The Prediction Factors of Anabolic-Androgenic Steroid Use among Bodybuilders: Application of Prototype Willingness Model

Zohreh Manoochehri
Hamedan University of Medical Sciences

Majid Barati
Hamedan University of Medical Sciences

Javad Faradmal (✉ javad.faradmal@umsha.ac.ir)
Hamedan University of Medical Sciences

Sara Manoochehri
Hamedan University of Medical Sciences

Research Article

Keywords: Random forest, Androgenic-anabolic steroids, Prototype willingness model

DOI: https://doi.org/10.21203/rs.3.rs-142529/v1

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Abstract

Background: One of the types of doping commonly used by bodybuilders is androgenic-anabolic steroids (AAS). The use of AAS in addition to violating sporting ethics, has serious consequences on physical and mental health. The purpose of this study was to determining the most important factors of AAS use among bodybuilders using prototype willingness model (PWM).

Methods: In this analytical cross-sectional study, 280 male bodybuilders were selected using multistage sampling from the bodybuilding clubs in Hamadan city in 2016. A self-administered questionnaire consisting of demographic information and constructs of the PWM was used to collect data and random forest model was used to analyses the gathered data.

Results: behavioral willingness, Attitude, previous AAS use were the most important factors in determining the behavioral intention. Subjective norms, attitude, BMI and prototypes were the factors that have the greatest impact on predicting of behavioral willingness of AAS use. Also behavioral intention was more important rather than behavioral willingness for predicting of AAS use.

Discussion: The results based on PWM and random forest showed that the reasoned action path has a greater impact than social reaction path to predict AAS use among bodybuilders.

Background

Androgenic Anabolic Steroids (ASS) are a group of steroids that contain natural androgens such as testosterone and testosterone-like industrial substances in terms of structure and function (1). The history of using these substances goes back almost 90 years ago to medical purposes. AAS are used to build muscle, increase appetite and also increase the physical strength of patients in diseases such as AIDS and cancer (2). they increase the volume of protein inside the cell, and bodybuilders use these derivatives to increase muscle size and increase strength (1). The prevalence of these substances reaches 1–5% worldwide and is more common among men (3). It is estimated that 2.9 to 4 million people among the US population of 13 to 50 years old use these substance so that about 1 million people in this population are heavily dependent on them (4). The prevalence of AAS use among American athletes is estimated to be around 20% (5). To the best of authors knowledge, there are no studies that have investigated the prevalence of AAS use in Iran so far, however, a study in Shiraz found that the prevalence of AAS among men’s bodybuilders was 39% (6). Some of the most motivations for using AAS as reported by bodybuilders in Kermanshah include: Increasing muscle mass, increasing physical strength, dietary supplementation and make the body more beautiful (7). In addition to violates sports ethics, AAS use, also has some serious consequences on physical and mental health, including cardiovascular problems, renal complications, thyroid disorder, tendon and ligament rupture, major mood disorders such as aggression and violence and even death (8, 9). Since having a muscular and beautiful body, along with the desire to get into the sports position has become an important social indicator, young people are increasingly using these substances (7). Health-centered educational interventions can partially reduce
the tendency to use these drugs so that these interventions reduce substance abuse (10). However, experts believe that one of the reasons for the failure of educational programs is the lack of attention to psychosocial factors such as having the ability to reject the offer for use and self-control (11). In this regard different theories have been proposed to explain the phenomenon of substance use. Although these theories are not specific to AAS, they provide a useful understanding of AAS use. One of these theories is the prototype willingness model (PWM) (12). According to PWM, there are two basic path to detect high-risk behavior, the reasoned action path and social reaction path. The reasoned action path that refers to an analytical and argumentative process includes structures of attitudes, subjective norms and behavioral intentions. The social reaction path that based on imagination and includes an exploratory process explains the behavior of individuals without prior intention. This path includes structures of prototypes and behavioral willingness (Fig. 1) (13). In PWM, intention to perform a behavior is determined by two factors, attitude and subjective norms. Attitude is positive or negative evaluation of a person about performing a behavior and subjective norms refers to the social pressure perceived by the individual to do or not to do the intended behavior. Also behavioral willingness can be predicted by prototypes and subjective norms constructs as such, these constructs are mental images of subjects with high-risk behaviors (12). Based on the results of several studies, the PWM to predict risky behaviors has shown a good performance (14, 15). Therefore, many researchers have focused on identifying risk factors for substance abuse in order to develop an effective preventive strategy (16, 17).

To describe the relationship between risk factors and response, classical statistical models such as regression, path analysis, etc. are used. Classical statistical models are very welcome in terms of interpretability, but this interpretation is based on the strong hypothesis of "knowing the form of the relationship" that must be determined by the analyzer. If the form of the choice relationship between the response and the risk factors is not correctly determined, the results may mislead the researcher. To this end, "machine learning" methods have been developed whose main purpose is to overcome this problem. In these methods the relationship is determine based on the functional form of data itself (18, 19). There are various regression and classification methods in the machine learning domain, among which the tree-based regression model has been favored for its high-order nonlinear models as well as its high interpretability (20). Also, the random forest model based on the development of several decision trees is able to more accurately predict the response and determine the importance of each variable (21, 22). Until now, random forest model has not been used to determine the relationship between different factors and AAS use. So the purpose of this study was to apply random forest model to determine the importance factors affecting on: (a) Behavioral intention; (b) Behavioral willingness and (c) AAS use, among bodybuilders of Hamadan city.

**Methods**

**Study setting, population and sampling method**

In this secondary analytical cross-sectional study, the population was male bodybuilders refer to bodybuilding clubs of Hamadan city, the capital of Hamadan province in western of Iran.
The sampling method in the initial study was briefly expressed hereafter and more information can be found in the initial study (10). Participants were selected based on a multistage sampling. The whole population was classified into three geographical zones and 5 clubs from the 1st, 3 clubs from the 2nd and 2 clubs from the last zones were selected randomly. 28 athletes were selected from each club using simple random sampling. Finally 280 subjects were included in the study.

**Data collection**

A self-administered questionnaire consisting of 2 sections was used to collect data. The first part of the questionnaire was contained of demographic information include age, degree of education, marital status, body mass index (BMI), history of sport club, tobacco smoking, alcohol consumption, AAS use by the best friend, AAS use by coach and nutrition supplement use. The second part concerned the constructs of the PWM. The face and content validity of the questionnaire was assessed by a panel of experts using the opinions of 10 health education experts. For this purpose, content validity ratio (CVR) and content validity index (CVI) for questions were extracted and by considering the values of the Lawshe table (CVR > 0.62 and CVI > 0.79) the questions were reviewed and corrected. To evaluate the reliability of the questionnaire, a preliminary study was performed on 32 athletes in Hamadan and the internal consistency coefficient of the questions was reviewed and confirmed (23).

**The PWM consisting of 6 constructs:**

a) **Positive attitude toward AAS use:** Includes 6 specific questions (e.g., “Taking anabolic steroids helps me have a stronger body”) with a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Higher score indicated a more positive attitude toward anabolic steroids use. Cronbach's alpha of this structure was estimated 0.798 in the pilot study (23).

b) **Subjective norms:** consisted of 4 questions relation to best friend, other friends, parent, and coaches, with a 5-point Likert that ranging from 1 (not at all) to 5 (very). One example of these questions is “If I use anabolic steroids, my coach will approve it”. Higher scores indicate higher subjective norms that encourage the use of anabolic steroids. Cronbach's alpha of this structure was estimated 0.701 in the pilot study (23).

c) **Prototype from AAS use:** Bodybuilders' images of substance use is expressed in the following sentence: “Imagine a bodybuilding friend of your age regularly taking anabolic steroids. In your opinion each of the following traits is appropriate to describe his?” . It consisted of 10 items with a 5-point Likert ranging from 1 (not at all) to 5 (very). These ten items are: happy, proud, kind, strong, nervous, high sexual desire, violent, attractive, bully, willing, illetrate. Higher score on this questionnaire indicates that one's mental conception is positive for peers taking AAS. Cronbach's alpha of this structure was estimated 0.902 in the pilot study (23).

d) **Behavioral intention of AAS use:** It consisted of 4 questions with a 5-point Likert. For example, one of these questions is: “do you want to use anabolic steroids for the next 6 months to improve your athletic
performance?” Higher scores in this questionnaire indicate that the individual tends to take AAS. Cronbach's alpha of this structure was estimated 0.770 in the pilot study (23).

e) Behavioral willingness of AAS use: This structure began by describing a hypothetical scenario: “Imagine you are in the midst of your bodybuilding friends and there is also anabolic steroids available. If your closest bodybuilding friend suggests using anabolic steroids, how likely are you to do one of the following?” The 4 items to respond to this scenario are: a) you take it and use, b) you only use it one or two times, c) you say no thanks and you continue to activity in the club, d) you leave your gym and sign up for a new club. Each item consist of 5-choice spectrum with a minimum score of 4 and a maximum of 20. A higher score on this questionnaire indicates a high willingness for AAS use. Cronbach's alpha of this structure was estimated 0.729 in the pilot study (23).

f) AAS use behavior: this construct was measured by two questions: (1) Are you currently using AAS? And (2) have you used AAS in your lifetime? The answer to these questions consists of two categories; yes or no.

**Statistical methods and software**

Sample was described using appropriate descriptive statistics. To compare quantitative variables in two groups (with and without currently AAS use), independent samples t-test and for qualitative variables chi squared test were used. To determine the importance factors affecting the outcomes (behavioral intention, behavioral willingness and AAS use), random forest model was applied separately. In order to evaluate the performance of the random forest model, we divided the data into two parts, 80% of the data for training and 20% for testing were used.

**Decision tree & Random forest models**

A random forest consists of many decision trees and is an ensemble learning method. A decision tree is a simple and robust method, which is used to classify a dataset into distinct and homogeneous categories. The decision tree algorithm has a non-rotating tree-like graph represented by a set of questions. Usually each question is posed with a variable. A decision tree graph consists of three main components: root, inner node and outer node (leaf). The process of developing a tree is such that all people first fall into the root node. Then, based on a certain feature, individuals are divided into two groups and each is placed in a new node. Each new node, like the root node, is split into other nodes to eventually achieve a level of homogeneity in the response of the individuals in each node. These nodes are also called leaf nodes. The selection of the variable to divide the individuals in a node into two parts is based on its relation to the response variable so that the variable that creates the most homogeneity in response in the resulting nodes is selected at each step (24). Normally, decision tree models are trained in two stages, namely partitioning in a two-step process. In the first step, binary recursive partitioning is used to construct the tree structure, which is mentioned in the two paragraphs above. Secondly, pruning is done to remove leaves that do not help to improve tree prediction in new data (20). In the random forest, a large number of trees are constructed based on random subsets of data and prediction is made based on the average prediction of each tree (22).
Software

SPSS software version 24 was used to describe the data and perform independent samples t-test, chi-square tests and one-way analysis of variance. To develop the random forest using R3.6.2 randomForest (25) package was used.

Results

From a total of 280 bodybuilders, 35 (12.5%) subject were currently AAS users and 245 (87.5%) were not currently AAS users (81.6 % are never used) . The mean (SD) age of the participants was 25.21 (6.35) years old.

Table 1 presents some demographical feature of bodybuilders’ participant in this study in terms of currently AAS use. According to the results showed in Table 1, compared to whom without currently AAS use, subjects with AAS use have more history of sport club and were more likely to alcohol and nutritional supplement use (P-value < 0.05). Also there is a statistically significant difference between user and non-user of AAS in terms of AAS use by coach and by the best athlete friend (P-value < 0.05).
Table 1
Demographical feature and status of activity in club of participants in terms of currently AAS use

| Quantitative features       | With currently AAS use (n = 35) | Without currently AAS use (n = 245) | p-value |
|-----------------------------|---------------------------------|------------------------------------|---------|
|                             | Mean (SD)                       | Mean (SD)                          |         |
| Age                         | 24.51 (4.95)                    | 25.31 (6.53)                       | 0.491   |
| Weight                      | 79.40 (14.51)                   | 78.30 (12.70)                      | 0.638   |
| Body mass index (BMI)       | 24.94 (4.70)                    | 24.74 (3.52)                       | 0.766   |
| History of sport club (month) | 66.00 (65.56)                | 44.37 (54.00)                      | 0.032*  |
| Qualitative features        | N (%)                           | N (%)                              | p-value |
| Marriage status             | Single 27 (77.1)                | 196 (80.0)                         | 0.659   |
|                             | Married 8 (22.9)                | 49 (20.0)                          |         |
| Degree of education         | Lower than diploma 7 (20.0)    | 26 (10.6)                          | 0.316   |
|                             | Diploma 16 (45.7)               | 103 (42.0)                         |         |
|                             | Academic 12 (34.3)              | 116 (47.3)                         |         |
| Titleholder in bodybuilding | No 14 (40)                      | 128 (52.2)                         | 0.370   |
|                             | Regional 16 (45.7)              | 97 (39.6)                          |         |
|                             | National 5 (14.3)               | 20 (8.2)                           |         |
| Alcohol use                 | Always 4 (2.4)                  | 6 (1.9)                            | 0.009*  |
|                             | Sometimes 11 (31.4)             | 54 (22.0)                          |         |
|                             | Never 20 (57.1)                 | 185 (75.5)                         |         |
| Tobacco smoking             | Always 4 (11.4)                 | 10 (4.1)                           | 0.127   |
|                             | Sometimes 5 (14.3)              | 26 (10.6)                          |         |
|                             | Never 26 (74.3)                 | 209 (85.3)                         |         |
| Previous AAS use            | Always 7 (20.0)                 | 4 (1.6)                            | < 0.001*|
|                             | Sometimes 24 (68.6)             | 41 (16.7)                          |         |
|                             | Never 4 (11.4)                  | 200 (81.6)                         |         |
| AAS use by the Coach        | Always 11 (31.4)                | 39 (15.9)                          | 0.042*  |

* Sign * indicates significant test in level 0.05.
Table 2 reports the relationship between PWM structures. As can be seen in this table, among these structures, the highest correlation was found between behavioral intention and behavioral willingness score for AAS use \( (r = 0.574, P\text{-value} < 0.001) \). On the other hand, the least linear relationship was observed between prototypes and behavioral willingness score \( (r = -0.029, P\text{-value} > 0.05) \).

| Variables                        | 1   | 2            | 3            | 4            | 5            | Mean(SD)  |
|----------------------------------|-----|--------------|--------------|--------------|--------------|-----------|
| 1. Attitude                      | 1.00| 0.312*       | 0.150*       | 0.514*       | 0.314*       | 17.01(5.15) |
| 2. Subjective norms              | 1.00| 0.144*       | 0.267*       | 0.338*       | 9.52(3.75)   |           |
| 3. Prototypes                    | 1.00| 0.085        | -0.029       | 29.34(8.67)  |              |           |
| 4. Behavioral intention         | 1.00| 0.574*       | 8.16(3.91)   |              |              |           |
| 5. Behavioral willingness        | 1.00| 7.36(3.24)   |              |              |              |           |

* Sign * indicates significant test in level 0.05.

The finding presented in Table 1 and 2 are crude and do not consider the simultaneous effects and possible interactions between the various features. Random forest model could be used in this situation to develop a predictive model and extract the importance of each feature to predict AAS use. As it was stated in previous section, a random forest is consisted of many, in this study 500, individual tree.

Based on the results from fitted random forest, the most important feature in determining the behavioral intention for AAS use is behavioral willingness in terms of the homogeneity in subgroups. Attitude,
previous AAS use, prototypes, subjective norms, history of sport club and BMI are the next most important factors in predicting the behavioral intention of AAS use. The order of the factors that are most important in predicting the behavioral intention of AAS use was reported in Fig. 2.

Also the order of the factors that are most important in predicting the behavioral willingness of AAS use was reported in Fig. 3. As can be seen in Fig. 3 subjective norms, attitude, BMI and prototypes are the factors that have the greatest impact on predicting of behavioral willingness of AAS use.

Based on the results of the random forest model that fitted based on the all factors and presented in Fig. 4, totally (directly and indirectly) previous AAS use, behavioral intention, BMI, age, history of sport club and behavioral willingness are predict AAS use well.

Part of the outcome of random forest were presented in Fig. 5. As could be seen in this figure, both of subjective norms and behavioral intention have direct association with willingness for AAS use. Also, in the right panel subjects with AAS use have higher the behavioral intention score.

**Discussion**

The aim of this study was to investigate the factors affecting AAS use among bodybuilders in Hamadan using PWM. The importance of the method in the present study is the use of random forest data mining model to investigate the effect of different factors on AAS use. One of the important features of the random forest model is the determination of the functional form of the relationship between the predictors and the response through the data itself. In other words, the functional form of the relationship between different factors and AAS use is not selected by the analyst, but the data determine this functional form. Therefore, this model is able to take into account the complex relationships between different factors with response and provide more accurate predictions. But based on our search in different databases, so far no study has been performed in which PWM and random forest model have been used to predict the factors affecting AAS use.

According to the results of the univariate analysis (Table 1), history of sport club, alcohol use, use by coaches, use by the best athlete friend and nutritional supplement use in AAS users were more likely than other subject, so this difference was statistically significant (P-value < 0.05). However, the two groups did not differ significantly in terms of demographic variables such as age, degree of education and marital status (P-value > 0.05). In this study, 27.1% of bodybuilders reported a history of anabolic steroid use, which is consistent with a similar study (26). However, the rate of steroid use in the present study is higher than 4.3% that reported by Ghobain et al (27) and it was less than 64% that was result from the study by Bijeh et al. (28). This discrepancy can be due to differences in the target community as well as differences in the geographic areas studied. For example, the target community of Ghobain's study was all Saudi athletes, but if these studies were performed only on professional bodybuilders, the prevalence of anabolic steroid use would increase (29). In general, it seems that the prevalence of anabolic steroids among Iranian bodybuilders is higher than other countries, which shows the importance of paying attention to prevention in this field.
Based on the results, the highest correlation was obtained between behavioral intention with behavioral willingness ($r = 0.574$) and attitude ($r = 0.514$). Thus, people with higher behavioral willingness scores also had higher behavioral intention and attitude scores. The results of the random forest analysis confirm the above mentioned result (Fig. 2), behavioral willingness and attitude had the greatest impact on predicting behavioral intention. In the study of Patiro et al., there was a direct relationship between attitude and behavioral intention of AAS use, which is consistent with the results of the present study (30). Also in the study of Abedini et al. attitude, subjective norms and behavioral willingness were reported as predictors of intention to use hookah among students (14).

Analysis of the social reaction path in PWM showed that subjective norms, attitude and positive prototypes about AAS users are associated with willingness to AAS use. This result is consistent with the results of a study in which the attitude and prototypes, were strong predictors for predicting of willingness to doping (31). The results of a similar study showed that attitude, subjective norms and prototypes were factors that predicted willingness to smoking among adolescents in Hamadan city. These factors predicted 43% of willingness variation that in the meantime, the role of subjective norms was more prominent than attitude and prototypes (32). Various studies on substance abuse prevention show that training of life skills such as problem solving and decision making skills increase cognitive-coping skills, which this reduces the tendency of individuals to use a variety of illicit substances. In this regard, other studies have pointed to the training of resistance skills against insistence of peer, such as the skill of saying "no" (33).

The results of the present study showed that reasoned action path is a better predictor for substance use in compare with social reaction path. By comparing the order of importance of intention and willingness in prediction of AAS use, the results showed that behavioral intention is a better predictor for AAS use (Fig. 4). In other words, the decision-making process for anabolic steroids use is based on people's previous intentions. In this regard, various studies have confirmed the effect of behavioral intention on predicting and occurring high-risk behaviors (34–36). However, the results of a study by Barati et al. showed that behavioral willingness in compare with behavioral intention was a better predictor of smoking behavior and these two structures predict a total of 43% of behavior variation (32). In other studies related to the PWM, the behavioral willingness structure has a higher predictive ability in compared with behavioral intention that is not consistent with the findings of the present study (37, 38). Age and previous experiences of individuals, may be explain the inconsistency of the results of the present study with other studies. Usually, as age increase, their life experiences increase, so they make more rational decisions (39). The mean age of the participants in the present study was 25.21 years, while in other studies, participants were mostly adolescents. Evidence suggests that the relationship between intention and behavior in adolescents is weaker than in other individuals (12). On the other hand, some similar studies have described experience as the reason for this problem and have pointed to the weakness of the relationship between intention and behavior in less experienced people (40). As can be seen from the results of random forest (Fig. 4), age is one of the most important factors for predicting AAS use.
One of the limitations of this study was the poor cooperation of some bodybuilders in filling the questionnaire. Also this study was performed only on male bodybuilders, therefore it is suggested that in future studies comprehensive comparison conduct between male and female bodybuilders as well as athletes of other sporting disciplines such as wrestling, weightlifting, and gymnastics.

**Conclusion**

The results indicated the importance of reasoned action path rather than social reaction path in PWM. Therefore, it is recommended to implement educational programs using the PWM with emphasis on subjective norms and behavioral intention to facilitate the prevention of AAs use.

**Declarations**

**Acknowledgement**

The authors wish to thank Hamadan gyms staffs and clients, respectively, for assistance and participating in this study.

**Authors’ contributions**

ZM, MB, and JF contributed to designing the study, MB and SM collected the data, and analyzed by ZM and JF. The final report and manuscript were written by ZM and JF. All the authors read and approved the version for submission.

**Funding**

The study was funded by Vice-chancellor for Research and Technology, Hamadan University of Medical Sciences (No. 970128440).

**Availability of data and materials**

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

**Ethics approval and consent to participate**

The study was approved by research ethics committee of Hamadan University of Medical Sciences. The written informed consent was obtained from all the participants. All methods were carried out in accordance with relevant guidelines and regulations.
Consent for publication

Not applicable.

Competing interests

The authors report no conflict of interest in the undertaking of this research.

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**Figures**
Figure 1

The prototype willingness model. adapted from Gibbons et al., 1998.

Figure 5

Relationship between behavioral willingness and subjective norms (left), Relationship between behavioral intention and behavioral willingness (Right) For subjects with (continuous line) and without currently AAS use (dashed line).