and the search for a perfect body today have led to the use of substances that can facilitate the acquisition of bulky muscles and decrease body fat. Thus, many individuals have sought methods of using Anabolic Androgen Steroids (EAAs), since these substances play an anabolic role with regard to the synthesis of contractile proteins (increases muscle volume and strength) and catabolic, in relation to lipid metabolism (stimulates lipolysis). These processes thus allow the acquisition of the body pattern so dreamed of by many today (Fares et al., 1019; Reggiani et al., 2019).

In sports, AAEs have been widely used, since they develop greater strength capacity in the athlete and, therefore, bring improvement in speed, power, and also cardiorespiratory capacity, since they can lead to better recovery, thus influencing sports performance (Long et al., 2019; Souza et al., 2018a).

However, the responses are not always beneficial, and can trigger considerable problems in users of AEAs, both at the physical level such as cardiovascular, metabolic, and endocrine changes, as well as at the psychological and social level, through changes in mood, cognition, and behavior (Kaufman et al., 2019; Zhong et al., 2024).

Therefore, it is necessary to seek to collect and understand the possible harm triggered by the indiscriminate use of EAAs, after all they are very important for the academic community and for society as a whole.

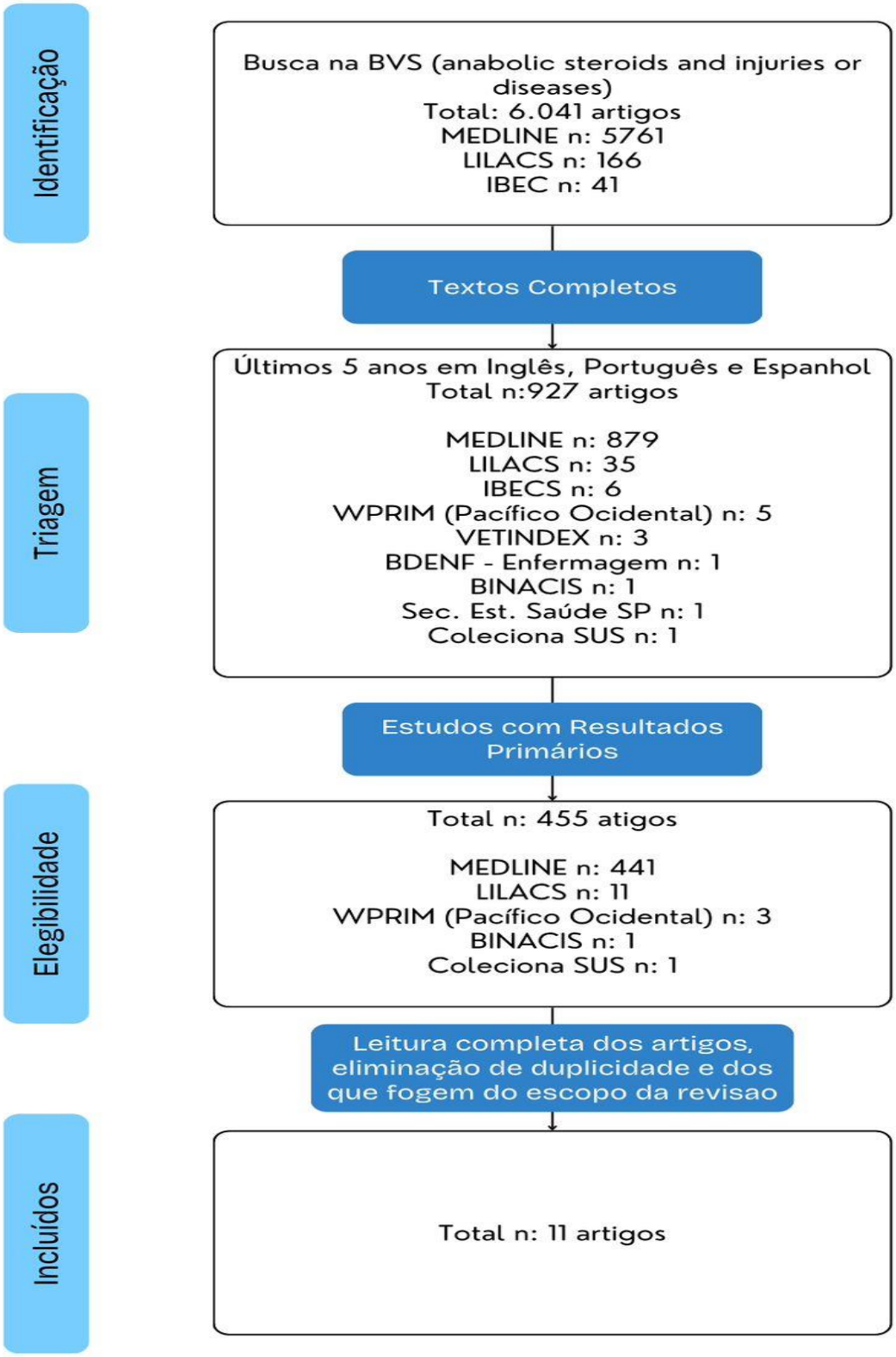
In view of this, the main objective of this systematic review is to seek, through the PRISMA method (Preferred Reporting Items for Systematic Reviews and Meta-analyses) and the PICO strategy (acronym for P: population/patients; I: intervention; C: comparison/control; 0: outcome), evidence in the literature of studies with primary data on the harm caused by the use of AEAs.

METHODOLOGY

To carry out this systematic review, the Methodological Guidelines for the Elaboration of Systematic Reviews were used in the study, following the determinations for the central question, for the selection and identification of the bibliography, maintaining well-established definitions for the inclusion and exclusion criteria of the articles (Donato & Donato, 2019). Considering that a systematic review is an interrogative research method, which makes use of scientific evidence already published, this proposal brings, with this, the integration of specific data in a certain area. To this end, therefore, the guidelines of the 2020 PRISMA protocol were followed in the present study, which are composed of a detailed checklist with elements considered fundamental.

Non-italicized elements are considered "essential" and should be reported in the main report or as supplementary material for all systematic reviews (Donato & Donato, 2019). To this end, on March 15, 2024 at 8:30 pm, searches were carried out on the VHL (Virtual Health Library) website (https://bvsalud.org/) by two authors concomitantly, the keywords: "anabolic steroids" and "injuries" or "illnesses". Then, the inclusion and exclusion criteria were applied, namely: Articles published in the last five years, in English, Portuguese and Spanish. Next, only the articles in which the full texts were found and that were part of studies with primary data were considered, excluding review articles and those that obtained secondary data. After reading the chosen articles in full (for which it was possible to find the keywords in the title or abstract), those that did not include the information related to the objective of the present study were excluded. It is then possible to recognize this analysis, as shown in figure 1, which represents the detailed flowchart of the search stages carried out in the present study. To this end, the methodology was divided into four stages in order to follow the PRISMA protocol, whose first stage included the identification from the searches of the terms in the databases presented, and, after collecting the complete texts, they went through the second stage, which would be the screening, in which the eligibility criteria were applied in the search in the databases. The third stage then proceeded with the selection of clinical and experimental studies with primary results, consisting of the selection made at screening, and, finally, those selected after complete reading to eliminate the articles outside the context of the review and confirm the analysis, in addition to eliminating the duplicateness, in which the included ones were obtained (Donato & Donato, 2019).

Figure 1 - Search flowchart. It presents the logical sequence of Identification, Screening, Eligibility and Inclusion of the articles found in the search.



Legend: VHL (Virtual Health Library; MEDLINE (Medical Literature Analysis and Retrieval System Online); LILACS (Latin American and Caribbean Literature in Health Sciences); IBECS (Spanish Bibliographic Index in Health Sciences); WPRIM (Index Medicus for the Western Pacific); VETINDEX (Brazilian Journals in Veterinary Medicine and Animal Science); BDENF (Nursing Database); BINACIS (Bibliografía Nacional en Ciencias de la Salud Argentina); Sec. Est. Saude SP (São Paulo State Health Secretariat); He collects SUS (Unified Health System). Source: Authors.

RESULTS AND DISCUSSION

After defining the theme to be searched, the searches were started from the keywords already described previously in the methodology. Having applied the inclusion and exclusion criteria, only thirty-seven articles were used for the present systematized review, which presented information directly aimed at the objectives of the present search. In turn, these articles are presented in Chart 1 below and their results will be discussed below. It is worth mentioning that the PRISMA methodology was used for the development of this review, to search and extract the results of the articles.

Huger and his collaborators (2019) found significantly important differences in androgen anabolic steroid (EAA)-dependent users. When compared to dependent users, non-dependent users used the substance approximately two years less and presented fewer problems in several areas, among which are presented in this review in classes of variables, namely: Psychological Variables: Lower values of Depression, Fatigue, Anxiety, Aggression, Report of Short Temper, Sleep Problems and Reduced Appetite. Medical Variables: Fewer Liver Problems, Hypertension, Reduced Sex Drive, and Sexual Dysfunction. Cognitive Variable: Fewer Memory Problems. Variable – Cerebral Volume and Cortex Thickness in area: Smaller volume of the Nucleus Accumbens, Left Lobe (Orbital, Mid-Temporal, Lingual, Caudal Mid-Forehead) and Right Lobe (Cuneus, Caudal Mid-Front, Supremarginal, Superior Front and Minor Lingual).

When evaluating the personality domains as well as the levels of impulsivity, Ability to Delay Gratification, Acceptance of Infidelity, Neuroticism and Extraversion, Argibay (2018) observed in his study changes that were quite expressed in users of AEAs. Among the results, the author found low Gratification scores, high attitudes of Infidelity, greater Neuroticism, Openness, Extraversion, and Impulsivity in the volunteers who used AAS.

In a cross-sectional experimental study, Reggiani and colleagues (2019) investigated possible differences in glycemic control, lipid profile, adipose tissue, expression of genes involved in energy metabolism, and skeletal muscle microstructure and pancreas of female mice that consumed a diet rich in trans fatty acids (TFAs) combined with AAS. As a result, they observed an increase in the body mass of the animals that consumed a standard diet combined with EAA and an increase in energy intake in the animals with a diet rich in trans fat, mainly combined with EAA. Regarding glucose kinetics, the authors reported an increase in blood glucose and a smaller area on the curve in the animals that consumed a diet rich in trans fat without combination with AAS. However, when fed with a standard diet and with low intake of AAS, the animals showed a greater and faster glucose decay in the intolerance test. In the pancreas, the authors observed higher gene expression of the

glucose transporter (GLUT-2) and the enzyme Glucokinase (important in the uptake and regulation of the glycolytic pathway) in animals that consumed a diet rich in TFA, especially when combined with AAS. When they evaluated the changes in the skeletal muscle of the animals, they observed an increase in mass, greater parenchymal distribution and in the diameter of the myocytes of the animals, in addition to increasing the gene expression of the glucose transporter in this tissue (GLUT-4) and the protein carnitine-palmitoyl transferase (CPT) (important in the lipolysis process) in the animals that consumed a standard diet in combination with EAA and in the animals that consumed a diet rich in AGT, especially when combined with AAS. When evaluating the lipid profile, the authors observed an increase in triacylglycerol and a decrease in high-density lipoprotein (HDL) in total cholesterol and low-density lipoprotein (LDL) in plasma, especially when the animals consumed a diet rich in TFA combined with AAS. Regarding white and brown adipose tissues, the same authors observed an increase in the gene expression of Acetyl-CoA Carboxylase (ACC) and Fatty Acids Synthase (AGS) (brown adipose tissue) in white adipose tissue in animals that consumed a standard diet, however, when combined with AAS and with the consumption of a diet rich in AGT, the expression of these same genes decreased. Finally, they observed an increase in uncoupling protein 1 (UCP-1) (important in the thermogenic characteristic of brown adipose tissue) in animals that consumed a diet rich in TFA, especially when combined with the use of AAS.

In a clinical study with young adult recreational weightlifters and recreational bodybuilding athletes, Souza and his collaborators (2019a) observed important changes in shear rate, cardiovascular behavior in response to Sympathetic Neuromuscular Activity (MSNA), and C-reactive protein at high sensitivities (CRP) in AAS users when compared to volunteers who did not use it. In this study, increased values were found in Heart Rate (HR), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP) and Mean Heart Rate (MAP), in MSNA per minute and per 100m heartbeat, in addition to increases in LDL and CRP in young people who used AAS when compared to those who also performed the same exercise modalities, however, did not use this substance. In addition to these findings, the authors recorded a decrease in foot-and-mouth disease and an increase in the retrograde and oscillatory shear rate, in the dilation mediated by the resting diameter and peak flow of the brachial artery in young AAS users.

Ganson & Cadet (2018), through a cross-sectional study with secondary data, evaluated whether there was a correlation between young male AAS users and dating violence. This study included 2080 young people (n=2080) and, when working with the data, the authors found a 1.1 times higher proportion of dating violence in men who used or

used AAS at least once when compared to their peers who never used it. In addition, it was possible to observe in AAS users at least one suicide attempt, violence against the person they met and unjustified sexual contact when compared to those who had never consumed these substances at least once.

In a cohort study by Horwitz et al. (2019), the authors aimed to investigate the morbidity and mortality of male gym-goers in Denmark who were users (n= 545) or not (n=5450) of AAS. Their findings were quite relevant and frightening at the same time. They had a thirteen-fold mortality rate in AAS users when compared to those who did not use this substance. Regarding cardiovascular disorders, the risks were three times higher in the occurrence of cardiomyopathies and atrial fibrillation and five times higher in thrombotic disorder users when compared to their peers who did not use this substance. In addition, in that same study, considerable recurrent changes in the disorders of the reproductive system of volunteers who used AAS were demonstrated. Of these, infertility had a 2.4 times higher risk, while the use of erectile dysfunction medication showed a three-fold increase and the appearance of gynecomastia thirteen times higher in these same individuals.

Chegeni et al. (2019), when evaluating through a longitudinal study possible associations between the use of AAS and physical or verbal aggression in Norwegian adolescents, did not find occurrences of such violence.

In a pilot study, Almaiman and his collaborators (2019) found decreased levels of testosterone, HDL, and Vitamin D in blood serum, followed by increases in LDL, Creatinine and urea levels, as well as increases in plasma liver (Alanine Amino Tranferase (ALT), Aspartate Amino Transferase (AST)), muscle (Creatine Kinase (CK) cardiac, skeletal muscle) and brain (CK) enzymes. They also observed changes in the hematological parameter of AAS users, such as increased hemoglobin, RBC (erythrocytes) and platelets, as well as alpha 2 proteins in the blood (nephrotic syndrome indicator).

When evaluating the functionality of HDL and the prevalence of Coronary Artery Disease (CAD) in AAS users, Souza and his collaborators (2019b) observed that volunteers who used AAS had increased SBP and DBP values and creatine, in addition to having lower HDL cholesterol efflux. In the same study, the authors reported that the number of people with CAD was 25% for arterial calcium plaques, 58% for fibrolipid plaques, 27% for lipid platelets, and 15% for calcium platelets. According to the authors, AAS users have increased two clinical cardiovascular risk indices (Castelli and Framingham Index).

In an experimental study, with the objective of investigating cardiac electrical and mechanical dysfunctions caused by chronic AAS, Seara and his collaborators (2019) observed important occurrences in male Wistars rats when exposed to an overdose of

nandrolone decanoate (DECA). The authors observed a decrease in the power of the high-frequency band concomitantly with the increase in the low-frequency band. In addition, they observed a decrease in the levels of messenger ribonucleic acid (mRNA) of the muscarinic receptor type 2 (M2R), an increase in the interval between depolarization and repolarization of the cardiac ventricles (QTc interval), in the action potential by 30% (APD30) and by 90% (APD90) in the animals that were submitted to AAS overdose. They also observed a decrease in the density of the L-type calcium stream and the transient potassium outflow, the calcium release charge by the sarcoplasmic reticulum and an increase in the sensitivity of calcium contractil. In view of these findings, the authors conclude that DECA overdose induced the cardiac rhythmic and mechanical abnormalities described above.

In an experimental study, in which they evaluated the effect of an AAS in atherosclerosis model mice (LDLrÿ/ÿ), Andrade and his collaborators (2019) observed an increase in TG in non-HDL cholesterol in lipid peroxidation, in oxidized LDL, in Tumor Necrosis Factor alpha (TNF-alpha) corroborating the lipid deposition by area in the aortic wall and atheromatous plaque in LDLry/y mice submitted to the use of AAS.

SUMMARY AND FINAL CONSIDERATIONS

As already described, the search for a perfect body in the molds of contemporaneity (with voluminous and defined muscles) has led a large part of society to the use of AAS. A significant increase in this use could be observed in populations, especially young people and adults. However, little is said about the harm related to the indiscriminate use of these substances. Thus, the importance of the present review is indisputable, since it presents valuable information about the harm that the indiscriminate use of AAS can cause to the individual. In order to compile and synthesize the findings made in this review, the authors' considerations were presented here. Through the evidence presented by the studies, it was possible to separate the changes promoted by the use of AAS into the following groups:

- Behavioral changes; -Changes in the Structure of the Central Nervous System; - Changes in Intermediate Metabolism; - Indicators of Tissue Injury and Inflammation; - Indicators of Vascular Changes; - Cardiac Risk Indicators; •Indicators of Gonadal Changes (shown in figure 2).

BEHAVIORAL CHANGES:

- ↑from Depression, ↑Fatigue, ↑Anxiety, ↑Aggression, ↑Reports of Short Temper, ↑Lack of sleep, ↑lack of appetite, ↓sexual desire (Hauger et al., 2019; Chegeni et al., 2019);

- ↓Gratification, ↑attitude of Infidelity, ↑Neuroticism, ↑Openness, Extraversion, and Impulsivity (Long et al., 2018);
- ↑Dating violence, ↑attempted suicide, ↑dating violence with sexual partners (Ganson & Cadet, 2018).

CHANGES IN THE STRUCTURE OF THE CENTRAL NERVOUS SYSTEM:

- ↓Menor volume do Núcleo Accumbens (Hauger et al., 2019);
- ↓Left Lobe (Orbital Pars, Temporal Middle, Lingual, Mid-Forehead Caudal Smaller) (Hauger et al., 2019);
- ↓Right lobe (Cuneus, Middle Caudal Front, Supremarginal, Superior Front, and Lingual minor) (Hauger et al., 2019).

ALTERATIONS IN INTERMEDIATE METABOLISM:

- ↑Glicemia, ↑GLUT 2/4, ↑Glicoquinase e CPT (Reggiani et al., 2019;
- ↑TG/LDL/LDLox (Reggiani et al., 2019; Almaiman et al., 2019; Souza et al., 2019b; (Andrade et al., 2019); Colesterol Total (Reggiani et al., 2019), Colesterol não HDL na peroxidação lipídica (Andrade et al., 2019); ↓Diminui HDL (Reggiani et al., 2019; Almaiman et al., 2019; Souza et al., 2019b; e Vitamina D (Almaiman et al., 2019);
- ↑Expressão de ACC/AGS/UCP1 (Reggiani et al., 2019);
- ↑ Clinical cardiovascular risk indices (Castelli and Framingham Index) (Souza et al., 2019b).

INDICATORS OF TISSUE DAMAGE AND INFLAMMATION:

- ↑Diâmetro do monócito (Reggiani et al., 2019);
- ↑Creatinina, ureia e Proteína α-2 (Andrade et al., 2019);
- Hemoglobin, erythrocyte and platelets (Almaiman et al., 2019);
- ↑PCR (Souza et al., 2019a);
- ↑ ALT/AST (Hepáticas no Sangue) (Almaiman et al., 2019);
- CK (Cardiac, skeletal and brain muscle creatine kinase) (Almaiman et al., 2019);
- ↑TNF alfa (Andrade et al., 2019).;
- ↑Proteína α-2 (Andrade et al., 2019).

INDICATORS OF VASCULAR CHANGES:

- ↑PAS/PAD/PAM (Souza et al., 2019a; Souza et a., 2019b);
- ↑Fibrilação Atrial (Horwitz et al., 2019);
- ↑trombose (Horwitz et al., 2019; 16, (Seara et al., 2019);
- ↑25% increase in arterial calcium plaque (Andrade et al., 2019).;
- ↑in 58% fibrolipidic plaque (Seara et al., 2019);
- ↑in 27% lipid plaque (Seara et al., 2019);
- ↑in 15% calcium plaque (Seara et al., 2019);
- ↑lipid deposition by area in the wall of the aorta artery and atheromatous plaque (Andrade et al., 2019);
- ↑the retrograde and oscillatory shear rate, the median dilation by the flow diameter at rest, the peak of the brachial artery (Souza et al., 2019a);
- ↑DAC (Souza et al., 2019b);
- ↑ Clinical cardiovascular risk indices (Castelli and Framingham Index) (Souza et al., 2019).

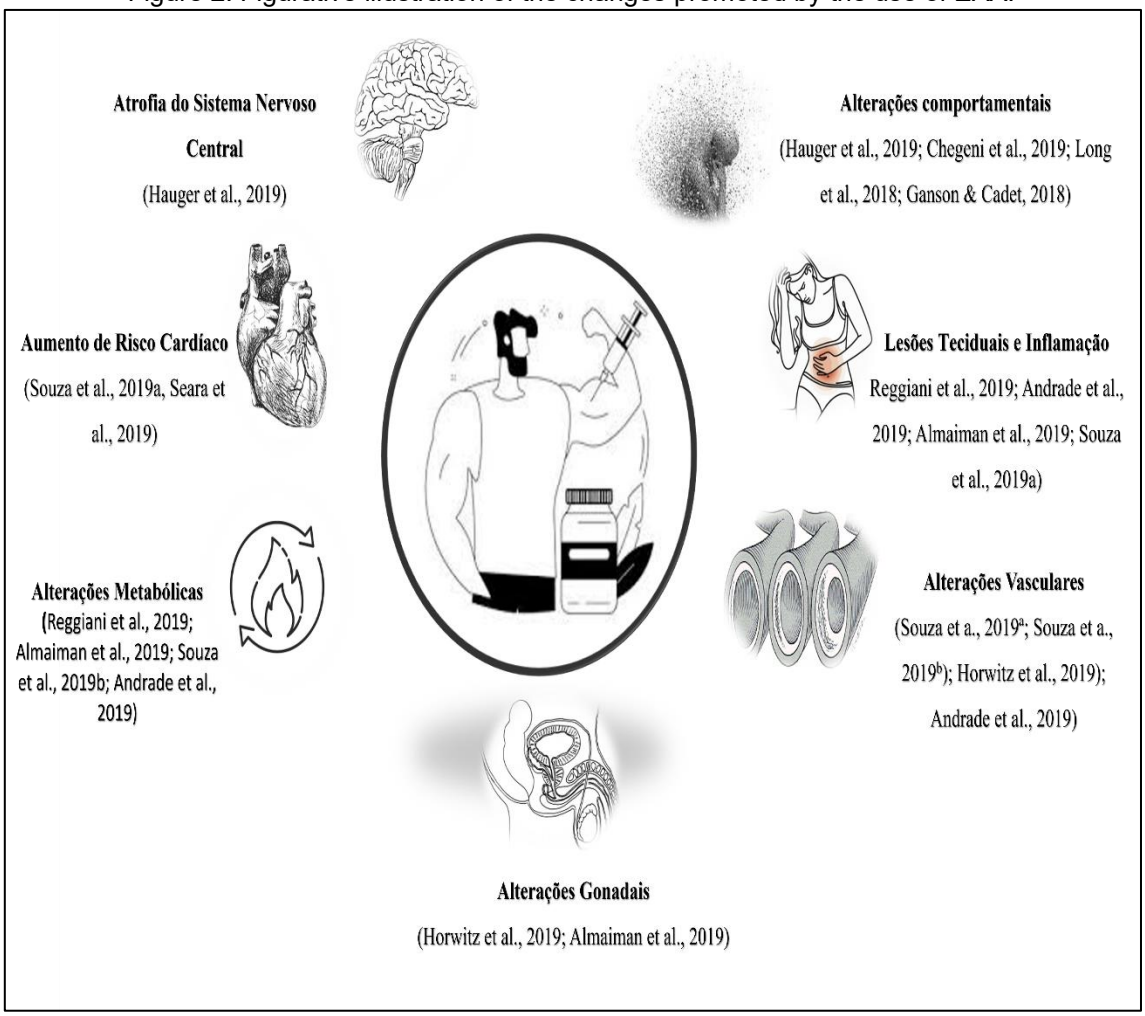
HEART RISK INDICATORS:

- ↑ FC (Souza et al., 2019a, Seara et al., 2019);
- ↑3 X more heart disease atrial fibrillation (Seara et al., 2019);
- ↑MSNA and MSNA per min. with each beat (Souza et al., 2019a);
- ↓the power of the high-frequency band concomitantly with the low-frequency band (Seara et al., 2019);
- ↓ nível de M2R (Seara et al., 2019);
- ↑QTc, of APD30 and APD90, the contractile sensitivity of calcium (Seara et al., 2019);
- ↓density of the calcium L stream and transient potassium outflow, of the calcium release charge by the sarcoplasmic reticulum (Seara et al., 2019).

INDICATORS OF GONADAL CHANGES:

- ↑2,4 X mais infertilidade (Horwitz et al., 2019; Almaiman et al., 2019);
- ↓ Testosterona endógena (Almaiman et al., 2019).

Figure 2. Figurative illustration of the changes promoted by the use of EAA.



Source: Authors

CONCLUSION

In this systematic review, it was concluded that the use of AAS can promote potential psychobehavioral changes in the structure of the central nervous system and energy metabolism, as well as promote an increase in systemic inflammatory indicators, liver, kidney and nerve tissue damage, in addition to an increase in indicators of vascular, cardiac and gonadal changes.

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TABLE 1. Characterization of the studies used for the construction of this work.

Author	Title	Objective	Nature of the Study	Sample	Key findings	Conclusion
Hauger, Lisa E. et. Al (2019)	Brain Structural Features of Anabolic-Androgenic Steroid Dependence in Men	To identify differences in brain morphology between male anabolic-androgenic steroid (AAS)-dependent and non-dependent users.	Cross-sectional study.	Eighty volunteers who were anabolic-androgenic steroid users who were dependent (n = 43) and non-dependent (n = 38).	Psychological Variables: Lower values of Depression (p<0.020), Fatigue (p=0.003), Anxiety (p=0.003), Aggression (p<0.001), Report of Short Fuse (p=0.028), Sleep Problems (p=0.009) and Reduced Appetite (p<0.001). Medical Variables: Fewer Liver Problems (p=0.007), Hypertension (p=0.026), Reduced Sexual Desire (p=0.038) and Sexual Dysfunction (p=0.031). Cognitive Variable: Fewer memory problems (p=0.001). Variable – Cerebral Volume and Cortex Thickness in area: Smaller volume of the Nucleus Accumbens (p=0.025), Left Lobe (Orbital Pars, Mid-Temporal, Lingual, Mid-Caudal Forehead) and Right Lobe (Cuneus, Middle Caudal Front, Supremarginal, Superior Front and Lingual Smaller).	Male-dependent anabolic-androgenic steroid users appear to have thinner cortex in generalized regions, specifically in prefrontal areas involved in inhibitory control and emotion regulation, in comparison to users not dependent on anabolic-androgenic steroids.
Argibay, Miguel G. (2018)	The relationship between the big five personalities, characteristics, impulsivity and anabolic steroid use	The aim of this study was to: (a) determine the differences between users and non-users of EAAs regarding their personality traits, as well as their scores on impulsivity, delay in gratification, and attitudes toward infidelity and (b) predict the use of EAAs based on these variables	Longitudinal Study	Two hundred and twenty-five male volunteers aged between 21 and 36 years, who frequented a gym.	Negative correlation between the ability to delay gratification (higher scores represent a greater ability) and impulsivity (r = 0.69, p < 0.001) and a moderate to weak negative association with infidelity (r = 0.32, p = 0.002). Openness and neuroticism showed a weak correlation with the ability to delay gratification (r = 0.22, p = 0.001; r = 0.36, p < 0.001, respectively). Impulsivity was moderately positively correlated with attitudes toward infidelity (r1/4 0.54, p < 0.001), neuroticism (r1/4 0.53, p < 0.001), and openness (r = 0.31, p = 0.004), and negatively with extraversion (r = 0.32, p = 0.003). Regarding personality traits, extraversion was negatively correlated with neuroticism (r = 0.39, p < 0.001) and positively correlated with agreeableness (r = 0.41, p < 0.001). Neuroticism showed a negative association between agreeableness and conscientiousness (r = 0.26, p = 0.019; r = 0.32, p = 0.003, respectively). Agreeableness showed a positive relationship between conscientiousness and	The results of this research highlight a key implication of impulsivity in AAS use in conjunction with traits of neuroticism, openness, and extraversion.

					openness (r = 0.34, p = 0.002; r = 0.40, p < 0.001, respectively).	
Gonçalvesa, Reggiani V. et. Al (2019)	Trans fatty acids aggravate anabolic steroid-induced metabolic disorders and differential gene expression in muscle, pancreas, and adipose tissue	To investigate the impact of a diet rich in trans fatty acids (HD) combined with EA on glycemic control, lipid profile, adipose tissue, skeletal muscle and pancreas microstructure, and expression of genes involved in energy metabolism.	Randomized cross-sectional experimental study	C57BL/6 female 12-week-old mice were maintained under controlled environmental conditions (temperature 22 ± 2 °C, air humidity 60-70%, and daily light/dark cycles of 12/12 hours).	Our results indicated that AS improved glycemic control, upregulated gene expression of Glut-4 and CPT-1 in skeletal muscle, FAS, ACC and UCP-1 in adipose tissue. AS also reduced total and LDL cholesterol in SD-fed mice. When combined with HFD, AS was unable to induce microstructural adaptations in adipose tissue, pancreatic islets, and ÿ cells, but it potentiated the upregulation of GCK and Glut-2 (pancreas) and Glut-4 and CPT-1 (skeletal muscle). HFD plus AS also downregulated the expression of FAS and ACC genes in adipose tissue. Combined with HD, AS increased circulating triacylglycerol levels, improved insulin sensitivity and glycemic control in mice.	The results indicated that AS improved glycemic control, upregulated the gene expression of Glut-4 and CPT-1 in skeletal muscle, FAS, ACC and UCP-1 in adipose tissue. AS also reduced total and LDL cholesterol in SD-fed mice. When combined with HFD, AS was unable to induce microstructural adaptations in adipose tissue, pancreatic islets, and ÿ cells, but it potentiated the upregulation of GCK and Glut-2 (pancreas) and Glut-4 and CPT-1 (skeletal muscle). HFD plus AS also downregulated the expression of FAS and ACC genes in adipose tissue. Combined with HD, AS increased circulating triacylglycerol levels, improved insulin sensitivity and glycemic control in mice.
Souza, Francis Ribeiro et. Al (2019)	Retrograde and oscillatory shear rate in young anabolic androgenic steroid users	To study the shear rate, muscle sympathetic nerve activity and C-reactive protein of young recreational weightlifters and amateur bodybuilding athletes who use (n=10) or not AAS (n=10).	Clinical study.	Twenty volunteers aged 18 to 40 years male, AAS users (AASU) (n=10) or 10 non-AAS (n=10), recreational weightlifters or amateur bodybuilding athletes.	The evaluation of doping control was negative in the UNSA group (mean T/E less than 1). In contrast, nandrolone decanoate, boldenone undecylenate, testosterone, Stanozolol were found in the AASU group. In addition, the mean T/E concentration ratio in urine was 50.75±24.46. The lifetime of AAS use was 5±3 years. The drug test assessment was positive for MD MA and amphetamine for a participant in the AASU group, and positive for cocaine for a participant in the AASNU group. In addition, both groups had similar years of resistance training (10±4 vs. 10±4 years, p=0.90)	AAS present brachial involvement, retrograde artery, and oscillatory RS, which are associated with increased ANSM. Therefore, these findings are clinically relevant because they suggest that young AAS users may be at risk for early development of atherosclerotic cardiovascular disease.

Kyle T. Ganson e Tamara J. Cadet (2018)	Exploring the use of anabolic androgenic steroids and Violence in adolescent dating among adolescent males	The objective of this secondary data analysis was to understand the relationship between AAS use and TDV in evils of adolescence. Based on the conceptual framework, the hypothesis that the ailments of adolescents who used aspirin at least once in their lives would be more likely to get involved in TDV was supported.	Cross-sectional analysis of secondary data.	This analysis included high school students from the research years of 2013 and 2015. The total number 2013 Combined Interviewee (n = 2,801) and 2015 (n = 2,618) was 5,419. be included in this analytical sample, the interviewees identified themselves as men and answered the following questions involving the use of aspirin, TDV, body image, and suicide attempts. 1.7 A final sample of 2,080 observations was used for this analysis.	The results suggested that male adolescents who used steroids at least once in their lifetime, compared to those who did not, were 1.1 times more likely to engage in adolescent dating violence. In addition, men who identified as a sexual minority were 1.1 times more likely to use anabolic androgenic steroids, as were those who had at least one suicide attempt in the previous 12 months.	The use of AAS by adolescent males is associated with multiple psychosocial factors that professionals, school staff, and parents should be aware of
Horwitz, H et. Al (2019)	Health Consequences of Anabolic Androgenic Steroid Use	To investigate mortality and morbidity among anabolic androgenic steroid (AAS) users.	This was a matched retrospective cohort study.	In this retrospective matched cohort study, 545 male subjects tested	Mortality was three times higher among AAS users than among non-user controls (hazard ratio 3.0, 95% CI 1.3–7.0). The median annual number of hospital contacts was 0.81 in the AAS user cohort and 0.36 in the control cohort (P < 0.0001). Acne, gynecomastia, and	Users of anabolic androgenic steroids have an increased risk of death and significantly more hospital admissions than their non-user peers. Side effects of ASAs and their

				positive for ASA in Danish fitness centers during the period from January 3, 2006, to March 1, 2018.	erectile dysfunction affected more than 10% of anabolic androgenic steroid users, and the prevalence of these disorders was significantly higher than in the control group (P<0.0001).	metabolites were highly prevalent. Given the high rate of abuse of anabolic androgenic steroids, these side effects are a public health problem.
Chegeni , R et. Al (2019)	Aggression and Anabolic-Androgenic Steroid Use Intention in Adolescents: A Longitudinal Study	We conducted a longitudinal investigation of the factors associated with intention to use AAS from 18 to 19 years of age, particularly examining the role of physical and verbal aggression. A sample of Norwegians completed questionnaires containing demographics, ASA use and intention, other addictions, aggression, and health measures at age 18 (N = 1,333, females = 58.9%) and 19 (N = 1,277, females = 61.7%).	A longitudinal study	From an initial sample of 3,000 (1,500 women) 17-year-olds randomly selected from the Norwegian National Institute. Registration and invitation to participate in a survey on addiction in 2012 (wave 1), 2055 (women1/4 53.0%) returned completed questionnaires (response rate 1/4 70.4%). In 2013, those who responded were contacted again (18 years old). A total of 1,333 people responded (wave 2: women = 58.9%, retention rate = 64.9%).	The third and final model, composed of all independent variables, explained 15% of the variance in the attempt to use AAS in wave 3: F (16,957) = 13.36, p < 0.01. Here, men (sex: b 1/4 0.066, p < 0.01) and individuals living alone (b 1/4 0.068, p < 0.05) had a higher intention to use AAS in wave 3. In addition, last year, the use of AAS in wave 2 had a positive association (b = 0.296, p < 0.05) with the intention to use AAS in wave 3	Our findings indicate temporal stability in the intention to use AAS, as well as the influence of demographic and health factors on the intention to use AAS between 18 and 19 years of age. The implications of the results for practice and future research are discussed.

				One year later (wave 3), participants were contacted again. A total of 1277 individuals (women = 61.7%) responded (retention rate = 62.1%).		
Almaiman, A A et. Al (2018)	Side effects of anabolic steroids used by athletes in Unaizah Gyms, Saudi Arabia: a pilot study	The present study aimed to investigate the abuse of anabolic steroids among athletes in the city of Unaizah, Qassim, Saudi Arabia.	Cross-sectional pilot study	A cross-sectional study was carried out, in which 16 regular gym goers, 12 (?)	Subjects reported having taken a 3-month course of an AAS composed of three compounds (testosterone enanthate, nandrolone decanoate, and methandienone). A two-week interval separated each of the courses, during which tamoxifen citrate (40 mg per day) and clomiphene citrate (10 mg per day) were taken to control serum testosterone levels. Ingestion of a course of AAS had notable effects on some parameters related to kidney function. However, three courses or more treatments of ASA showed abnormal liver and heart enzymes. In addition, endogenous testosterone levels decreased dramatically with long-term use of AAS (more than 10 courses). Increased alpha 2 protein taking more than 10 cycles, which can cause acute phase reaction of infection or inflammation of the liver.	AAS products should be controlled by the Saudi Ministry of Health and should not be taken randomly without the supervision of the healthcare professional.
Souzaa, F R et. Al (20190)	Decreased HDL-Mediated Cholesterol efflux and Coronary Artery Disease in Young Male Anabolic Androgenic Steroid Users	In the present study, we evaluated the functionality of HDL, which could be one of the mechanisms of the atherosclerotic process. We also evaluated the prevalence of subclinical CAD in AAS users.	This was a cross-sectional study.	68 healthy male participants. 50 participants of the same age were evaluated and allocated: 20 AAS users (AASU group), 20 non-AAS users (AASNU group).	Cholesterol efflux was lower in SUA compared to UNSA and SC (20 vs. 23 vs. 24%, respectively, $p < 0.001$). However, the latency time for LDL oxidation was longer in AASU compared to AASNU and SC (41 vs. 13 vs. 11 min, respectively, $p < 0.001$). We found at least 2 coronary arteries with plaques in 25% of SUA. None of the AASNU and SC had license plates. The duration of AAS use was negatively associated with cholesterol efflux.	This study indicates that AAS abuse impairs HDL-mediated cholesterol efflux. Long-term AAS use appears to be correlated with lower cholesterol efflux and early subclinical CAD in this population.

				Both groups (AASU and AASNU) were either recreational weightlifters or amateur bodybuilding athletes recruited from gyms.		
Seara, F A C et. Al (2019)	Cardiac electrical and contractile disturbances promoted by anabolic steroid overdose are associated with delayed autonomic imbalance and Ca2+ deficiency management	To investigate cardiac electrical and mechanical dysfunctions caused by chronic anabolic steroids (AS). overdose.	Longitudinal experimental study	Male Wistar rats were treated with nandrolone decanoate (DECA) or vehicle (CTL) for 8 weeks.	Compared with the CTL group, the DECA group exhibited decreased high-frequency band power density (HF) and increased low-frequency (LF) power density, the mRNA level of cardiac M2R was decreased. QTc interval at the 2nd, 4th, and 8th weeks, as well as APD30 and APD90 were increased by DECA. The density of Ito decreased, while ICaL density was increased by DECA. The charge and release of Ca2+ in the SR were decreased by DECA, while the contractile sensitivity to Ca2+ was increased in relation to the CTL group.	DECA overdose induced cardiac rhythmic and mechanical abnormalities that may be associated with autonomic imbalance, upregulated ICaL and negative-regulated Ito, abnormal Ca2+ SR mobilization, and increased contractile sensitivity to Ca2+.
Andrade, T U et. Al (2019)	Stanozolol promotes lipid deposition in the aorta through an imbalance in inflammatory cytokines and oxidative status in LDLr knockout mice fed normal diet	The aim of this study was to evaluate the effect of an anabolic steroid, stanozolol, in a model of atherosclerosis and to investigate the involvement of inflammatory cytokine modulation and oxidative stress in vascular lipid deposition.	Cross-sectional experimental study	This study used male LDL receptor knockout mice (LDLrÿ/ÿ)	Our results suggest that the anabolic steroid stanozolol, in the absence of functional LDL receptors, by increasing systemic inflammation and oxidative stress, may increase the risk of development and progression of atherosclerosis.	This study demonstrated for the first time that treatment with stanozolol for 8 weeks was able to increase vascular lipid deposition in LDLr-/ÿ mice. This effect can be attributed, at least in part, to a change in the lipid profile and probably to systemic inflammation and oxidative stress, all independent of a Western-type diet.