Sports supplements and Anabolic Androgenic Steroids

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Abstract
Recently, the use of sport supplements has become so common among most athletes. These supplements may contain undeclared substances that are banned by such international authorities as WHO, IOC and WADA. The present study, thus, is aimed at examining the final sport supplement products in terms of banned substances and measuring the adulteration level in order to prove the safety of these products and promote public health. The Food and Drug Administration of the Ministry of Health and Medical Services of Iran confirms the safety of these products, monitors their production and import, and also marketing them at authorized places like the pharmacy.

According to the existing regulations in Iran and other countries, the safety of sport supplements and the level of their androgenic-anabolic steroids are monitored and measured by such methods as GC/MS, LC/MS/MS. Beside the well-known side effects of anabolic steroids, new problems have emerged from using sport supplements distributed in the black market which may contain banned substances not declared on the label. These effects will cause harmful and dangerous changes in levels steroids and heart’s structure. Conditions pertaining to hormonal imbalances may also be caused by anabolic steroids. Due to the increasing use of sport supplements in order to achieve an effective training, the presence of adulterated, illegal and unsafe products continue to be a concern for many consumers and professional athletes alike. Since using sport supplements have become perilous, a credibility gap seems to exist between the athletes and medical communities who, it is believed can be overcome by efficient supervision and monitoring of the products.

Keywords: sport supplements, Food Safety Management System (FSMS), anabolic steroid, FDO, contaminations

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Introduction

There are obviously a great number of sport supplements available, particularly on the internet. Most adolescents are quite unaware of the unknown health risks associated with particular supplements. (Bahrke & Yesalis, 2004; Jenkinson & Allison J, 2008) Performance-Enhancing Substances (PESs) have turned into a common and important issue in sports. Sometimes referred to as ‘doping’, PESS implies the consumption or manipulation of synthetic substances with the purpose of changing sports performance. (Botrè & Pavan, 2009; Eduardo, 2008) Nowadays, the use of sport supplements is much common among most sportsmen. (Dodge, 2015) Sport supplements may contain undeclared substances forbidden by such international authorities as WHO, IOC and WADA. This issue at stake certainly demands the attention of large number of interested parties, including athletes and other sport supplement consumers, national anti-doping organizations and the world anti-doping agency. The development of sport supplements industry has recently been phenomenal in the United States. Sale records indicate that a great deal of money is annually spent on sport supplements. (Baylis, Cameron-Smith & Burke, 2001; Kayser, Mauron & Miah, 2007; Lippi, Banfi, Franchini & Guidi, 2008; Mottram, 1999) Since the 1960s, the highest consumption rate of anabolic steroids has been related to sportsmen in track and field events. (Geyer, Schänzer & Thevis, 2014; Momaya, Fawal, & Estes, 2015) Nevertheless, there have recently been considerable monitoring processes on the sport supplements industry. It is acknowledged that there are a number of synthetic supplements that are deliberately combined with substances forbidden in sport (according to the Prohibited List provided by the World Anti-Doping Agency). Investigations have also shown that a high proportion of supplements may inadvertently contain forbidden substances. Recent studies have confirmed that athletes are increasingly consuming immeasurable androgenic-anabolic steroids in an attempt to gain competitive excellence. (Foster & Housner, 2004; Noppe, B., Verheyden, & De Brabander, 2008) For the same reason, many studies have been conducted on the posing health risk over sports societies. (Evans, 2004; Fuller, Junge, & Dvorak, 2012; Perret, 2017) While the sport supplements are widely consumed, their adverse effect spreads among the high-performing sportsmen population ranging from teenagers to senile people. (Knapik et al., 2016; Petroczi, Taylor, & Naughton, 2011).

Abuse of Androgenic Anabolic Steroids

The first reports of misuse of Androgenic-Anabolic Steroids (AAS) by athletes emerged in the 1950s. The abuse of AAS among athletes in athletic competitions began some years before these substances were banned in sport in 1974. In the early 1940s, scientists showed that muscle tissues grown at the presence of testosterone had a bulked for toleration act. (Eichner & Tygart, 2016; Fitch, 2008; Hambleton & Kanjee, 1995; Rashid & Ormerod, 2007) Of 4500 analytical findings presented by the World Anti-Doping Agency (WADA) via the Anti-Doping Administration and Management System (ADAMS), about 50% are anabolic agents. (Hartgens, Rietjens, Keizer, Kuipers, & Wolffenbuttel, 2004; Sagoe, Molde, Andresen, Torsheim, & Pallesen, 2014). Concerns about the abuse of AAS and its prevention in athletes, which currently affects the public too, are compared with the efforts to prevent narcotics abuse. While the adverse effects of AAS have remained unknown, its illegal consumption still continues. (van Amsterdam, Opperhuizen, & Hartgens, 2010). Androgenic-anabolic steroids have been consumed by athletes for five decades in order to increase their activity by increasing their strength. A growing number of athletes misuse AAS to obtain a well-shaped body or increase muscular strength. Most of them take AAS for a period of 8–12 weeks several times a year. (Sjöqvist, Garlé, & Rane, 2008; Urhausen, Albers, & Kindermann, 2004) In 2009, the analysis of sport supplement products demonstrated that black market products contained various peptide hormones rather than only steroid hormones. (Greydanus & Patel, 2010) The assessment of steroids originating from synthetic precursors versus their analogous natural chemicals has proved to be an important challenge for doping control laboratories validated by the WADA. Despite the laws enacted against the prescription and supply of AAS, the nonmedical consumption of its supra-physiologic doses has remained prevalent for enhancement of athletic performance. (Cawley & George, 2012; Kohler et al., 2010) Reports obtained from several
athletic communities may inform others about hormone consumption in order to help them reach an optimal and healthy anabolic hormone range. (Pieter & Cohen, 2014) The global prevalence of AAS consumption is 3.3%, with a higher rate of 6.4% in men compared to 1.6% in women. (Taylor, Padilla, & Hernández, 2017) Scientific studies play a central role in WADA’s anti-doping strategies and its educational plans seem to be fostering a lasting anti-doping culture. (Christou et al., 2017) This belief has given rise to a billion-dollar industry that aggressively offers its products to sport teams as performance-enhancing agents, often without any objective or scientific document to support such pretensions. (Bishop, 2010; Morente-Sánchez & Zabala, 2013).

Toxicity of Androgenic-Anabolic Steroids
Numerous studies have been recently dedicated to a special class of AASs called Endocrine Disrupting Compounds (EDCs). (Collomp et al., 2016; Committee, 2013; Maennig, 2002) They may interfere with human hormonal systems through various mechanisms. Since 1960s, many researchers have studied the effects of these sport supplements on athletes. (Gibson & Saunders, 2014) Consumption of doping agents, particularly AASs, leads to the ignorance of their dermatological effects and thus, gonad diseases. Doping agents’ consumption is no longer limited to competitive sports but, as medical studies in USA indicate, has become common in leisure sports, especially among fitness and bodybuilding sports. (Achar, Rostamian, & Narayan, 2010; Courant et al., 2008; Király, Collan, & Alén, 1987) In several studies, EDCs have been linked to the presence of behavioral disorders and infertility problems. (Attalah, Nasr, El-Gammal, & Nour El-Dien, 2016; Bährke & Yesalis, 2004; Basaria, Wahlstrom, & Dobs, 2001; Kimman, 2008; Saseen & MacLaughlin, 1999) Abuse of AASs has also been linked to a variety of cardiovascular side effects. (Clark & Henderson, 2003; Feldman & Limbird, 2017; Johnston et al., 2016; Socas-Rodríguez, Asensio-Ramos, Hernández-Borges, Herrera-Herrera, & ÁngelRodríguez-Delgado, 2013) Inspection of fitness centers in Germany revealed that millions of hepatotoxic substances, mainly procured in the black market, have been taken by fitness workers. The occurrence of complications linked with nonmedical consumption of AAS, as performance-enhancing substances, cannot be predicted. Psychological effects of exogenous steroids’ abuse including increased aggression and depression should be viewed from the safety point of view in a sociological context. (Bonetti et al., 2008; Busch et al., 2017; Hassan, Salem, & Sayed, 2009; Jakimska et al., 2013; Plotan, Elliott, Frizzell, & Connolly, 2014).

Application of Steroid Hormones Measurement Methods
Determining the concentration of exogenous steroid hormones constitutes an important aspect of clinical, epidemiological or other similar investigations. (Socas-Rodríguez et al., 2013) Anti-doping research centers apply targeted highly-sensitive chromatographically techniques next to non-targeted analyses to provide retrospective information mining. (Delanghe, Maenhout, Speeckaert, & De Buyzere, 2014) Radioimmunoassay and ELISA (Enzyme-Linked Immunosorbent Assay) have shown good sensitivity for screening AASs. However, their defect was their limited specificity due to the presence of antibody across reactivity profiles. (Abushareeda et al., 2014; Key et al., 2015) Due to their simplicity, speed and sensitivity, immunoassay tests are widely performed in laboratories. The quality of analytical results in terms of integrity and resolution must be regularly controlled through good validation methods. One of the defects of immunoassay is the need to do various tests for each steroid in a low dynamic range. (Brooks, Jeremiah, Webb, & Wheeler, 1979; Gosetti, Mazzucco, Gennaro, & Marengo, 2013) Many studies have concentrated on the measurement of Anabolic Androgenic Steroids, by means of GC–MS/MS. Overall: GC-MS is useful for unidentified molecules and non-conjugated steroids with low molecular weight (molecular weight < 500 DA). GC-MS has some limitations the most important of which are the derivatization of polar compounds and the lack of direct analysis of conjugated metabolites. Derivatization is essential for separation of hormones and significantly increases the time of analysis (it takes at least 30 min to perform the assay). (Dunn et al., 2011; Hampl & Stárka, 1979) Lately, the capability to analyze isotope distribution at natural abundance with good accuracy and high precision has increased the application of GC/MS. Accordingly, a number of sport supplements’ steroid analytical protocols, based on LC-MS, have been analyzed. (Ponzetto et al., 2017) LC-MS/
MS has the capacity to analyze conjugated metabolites directly and the possibility to apply open techniques for analyzing metabolites with a common chemical structure. (Daems, Romnee, Heuskin, Froidmont, & Lognay, 2016; Gomez et al., 2014; Nielen, Hooijerink, Claassen, van Engelen, & van Beek, 2009) Extraction of steroids before using LC-MS/MS technique is mandatory in order to avoid such interference as matrix effects and the risk of signal inhibition which limit the application of this technique in a large number of samples. (Gomez et al., 2014; Nielen et al., 2009; Ponzetto et al., 2017) Therefore, due to its simplicity, no need for derivatization and also shorter application time (about 10 min), LC-MS/MS technique is simpler to use. (Adamusova, Bosakova, Coufal, & Pacakova, 2014; Daems et al., 2016; Kushnir, Rockwood, & Bergquist, 2010; Soldin & Soldin, 2009) The results of other quality controls demonstrate important differences between the results obtained by different laboratories. However, the variability of results obtained by immunoassay was less than those obtained by mass spectrometry. The majority of reference intervals have been so far established by RIA methods in the studies conducted over the last fifty years. It seems essential, thus, to determine new intervals specific to mass spectrometry. (Janssens et al., 2015; Stanczyk & Clarke, 2010; Vogeser & Parhofer, 2007; Zendjabil, Chellouai, & Abbou, 2016)

**Conclusion**

The consumption of sport supplements to unnaturally increase the athletic performance is called doping which is prohibited by antidoping rules and may pose a health risk to some people. Such strengtheners supplements as Androgenic Anabolic Steroids (AASs) can pose significant health risks if consumed by adolescents. It is as well very clear that some of these supplements should be avoided by sportsmen at all costs. AASs are believed to have harmful effects on the health of organisms. The awareness level of people of how sport supplements become contaminated with small traces of forbidden substances has greatly increased over the last decade. Moreover, some reputable companies with appropriate quality control systems to address this problem can offer the athletes minimal-risk products. Doping detecting is more than an analytical problem. Therefore, improving pre-analytical care and a better tailoring of threshold values will increase the tests’ sensitivity. In the research broadened by and oriented to UHPLC–MS/MS- GC-MS-LC-MS/MS techniques, this type of techniques are faster, more sensitive and capable of measuring steroid hormones.

**References**


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