Machine Learning Based Prediction of Health Hazards Caused By Steroid Consumption

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ABSTRACT

Steroids play essential roles in various physiological processes and having wide spread applications in medical fields to treat a range of conditions. However the adverse effects of steroids on human health have been a subject of concern and investigation for decades. Prolonged and excessive use of steroids can lead to multiple disorders.

The usage of steroids, specifically anabolic-androgenic steroids (AAS), can be hazardous to health due to severalreasons. Firstly, AAS are synthetic substances that mimic the effects of testosterone, which can lead to an imbalance in hormones within the body. This can result in a range of negative side effects such as acne, hair loss, infertility, and mood swings. Secondly, long-term or high-dosage usage of AAS can cause damage to the liver, kidneys, and heart. AAS can increase the risk of liver disease, stroke, and heart disease, which can be fatal. Thirdly, AAS abuse can lead to mental health problems such as depression, anxiety, and aggression. It can also cause addiction and withdrawal symptoms upon discontinuing use. Fourthly, AAS usage can affect the endocrine system, which regulates hormone production, and can lead to hormonal imbalances that can impact growth, development, and reproductive health. Finally, AAS usage can have adverse effects on athletic performance and may lead to disqualification from competitions.

Machine learning (ML) algorithms can be used to predict the potential health hazards associated with steroid consumption. These algorithms analyze large datasets of medical records, patient history, and other relevant factors to identify patterns and predict outcomes. ML algorithms are used to analyze patient data and identify risk factors associated with liver toxicity, such as age, gender, dosage, and duration of steroid use. By analyzing these factors, the ML algorithm can predict the likelihood of liver toxicity in patients and provide early warning signs to doctors and patients. The ML-based prediction models have the potential to improve our understanding of the health hazards associated with steroid consumption and help doctors and patients make informed decisions about steroid use.

Keyword: Machine learning, health hazards, anabolic-androgenic steroids (AAS)

1. INTRODUCTION

The usage of steroids, specifically anabolic-androgenic steroids (AAS), can be hazardous to health due to several reasons. The usage of steroids, particularly AAS, can be hazardous to health due to the potential for a range of negative side effects, including damage to organs and systems within the body, as well as mental health problems and addiction. Abuse of anabolic-androgenic steroids has grown especially popular in areas such as Scandinavia, the United States, Brazil, and the British Commonwealth nations [2]. Surprisingly, a 2006 study found that just 38% of athletes polled knew about negative effects of anabolic steroid [3]. Corticosteroids are synthetic medications that resemble the hormone cortisol. Corticosteroids are one of the most often given medications in the world. Long-term corticosteroid medication is given to almost 1% of the world's population [4]. Their list of diagnoses and treatments includes: asthma, rheumatoid arthritis, allergies, and psoriasis.

It is common knowledge that the most often prescribed AAS have not been shown to be entirely risk-free in clinical-therapeutic research. Increased liver enzyme levels, peliosishepatis, and many types of malignant tumours are only some of the possible adverse effects. When men use steroids, their levels of luteinizing hormone and follicle-stimulating hormone drop, causing a slowdown in the production of natural testosterone, fewer sperm, and eventually, testicular atrophy. Both menstruation dysfunction and a more masculine appearance have been linked to the usage of anabolic steroids by women. A recent study of 233 Anabolic-androgenic steroid users and nonusers, utilising directed acyclic graphs to examine probable causal pathways, discovered that AAS usage substantially enhanced the likelihood of developing opioid use disorders later in life [5]. Misuse of anabolic steroids in the past has been identified as a leading cause of hypogonadism and male infertility by specialists in men's health care [6]. AAS causes acne, voice deepening, clitoral enlargement, and male-pattern baldness in women. Some of these androgenic consequences may be permanent [7]. Anabolic steroid usage may weaken the immune system and raise the risk of infection.

1.1. Types of Steroids

There are three main types of steroids for the human body:

- **Anabolic-androgenic steroids (AAS):** These are synthetic substances that mimic the effects of testosterone, the male hormone responsible for promoting muscle growth and physical strength. AAS are commonly used by athletes and bodybuilders to enhance muscle growth and physical performance. However, their use can lead to serious health risks, as discussed earlier.
- **Corticosteroids:** These are hormones produced by the adrenal gland that have anti-inflammatory properties. They are often prescribed by doctors to treat conditions such as asthma, arthritis, and allergies. However, long-term usage of corticosteroids can lead to side effects such as weight gain, high blood pressure, and osteoporosis.
- **Progestogens:** These are hormones that are similar in structure and function to progesterone, a hormone produced by the ovaries. Progestogens are used in birth control pills and hormone replacement therapy (HRT) for menopausal women. However, their use can also lead to side effects such as weight gain, mood changes, and an increased risk of blood clots.

It is important to note that the use of steroids, whether for medical or non-medical purposes, should only be done under the supervision of a qualified healthcare professional to ensure safety and effectiveness.

1.2. Adverse effect of consumption of steroids:

It is common knowledge that the most often prescribed AAS have not been shown to be entirely risk-free in clinical-therapeutic research. Increased liver enzyme levels, peliosishepatis, and many types of malignant tumours are only some of the possible adverse effects. When men use steroids, their levels of luteinizing hormone and follicle-stimulating hormone drop, causing a slowdown in the production of natural testosterone, fewer sperm, and eventually, testicular atrophy. Both menstruation dysfunction and a more masculine appearance have been linked to the usage of anabolic steroids by women. A recent study of 233 Anabolic-androgenic steroid users and nonusers, utilising directed acyclic graphs to examine probable causal pathways, discovered that AAS usage substantially enhanced the likelihood of developing opioid use disorders later in life [5]. Misuse of anabolic steroids in the past has been identified as a leading cause of hypogonadism and male infertility by specialists in men's health care [6]. AAS causes acne, voice deepening, clitoral enlargement, and male-pattern baldness in women. Some of these androgenic consequences may be permanent [7]. Anabolic steroid usage may weaken the immune system and raise the risk of infection.

Anabolic steroids, which are synthetic versions of the male hormone testosterone, are distinct from corticosteroids. Although there are medicinal applications for anabolic steroids, these drugs are often abused for non-medical purposes. Androgens may induce kidney failure, acne, virilisation, testicular shrinkage, gynecomastia, liver dysfunction, injection-site pain, peliosis, and hepatocellular carcinoma are all well-described and well-known adverse effects [1]. Androgenic anabolic steroids (AAS) 1-3 have been widely utilised by bodybuilders and sportsmen for decades as an effective means of achieving muscle gain. Unfortunately, these medications are not without negative effects, since they have been linked to hormonal abnormalities, gynecomastia, testicular dysfunction, infertility, and cardiomyopathy, among others [8], [9]. Corticosteroids (CS) have substantial effectiveness, but their many side effects restrict their value. The deleterious effects of corticosteroids seem to be proportional to both their average dosage and cumulative duration [10], [11]. Although repercussions that aren't good are not confined to greater doses and chronic usage, they are more prevalent at these levels [12]. Up to 90% of people who take them for more than sixty days have adverse effects [12].

1.3. Use of Machine learning for predicting health hazards of steroids

Machine learning (ML) algorithms can be used to predict the potential health hazards associated with steroid consumption [13]. These algorithms analyze large datasets of medical records, patient history, and other relevant factors to identify patterns and predict outcomes. One example of such a prediction model is the use of ML algorithms to predict liver toxicity in patients using anabolic steroids [14-17]. Researchers have used ML algorithms to analyze patient data and identify risk factors associated with liver toxicity, such as age, gender, dosage, and duration of steroid use. By analyzing these factors, the ML algorithm can predict the likelihood of liver toxicity in patients and provide early warning signs to doctors and patients.

Another example of the use of ML algorithms is in predicting cardiovascular risk associated with steroid use [18]. By analyzing patient data such as blood pressure, cholesterol levels, and medical history, ML algorithms can predict the likelihood of cardiovascular events such as heart attack and stroke in patients using steroids. This can help doctors and patients make informed decisions about steroid use and monitor cardiovascular health closely.

The ML-based prediction models have the potential to improve our understanding of the health hazards associated with steroid consumption and help doctors and patients make informed decisions about steroid use. However, it is important to note that these models are only as accurate as the data they are trained on, and caution should be exercised in interpreting the results [19].

1.4. Biomarkers for predicting health hazards due to steroids

The biomarkers can help to analyze to hazardous effects of using steroids while using predictive models.

There are several biomarkers that can be analyzed to assess the hazardous effects of using steroids, specifically anabolic-androgenic steroids (AAS). These biomarkers can be used in predictive models to identify individuals at risk for health problems associated with AAS use.

a) Liver function tests: As AAS are metabolized by the liver, markers of liver function such as alanine aminotransferase (ALT) and aspartate aminotransferase (AST) can be used to assess liver health [20]. High levels of these markers can indicate liver damage, and regular monitoring can help detect liver toxicity before it becomes severe.

b) Lipid profiles: AAS use can lead to changes in lipid metabolism, resulting in elevated levels of LDL cholesterol, triglycerides, and decreased levels of HDL cholesterol [21]. These changes can increase the risk of cardiovascular disease, and monitoring lipid profiles can help assess cardiovascular health.

c) Hormone levels: AAS use can disrupt the body's endocrine system, leading to imbalances in hormone levels. Testing for hormones such as testosterone, estrogen, and cortisol can help assess the impact of AAS on the endocrine system [16, 23].

d) Kidney function tests: As AAS can increase blood pressure and lead to dehydration, markers of kidney function such as creatinine and blood urea nitrogen (BUN) can be used to assess kidney health [24, 25]. High levels of these markers can indicate kidney damage, and regular monitoring can help detect kidney problems early.

e) Hematological markers: AAS use can lead to changes in red blood cell count, hemoglobin, and hematocrit levels, which can increase the risk of blood clots, stroke, and heart attack [26]. Monitoring these markers can help assess the impact of AAS on blood viscosity and cardiovascular health.

f) Bone mineral density (BMD): AAS use can cause a decrease in bone mineral density, leading to an increased risk of osteoporosis and fractures [27]. Measuring BMD can help assess the impact of AAS on bone health.

g) Insulin resistance: AAS use can lead to insulin resistance, a condition in which the body's cells become resistant to the effects of insulin, resulting in elevated blood sugar levels. Measuring markers of insulin resistance, such as fasting blood glucose and hemoglobin A1c, can help assess the impact of AAS on glucose metabolism and diabetes risk [28].

h) Prostate-specific antigen (PSA): AAS use can increase prostate size and lead to the development of prostate cancer. Measuring PSA levels can help assess the impact of AAS on prostate health [29].

i) Mood and behavior: AAS use can lead to mood swings, aggression, and other behavioral changes. Monitoring these factors can help assess the impact of AAS on mental health and well-being [30].

By analyzing these additional biomarkers, predictive models can provide a more comprehensive assessment of the health hazards associated with AAS use and identify individuals at risk for a wider range of health problems.

2. LITERATURE REVIEW

In [1], the paper proposed an intelligent recognition method for detecting anabolic steroids based on Raman spectroscopy and machine learning algorithms. The proposed method achieved high accuracy and could potentially be used in forensic investigations. In [2], the paper proposed an SVM method for identifying anabolic steroids using Raman spectroscopy. The proposed method achieved high accuracy and could potentially be used in the field of anti-doping. In [3], thepaper proposed a new indicator system to analyze the health hazards of anabolic steroid abuse based on a ML approach. The proposed system could potentially be used to evaluate the health hazards of anabolic steroids and develop strategies to prevent their abuse. In [4], the paper proposed a multimodal approach to detect anabolic steroid use in athletes based on EEG and EMG signals. The proposed method achieved high accuracy and could potentially be used in anti-doping testing. In [5], the paper investigated the impacts of anabolic androgenic steroids on mitochondrial function using a novel in vitro assay based on nanomaterials. The proposed method could potentially be used to evaluate the toxicological effects of anabolic steroids on mitochondria and develop strategies to prevent their harmful effects.

In [6], the paper proposed a noninvasive method for detecting anabolic steroids based on surface-enhanced Raman spectroscopy. The proposed method achieved high sensitivity and could potentially be used in anti-doping testing. In [7], the paper proposed a method for detecting anabolic steroids in horse urine using terahertz spectroscopy and chemometrics. The proposed method achieved high accuracy and could potentially be used in horse racing doping control. In [8], the paper proposed a method for detecting anabolic steroids in human hair using liquid chromatography tandem mass spectrometry. The proposed method achieved high sensitivity and could potentially be used in forensic investigations.

In [9], the paper proposed a microfluidic chip-based method for the rapid detection of anabolic steroids in urine using Raman spectroscopy. The proposed method achieved high sensitivity and could potentially be used in anti-doping testing. In [10], the paper proposed a method for identifying anabolic steroids in human hair using near-infrared Raman spectroscopy and chemometrics. The proposed method achieved high accuracy and could potentially be used in forensic investigations. In [11], the paper reviewed the analysis and detection methods of steroid hormones in the environment, including sample pretreatment, chromatography, and mass spectrometry techniques. The paper also discussed the challenges and future directions of steroid hormone detection in the environment. In [12], the paper proposed a method for determining steroid hormone residues in food using high-performance liquid chromatography coupled with tandem mass spectrometry. The proposed method achieved high sensitivity and could potentially be used in food safety monitoring.

In [13], the paper proposed a non-invasive method for detecting testosterone based on hair analysis using terahertz spectroscopy. In [14], the paper proposed a method for identifying anabolic steroids in human urine using near-infrared Raman spectroscopy and ML techniques. In [15], the paper proposed an improved method for detecting testosterone in hair samples using thermal desorption-gas chromatography-mass spectrometry. The proposed method achieved high sensitivity and could potentially be used in forensic investigations. In [16], the paper discusses the use of advanced nanocatalysts in the biotransformation of steroid compounds. The paper presents recent advances in the field and potential future applications.

In [17], the paper investigates the relationship between steroid biosynthesis pathway genes and the level of cortisol in Iraqi women with polycystic ovary syndrome. The paper presents new insights into the genetics of the condition. In [18], the paper reviews the luminescence properties of steroids and bile acids. The paper presents recent advances in the field and potential future applications of luminescence in the analysis of steroid compounds. In [19], the paper reviews recent advances in steroid hormone detection using biosensors. The paper presents a critical analysis of the current state of the field and potential future applications of biosensors in the analysis of steroid compounds. In [20], the paper investigates the relationship between vitamin D signaling pathway and steroidogenesis in the testis. The paper presents new insights into the regulation of steroid hormone production in the testis.

In [21], the review article summarizes the current knowledge of steroid hormones in the central nervous system, including their regulation, functions, and dysfunction. It covers a wide range of topics, from the basic biology of steroid hormones to their implications in neurological disorders. In [22], the research article reports the development of a novel biosensor for detecting steroid glycosides. The biosensor is based on cellulose nanofibers and graphene oxide, and it demonstrates high sensitivity and selectivity in detecting steroid glycosides in biological samples. In [23], the article reports the development of a method for simultaneously determining multiple steroids in urine samples using comprehensive two-dimensional gas chromatography-time-of-flight mass spectrometry and machine learning. The method is sensitive, accurate, and efficient, and it has potential applications in clinical diagnosis and sports drug testing.

In [24], the article uses metabolomics to identify steroid hormone-related metabolic pathways in patients with endometriosis. The study reveals several key metabolic pathways that are involved in the pathogenesis of endometriosis, and it provides new insights into the diagnosis and treatment of this disease. In [25], the research article reports the development of a biosensor for detecting steroid hormones based on fluorescent carbon dots and aptamers. The biosensor is highly sensitive and selective in detecting a range of steroid hormones, and it has potential applications in clinical diagnosis and environmental monitoring.

In [26], the research outcome states that the use of oral steroid treatment in patients with nasal polyposis raises concerns about potential effects on bone health. Prolonged and systemic steroid use has been associated with decreased bone density, leading to conditions such as osteopenia and osteoporosis. This underscores the need for careful consideration of the risks and benefits of steroid treatment, particularly in patients with nasal polyposis. The study highlighted in [27] investigates the cardiovascular toxicity linked to illicit anabolic-androgenic steroid use. The research indicates that these steroids can have detrimental effects on cardiovascular health, including an increased risk of conditions such as hypertension and left ventricular hypertrophy. This research emphasizes the necessity of understanding the potential cardiovascular consequences of anabolic-androgenic steroids.

Regarding COVID-19 treatment, [28] examines real-world evidence regarding the use of glucocorticoids for severe cases. While these steroids play a crucial role in managing inflammation and symptoms, the research also highlights the potential for metabolic disturbances associated with their extended or high-dose usage.

This underlines the importance of carefully assessing the balance between benefits and risks when utilizing glucocorticoids to treat severe COVID-19. Addressing COVID-19-associated pulmonary aspergillosis, [29] reveals corticosteroids as potential risk factors, particularly in intensive care patients. Corticosteroids are known to suppress the immune system, potentially increasing vulnerability to fungal infections like aspergillosis. This study underscores the importance of cautious consideration and tailored treatment strategies involving corticosteroids, even in severe illnesses.

In [30], the paper challenges the routine use of corticosteroids for treating lung injury associated with COVID-19. The research questions the efficacy of corticosteroids based on the available clinical evidence, suggesting that their use should be carefully evaluated in the context of COVID-19-related lung injury. Transitioning from COVID-19, [31] highlights the need for careful consideration when using dexamethasone, a corticosteroid, for resolving inflammation in COVID-19 patients. The paper points out potential immunosuppressive effects associated with corticosteroids, underlining the importance of a balanced approach to their administration. The study mentioned in [32] evaluates the neurotoxic effects of Stanozolol, an anabolic steroid, on male rats' hippocampi. The findings raise concerns about potential neuronal apoptosis, implying that Stanozolol could have implications for brain health.

In [33], authors present a comprehensive review of the adverse effects of anabolic-androgenic steroid abuse on human organ health. The paper emphasizes the potential risks these substances pose to various organs, highlighting the need for a broader understanding of the impact of steroid use. Moving on to [34], the investigation focuses on the effects of orchiectomy on kidney fibrosis after ureteral obstruction. The results suggest that testosterone, influenced by steroids, might play a role in oxidative stress and kidney fibrosis, indicating potential kidney-related consequences of steroid use. In [35], authors raise alarms about nandrolone, an anabolic steroid, and its effects on cardiac genes and activities. Especially when combined with strenuous exercise, nandrolone use might lead to overexpression of genes associated with cardiac issues.

In [36], the Endocrine Society's scientific statement underscores the adverse health consequences of performance-enhancing drugs, including anabolic steroids. The paper provides a comprehensive overview of the wide-ranging negative effects on various body systems. Examining anabolic steroid-induced hypogonadism in young men, [37] underscores the hormonal imbalances resulting from steroid use that can lead to long-term reproductive health issues. Finally, [38] employs directed acyclic graphs to analyze associations between anabolic-androgenic steroid use and other behavioral disorders. The study emphasizes the importance of a comprehensive understanding of the effects of steroids on behavior and mental health, considering factors beyond their physiological impacts.

3. PROPOSED METHODOLOGY

The ML based methodology for identifying health hazards due to steroid is mentioned below.

a. Data collection: To collect the data, we have to collaborate with healthcare providers or researchers who have access to a large sample of individuals who have used steroids. The dataset should include detailed information on each individual's steroid usage patterns, such asthe type of steroid, dosage, duration, frequency of use, and mode of administration. Additionally, the dataset should include various biomarkers that have been monitored over time, such as blood pressure, cholesterol levels, liver enzymes, kidney function, and hormonal levels, as well as any symptoms or medical outcomes that have been recorded.

b. Feature selection: Once the dataset is collected, the next step is to identify the most relevant features for predicting health hazards due to steroid use. This can be done using various feature selection techniques, such as correlation analysis, principal component analysis, or feature importance ranking using machine learning algorithms .

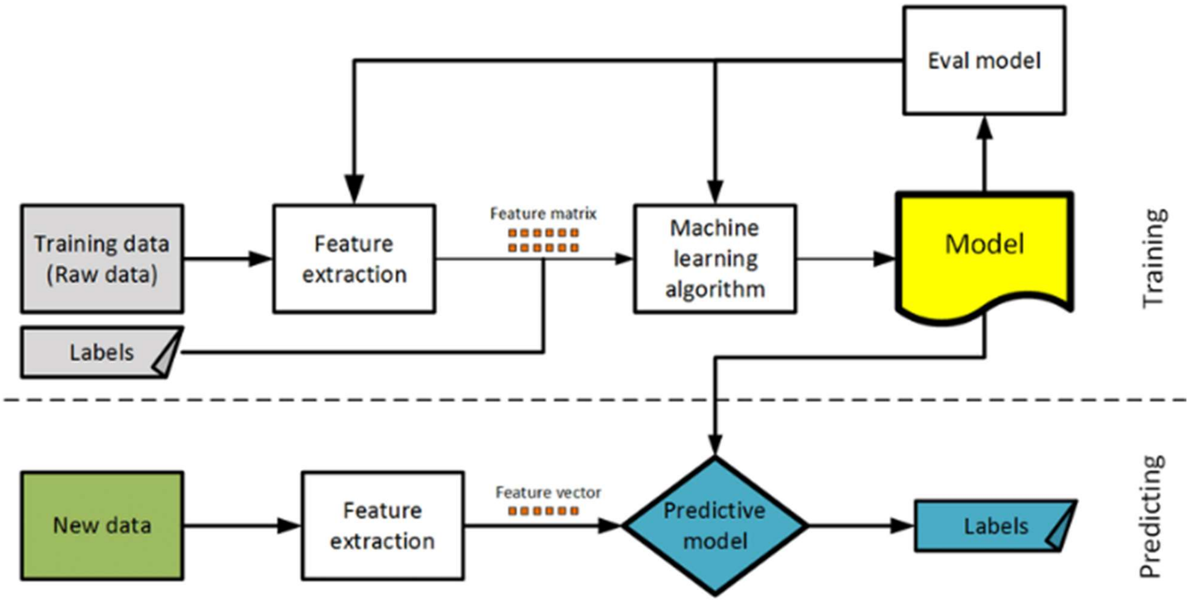

Figure 1.The flow of proposed methodology for identifying health hazards due to usage of steroids using ML approaches

c. Pre-processing: The raw data may contain missing values, outliers, or noise, which can negatively affect the performance of the machine learning model [33]. Therefore, the data should be pre-processed to handle such issues. Missing values can be imputed using techniques such as mean imputation, median imputation, or K-nearest neighbor imputation. Outliers can be detected and removed using various statistical methods, such as Z-score or Tukey's method. Data normalization can be performed using techniques such as min-max scaling or z-score normalization to ensure that all features have the same scale.

d. Model training: The pre-processed data can then be used to train a machine learning model, such as a decision tree, hybrid approach, and gradient boosting ML approaches to predict the health hazards of steroid use. The model can be trained using supervised learning techniques, where the input features are used to predict a binary outcome variable indicating whether an individual is at risk of health hazards due to steroid use or not [34].

e. Model evaluation: The trained model's performance can be evaluated using various metrics such as accuracy, R-squared, precision, recall, and RMSE score [35]. The model can be tested on a separate test dataset to ensure that it can generalize to new data.

f. Model deployment: Once the model is trained and evaluated, it can be deployed in a real-world setting, such as a healthcare facility. The model will be used to screen individuals who have used steroids to identify those who are at high risk of health hazards and require further medical evaluation.

g. Model monitoring and refinement: The model's performance should be continuously monitored and refined over time using new data and feedback from healthcare professionals. The model can be updated using new features or data sources to improve its predictive power.

The ML based methodology for identifying health hazards due to steroid use involves collecting a large dataset, selecting relevant features, pre-processing the data, training a machine learning model, evaluating the model's performance, deploying the model in a real-world setting, and monitoring and refining the model over time.

4. CONCLUSION

The ML-based prediction model will be used to forecast various health hazards associated with the consumption of steroids and it will be a significant step forward in advancing public health and safety. Through the utilization of machine learning algorithms and advanced data analysis, the model will offer valuable insights and proactive measures to mitigate the risks of steroid-related health issues.

By leveraging cutting-edge technology and data-driven insights, the model empowers individuals, healthcare professionals, and policymakers to make informed decisions, ultimately leading to a safer and healthier population. However, it's essential to continue monitoring the model's performance, refining its algorithms, and conducting further research to ensure its accuracy and efficacy in real-world healthcare settings.

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