Associations Amongst Physical Activity, Substance Use and Fitness Industry Trends

by

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ABSTRACT

Dietary supplement (DS) use among adults is on the rise. This growing trend in DS use mirrors the quick and exponential growth of the fitness industry. The fitness industry focuses on the "appearance of health", although some individuals focus on their appearance over and above their health. As a result of this focus on appearance, certain aspects of this unregulated industry promote unhealthy standards of beauty and an increase in negative body image, and influences at-risk youth to engage in dangerous practices such as extreme diet and exercise routines, or the misuse of dietary supplements. All of these factors have been linked to appearance and performance enhancing drug use, which is associated with substance use in athletes and non-athletes. This study sought to explore the role of gender as it pertained to dietary supplement use, specifically how gender differences amongst predictors of DS use (including BMI, physical activity, and body image) were associated with overall substance use in college students. The relationship between current DS use and other substance use was also examined. Students recruited from ASU fitness centers completed a survey which included questions on demographics, height and weight to calculate BMI, and several published, standardized questionnaires used to measure drug use, physical activity, body image, steroid and ephedrine use and attitudes, and dietary supplement use. There were significant gender differences in DS use as well as predictors or DS use. Controlling for demographic information, energy enhancing DS use and knowing someone who used steroids increased the likelihood an individual intended on using steroids in the future. Body image was not related to substance use in males, and physical activity mediated the relationship between DS use and substance use in males. While body image was

associated with substance use in females, neither physical activity nor body image mediated the relationship between DS use and substance use in females.

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INTRODUCTION

Dietary supplement (DS) use among adults has increased over the past 30 years. In the 1980's, data from the United States Health and Nutrition Examination Surveys suggested about a third of the adults in the US were taking some DS regularly (Koplan, Annest, Layde & Rubin, 1986; Subar & Block, 1990). In 1994, Congress amended the Federal Food, Drug, and Cosmetic Act to establish standards for DS to protect the right of access of consumers to safe DS to promote wellness (National Institutes of Health [NIH], 1994). The trend continued and by 2011 prevalence rates of DS use fluctuated between 64% and 69% (Dickinson, Blatman, El-Dash, & Franco, 2014).

The U.S. Food and Drug Administration (FDA) defines a DS as, "a product intended for ingestion that contains a 'dietary ingredient' intended to add further nutritional value to (supplement) the diet" (FDA, 2015). DS of all varieties are now marketed in the United States, including single-ingredient products and various combinations of vitamins, minerals, botanicals, and other constituents. Multivitamins, calcium and omega-3's were the most common supplements reported amongst adults in the United States from 2007-2010 (Bailey, Gahche, Miller, Thomas, & Dwyer, 2013). In 2015, more college students reported taking DS at least once a week than the general population (66 vs. 50%), with 41% reporting taking multiple supplements (Lieberman, et al., 2015). The most commonly DS used by students include vitamins, protein or amino acids, and herbal products (Hildebrandt, Harty, & Langenbucher, 2010). Students take DS to promote health, provide energy, and increase muscle strength, endurance and performance (Lieberman, et al., 2015). Only 23% of adults reported using supplements per the recommendation of a health care professional (Bailey et al., 2013).

This growing trend in DS use mirrors the quick and exponential growth of the fitness industry (Andreasson & Johansson, 2014). From 2005 to 2015, health club memberships increased from 41.3 million to 55.3 million, and the number of health clubs increased from 26,000 to 36,000 (International Health, Racquet & Sportsclub Association, 2016). To achieve this level of growth the health and fitness industry became a business enterprise targeting aesthetically conscious consumers (Smith-Maguire, 2008). The annual survey of worldwide fitness trends found that body weight training was considered the number 1 fitness trend in 2015, and the number 2 fitness trend in 2016 (Thompson, 2016). The development of a global gym and fitness culture has been accentuated by mediatization blurring the relationship between health and beauty (Andreasson & Johansson, 2014). For example, the term "fitsporation," short for Fitness Inspiration, is flooding social media platforms, encouraging followers to find inspiration to attend the gym (Carrotte, Vella & Lim, 2015). While a majority of these "fitspiration" posts contain images of people, some also contain text, or images of food or DS (Santarossa, Coyne, Lisinski & Woodruff, 2016). These posts are supposedly meant to promote health and fitness, however the content provided has been shown to be associated with at-risk youth engaging in dangerous practices, including extreme diet and exercise routines, and misuse of weight loss supplements (Carrotte, et al., 2015). These dangerous practices might have damaging, long-term health and psychological consequences including unhealthy standards of beauty and an increase in negative body image (Boepple & Thompson, 2016; Ghaznavi & Taylor, 2015; Lewallen & Behm-Morawitz, 2016; Tiggemann & Zaccardo, 2015).

Those new to the fitness industry can also reach for magazines such as *Men's Health, Women's Health, Shape*, or *Muscle and Fitness*, which are filled with images of muscular males and toned females, along with advertisements for muscle-building and weight-loss supplements (Figure 1; Wasylkiw, Emms, Meuse, Poirier, 2009). Historically magazines popular among young women contained 10.5 times more pieces (ads and articles) promoting weight loss as the men's magazines ($p < .005$); while young men's magazines disproportionately contained ($p < .01$) messages on body shaping compared to weight loss (Andersen 1992). Recently, Willis and Knobloch-Westerwick (2014) reported health and fitness magazines such as *Women's Health* have become the main source of weight-loss and body-shaping messages, and have taken the market away from the traditional beauty, fashion, or general interest magazines. In their analysis, the authors found that the messages in the health and fitness magazines emphasized appearance and exercise with approximately one-fifth of all editorial content dedicated to messages emphasizing body-shaping and weight-loss. Furthermore, recent evidence (Bazzini, Pepper, Swofford and Cochran, 2015; Stevens-Aubrey and Hahn, 2016) suggests that health and fitness magazines have an increased focus on appearance rather than overall health, particularly those with women readership. While the increased focus on fitness may help with the growing rate of obesity in the U.S. (Dunlop, et al., 2016; Flegal, Kruszon-Moran, Carroll, Fryar & Ogden, 2016; National Center for Health Statistics, 2015), potentially dangerous results of this emphasis are also of concern (Austin, 2011). For example, 34.7% of adolescents surveyed reported using protein powders or shakes and 5.9% reported steroid use (Eisenberg, et al., 2012). Excess body weight ($BMI \geq 25$) and participation in team sports have been associated with muscle-enhancing behaviors

(Eisenberg, et al., 2012). Similarly, Hoffman found that people who use DS and anabolic-androgenic steroids (AAS) exercise more than non-users, and their exercise tends to be more intense (Hoffman, et al., 2008).

In addition, there is evidence that exposure to extreme body types in popular media has detrimental effects in both young females and males (Peixoto-Labre, 2002; Raevuori, Keski-Rahkonen, Bulik, Rose, Rissanen, & Kaprio, 2006; Arbour, & Martin-Ginis, 2005; Cramblitt & Pritchard, 2013; Hildebrandt, et al., 2006; Field et al., 1999; Hawkins, et al., 2004; Duggan & McCreary, 2004). Exposure to images of severely thin female models has been shown to increase the risk for bulimia and anorexia nervosa and has also been associated to high levels of body dissatisfaction (Field et al., 1999; Hawkins, Richards, Granley & Stein, 2004; Boepple & Thompson, 2016; Holland & Tiggemann, 2017). Further, media exposure to extreme body types showed negative long-term effects on women with low levels of social support, who were already at a higher risk of negative body-image, leading researchers to believe that messages seen in the media may reinforce the messages in one's immediate social environment (Stice, Spangler & Agras, 2001).

Research looking at the influence of media on males has focused more on the muscular body-ideal (Peixoto-Labre, 2002; Raevuori, Keski-Rahkonen, Bulik, Rose, Rissanen, & Kaprio, 2006; Arbour, & Martin-Ginis, 2005; Cramblitt & Pritchard, 2013; Hildebrandt, et al., 2006). For example, Cramblitt & Pritchard (2013) found that reading men's health magazines and watching image-focused television led to a greater drive for muscularity in men. Similar results were seen in a study looking at homosexual men, which showed that greater consumption of fitness magazines correlated with higher

scores in body dissatisfaction (Duggan & McCreary, 2004). Furthermore, there is evidence that exposure to images of hyper-muscular males in the media is associated to an increase in binge eating (Peixoto-Labre, 2002), bulimia (Raevuori, Keski-Rahkonen, Bulik, Rose, Rissanen, & Kaprio, 2006), as well as higher levels of muscle dissatisfaction (Arbour, & Martin-Ginis, 2005; Cramblitt & Pritchard, 2013; Peixoto-Labre, 2002). In addition, high levels of muscle dissatisfaction significantly correlated with bulimia in men (Raevuori et al. 2006). It is not clear if exposure to images of hyper-muscular males increases body dysmorphic disorders (BDD), if the relationship is bi-directional, or if BDD precede the exposure to fitness magazines (Shoger, 2008; Krawiec, 2016; Peixoto-Labre, 2004). BDD is characterized by a distressing or impairing preoccupation with slight or imagined defect(s) in one's physical appearance, with estimates ranging between 2-13% among college students (Bjornsson, Didie, & Phillips, 2010). Muscle dysmorphia is a type of BDD with a focus on feelings of inadequacy regarding the size of lean muscle mass, despite already being muscular (Hagerman, Dawes, & Mankin, 2004). This form of BDD in particular seems to be growing among male athletes, bodybuilders and weightlifters (Peixoto-Labre, 2002; Hildebrandt, et al., 2006; Pope, Khalsa, & Bhasin, 2017; Leone, Sedory, & Gray, 2005). Some males are going to extremes to achieve a particularly muscular look, which include taking untested supplements or appearance and performance enhancing drugs (APED), and/or engaging in extreme dieting that can lead to serious eating disorders (Melki, Hitti, Oghia, & Mufarrij, 2015**;** Peixoto-Labre, 2002; Raevuori, Keski-Rahkonen, Bulik, Rose, Rissanen, & Kaprio, 2006; Arbour, & Martin-Ginis, 2005; Cramblitt & Pritchard, 2013; Hildebrandt, Schlundt, Langenbucher &

Chung, 2006). These unhealthy practices have been shown to have severe long-term health consequences (Leone, Sedory, & Gray, 2005).

Researchers comparing body image dissatisfaction between males and females have found that dissatisfaction in females is characterized by a desire to lose weight (Kelley, Neufeld, & Musher-Eizenman, 2010; Furnham, Silberstein, Abell, 2002; Silberstein, Striegel-Moore, Timko, & Rodin, 1988; Abell & Richards, 1996), while body dissatisfaction for males seems to be split between a desire to lose weight and a desire to gain weight through an increase in lean muscle mass (Kelley, et al., 2010; Arbour, & Martin-Ginis, 2005; Cramblitt & Pritchard, 2013; Peixoto-Labre, 2002; Furnham, Silberstein, Abell, 2002; Silberstein, et al., 1988; Abell & Richards, 1996). For example, Furnham et al. (2002) found strikingly high levels of body dissatisfaction among adolescents, with only 21.1% of the boys and 18.3% of the girls reporting satisfaction with their body image (Contour Drawing Rating Scale [CDRS] score of 0). Interestingly, they also found a significant difference in the direction of their dissatisfaction with 36.1% of the males wanting to lose weight and 42.8% of the males wanting to become bigger, compared to only 8.1% of the females desiring to be bigger and 74.6% wanting smaller frame. It is important to note, though, that a drive for thinness and a drive for muscularity are not mutually exclusive, and should not be looked at as a continuum (Kelley, et al., 2010; Eisenberg, Wall, & Neumark-Sztainer, 2012; Cramblitt & Pritchard, 2013). In fact, a recent study found that women who regularly post fitness related images on social media scored higher on both drive for thinness and drive for muscularity (Holland & Tiggemann, 2017).

It has been proposed that the underlying mechanism driving the relationship between what is seen on social media and the attitudes and behaviors of individuals is rooted in social learning (Peixoto-Labre, 2002; Bandura, 2001).

According to Bandura (2001), humans are capable of observational learning, meaning they do not have to directly experience an event in order to learn from it; this is the proposed mechanism through which mass media influence behavior (Bandura, 2001; Bandura, 2002). While the mass media has been shown to shape people's beliefs, people are also greatly influenced by the behaviors and actions of others through social prompting (Bandura, 2001; Bandura, 2002). Modeling not only influences our behaviors, but outcomes from these observed behaviors can serve as an incentive or disincentive by creating a reference point for social comparison (Bandura, 2001; Bandura 2002).

In addition, Bandura's (2001) Social Cognitive Theory (SCT) characterizes human as knowers, performers, and self-managers of their own behaviors and environment; who are embedded in complex social systems. Hence, human psychosocial functioning is the result of "cognitive, affective, and biological events, behavioral patterns, and environmental events all operat[ing] as interacting determinants that influence each other bidirectionally" (p. 266). One maintains self-motivation through internal standards and evaluative reactions to one's own behavior. Substandard self-evaluated performances provide the negative feedback and motivation for a new action toward achieving the behavior to be mastered.

According to Peixoto-Labre (2002), young males engage in social comparison by utilizing images of other men in fitness and bodybuilding media as points of reference for what is socially desirable. They are then motivated by this comparison to engage in

similar behaviors, both healthy and dangerous, in order to obtain this desired, muscular body-type (Melki, et al., 2015**;** Peixoto-Labre, 2002; Eisenberg, et al., 2012; Frison, Vandenbosch & Eggermont, 2013).

The food and beverage industry effectively applies these principles using various print and social media to market products to young adults (Freeman, et al., 2014), including products that negatively influence health behaviors (Dunlop, Freeman, & Jones, 2016). The DS marketed to young adults through ads in social media outlets and popular magazines can mislead consumers, placing these products next to images of individuals who have potentially obtained their build through practices other than taking these supplements (see Figure 1).

In addition to the negative behavioral and psychological consequences, such as unrealistic and/or unhealthy standards of beauty, the availability and aggressive marketing of DS presents a very real and dangerous risk to the health of consumers. This health risk for consumers arises from the lax rules regarding food labeling, because some products marketed as DS may contain ingredients, specifically steroids, not listed on the product packaging (Abbate, et al., 2014). Further, both males and females have been shown to pursue potentially dangerous muscle-enhancing behaviors (Clark & Henderson, 2003; Eisenberg, et al., 2012; Frison, et al., 2013) including DS misuse. The consequences of misguided chronic overuse of DS may lead to wasteful spending at a minimum (Lieberman, et al., 2015), but could also lead to more serious adverse health effects such as insomnia, vomiting, gastrointestinal bleeding, impaired renal function and deteriorated bone health (Barzel & Massey, 1998; Maughan, King & Lea, 2004; Stickel, Kessebohm, Weimann & Seitz, 2011; Thorsteinsdottir, Grande & Garovic, 2006). The

risk of side effects is the same for individuals who use DS for their general health and well-being as for individuals who use DS to improve their performance in sports or to improve their appearance for bodybuilding competitions (Navarro, et al., 2014).

Consumption of DS has been associated to the consumption of many other potentially dangerous substances (Raevuori, et al., 2006; Yager and O'Dea, 2014; Backhouse, et al., 2013; Hildebrandt, et al., 2010; Hoffman, Faigenbaum, Ratamess, Ross, Kang & Tenenbaum, 2008; Buckman, Farris & Yusko, 2013). For example, higher use of DS correlates with higher rates of steroid use and higher levels of muscle dissatisfaction in males (Raevuori, et al., 2006; Yager and O'Dea, 2014). Similarly, Backhouse, et al. (2013) found that DS users consumed more substances that are banned by World Anti-Doping Agency (WADA), had more positive beliefs about using banned APEDs, and were more willing to take a substance to both improve their performance and their appearance. This pattern has also been observed among college students, with research showing that both athletes and non-athletes who use DS are more likely to use or intend on using AAS (Hildebrandt, et al., 2010; Yager & O'Dea, 2014; Backhouse, et al., 2013; Hoffman, et al., 2008; Buckman, et al., 2013).

APEDs are substances used to improve one's appearance as well as athletic or physical performance (Hildebrandt, Lai, Langenbucker, Schneider, Yehuda & Pfaff, 2011; Hildebrandt, Langenbucher, Carr, & Sanjun, 2007). APED is an umbrella term for substances that build up muscle, such as AAS or human growth hormone, or reduce body fat, such as thyroid hormones, beta-2 agonists (e.g. clenbuterol), and central nervous system stimulants (e.g. ephedra) (Hildebrandt, 2007).

AAS are synthetic variations of testosterone (Drug Enforcement Administration [DEA], 2004; McDuff & Baron, 2005); anabolic refers to tissue building, and androgenic refers to the promotion of masculine characteristics (DEA, 2004; Clark & Henderson, 2003). They can be ingested in pill form, or injected with a syringe (DEA, 2004; Parkinson & Evans, 2006). AAS can also be applied to the skin like a cream (DEA, 2004); this method is utilized by many athletes to avoid positive drug test results (Bahrke & Yesalis, 2004). Steroid abusers follow patterns of use described as "stacking" and "cycling"; that is an abuser will use two or more steroids at a time (stacking), and will going through periods of use followed by periods of low or non-use (cycling) (DEA, 2004; Maravelias, Dona, Stefanidou, & Spiliopoulou, 2005; Parkinson & Evans, 2006).

APEDS have both positive and negative side effects – while they can improve one's performance and appearance (Clark & Henderson, 2003; Bahrke & Yesalis, 2004; Hildebrandt, 2007; Parkinson, & Evans, 2006; McDuff & Baron, 2005), they are also linked to altered reproductive and hepatic function, and have been shown to alter cardiac structure (Thiblin, Mobini-Far & Frisk, 2009; Hildebrandt, 2007; Clark & Henderson, 2003; Maravelias, et al., 2005). Although the use and distribution of certain APEDs, like ephedra, are illegal, other products containing similar chemical structures to ephedra have been created and sold as weight loss or performance enhancement supplements (McDuff & Baron, 2005). These items are utilized for the same purposes as the illegal substances, and cause many of the same side effects (McDuff & Baron, 2005). The same patterns can be seen in AAS use. To circumvent laws banning the sale to the public of prescription steroids (McDuff & Baron, 2005), many steroid-like supplements are legally sold in the U.S. with components such as testosterone precursors or prohormones, which are

chemically modified versions of illegal steroids (Rahnema, Crosnoe & Kim, 2014; McDuff & Baron, 2005; Rahnema, et al., 2014) with similar effects and side-effects as AAS (Rahnema, et al., 2014).

Side effects of AAS abuse include acne, high cholesterol, hypogonadism and fluid retention, and psychological side effects such as hostility, depression, and mood swings (Clark & Henderson, 2003; Bahrke & Yesalis, 2004; Maravelias, et al., 2005; Parkinson & Evans, 2006; Rahnema, et al, 2014; Coward, Rajanahally, Kovac, Smith, Pastuszak & Lipshultz, 2013; McDuff & Baron, 2005). While most side effects may be reversible, others, such as the masculinizing effects seen in women, are not (DEA, 2004).

While there is some contending evidence that APED use in athletes is decreasing (Hoffman, et al., 2008), other research suggests that both legal and illegal APED use may be actually on the rise (McCabe, Brower, West, Nelson & Wechsler, 2007; Hoyt, Albert & Heard, 2013) due to pressures to perform and the allure of fame and fortune that comes with success (Ehrnborg & Rosen, 2009; Wood, 2008).

In addition to its association to DS use, there is also evidence suggesting AAS use may be associated to other substance use, including heroin, cocaine and tobacco (DuRant, Escobedo & Health, 1995; Buckman, et al., 2013; McDuff & Baron, 2005; McCabe, et al., 2007; Kanayama, Pope, Cohane, & Hudson, 2003); which is of great concern given the evidence that substance use in general (i.e., alcohol, marijuana, amphetamines, tobacco, and narcotics) is widespread amongst athletes (Green, Uryasz, Petr & Bray, 2001; McDuff & Baron, 2005; Buckman, et al., 2013; McCabe, et al., 2007; Buckman, Yusko, White & Pandina, 2009; Lisha & Sussman, 2010). For example, alcohol consumption and binge drinking is greater in athletes than non-athletes, with 75% - 93%

of athletes reporting alcohol use compared to 75% -80% of non-athletes (Lisha & Sussman, 2010; McDuff & Baron, 2005).

While steroid use has been studied in athletes (Eisenberg, et al., 2012; Ehrnborg & Rosen, 2009; Hildebrandt, et al., 2010; Yager & O'Dea, 2014; Backhouse, et al., 2013; Hoffman, et al., 2008; McDuff & Baron, 2005; Buckman, et al., 2013), there is evidence that APED and AAS use for aesthetic purposes amongst college students and gym-goers is also increasing (Hoyt, Albert & Heard, 2013; Parkinson & Evans, 2006; Ehrnborg & Rosen, 2009; Rahnema, et al., 2014- *Fertility and Sterility*; Lippi, Franchini & Guidi, 2008). The increase in APED use is seen in both men and women (Bahrke & Yesalis, 2004; Thiblin, et al., 2009) and a wide age range, from high school students to middle-aged individuals (Coward, et al., 2013). APED use is more commonly reported amongst male weight lifters (Kanayama, Pope, Cohane, & Hudson, 2003; Pope, Kanayama, & Hudson, 2012), and has been linked to negative body image (Coward, et al., 2013; Ehrnborg & Rosen, 2009; Kanayama, et al., 2003; Pope, et al., 2012), and conduct disorders (Pope, et al., 2012). Individuals who are interested in using APEDs can not only buy many of these substances online without a prescription, but can also find out information on administering, cycling and stacking these substances online (Parkinson & Evans, 2006; Brennan, Kanayama & Pope, 2013).

DS currently on the market do not have to be tested or approved for safety and effectiveness by the FDA (Dodge, Litt & Kaufman, 2011); but the FDA is responsible for removing products from the market once harmful side-effects are reported (Dodge, Litt & Kaufman, 2011; Government Accountability Office, 2013). Individuals may be motivated to take DS in order to improve their athletic performance (Schwenk and Costley, 2002),

an unproven benefit commonly used for marketing purposes (Molinero and Marquez, 2009; Williams, 2006). In fact, knowledge of the safety or efficacy of DS use does not seem to affect the amount of DS used, whether it be for aesthetic or performance purposes. When looking specifically at elite athletes, for example, higher DS use is seen in athletes at higher levels of performance, and in athletes who compete in individual sports as opposed to team sports (Giannopoulou, Nautsos, Apostolidis, Bayios and Nassis, 2013).

Unfortunately, knowing that a product had received (or not) FDA approval (i.e., information alone) does not seem to impact consumers' beliefs. In an experimental condition, Dodge et al. (2011) found that knowing whether or not the FDA had approved a product did not influence participants' ratings of safety or effectiveness of a DS.

Popular media's focus on the fitness industry has increased young adults' motivation to obtain a very specific body type, leading to various dangerous muscle-building and weight-loss behaviors. The purpose of this study was to examine the relationships between substance use (including DS, APED and other substances), body image, and physical activity (including participation in sport, regular exercise and weight lifting), to see if gender affects these relationships, and to identify which of these variables act as protective or risk factors.

Because previous research has found gender differences in DS use, this study will look at gender differences in APED use and factors related to APED use in a population of young adults.

H_{1A}: There are significant gender differences in physical activity, BMI, dietary supplement use, ephedrine use, steroid use, and intent on using steroids.

H_{1B}: There are significant gender differences in scores on body image, which will have an effect on physical activity, dietary supplement use, ephedrine use, steroid use, and intent on using steroids in the future.

Exposure to the fitness culture through popular media has been shown to lead to an increase in APED use, particularly AAS use. Hypothesis 2 will look at AAS use and variables related to fitness.

H_2: Dietary supplement use, substance use, BMI, physical activity, participation in a sport and knowing someone who uses steroids will increase the risk of someone using steroids in the future. The relationships will vary by gender.

Because previous findings have shown a relationship between DS use and substance use, hypothesis 3 will look whether there are any potential mediators in this relationship.

H_3: Physical activity will mediate the relationship between DS use and substance use, and this relationship will be moderated by body image. The relationships will vary by gender.

METHODS

Participants

Participants were ASU students between the ages of 18 and 34 who had participated in some sort of physical activity at least once per week, outside of the job or housework. Looking to enroll more health-conscious individuals, participants were recruited from Sun Devil Fitness Facilities. Participants in this study had similar median BMIs, 23.02 vs 23.36, but reported higher use of DS than a sample of students in the psychology program (Bucko, Velez-Bermudez, Hartman, Mills, Vargas, 2016; Lara, Altholz, Flores, Jackson, Vargas, 2013). The listserv included 70,872 students who have

used the Sun Devil Fitness Centers facilities at any of ASU four campuses. Students in the listserv received two email invitations to complete an online survey. The study was approved by Arizona State University's Institutional Review Board.

Procedure

Data were collected online through Surveymonkey.com. Participants (n = 667) read a description of the study and gave passive consent by continuing to complete the survey. Students who completed the survey were entered into a raffle to win 1 of 50 $10 electronic VISA gift cards. The survey included questions on demographics, height and weight to calculate BMI, and several published, standardized questionnaires used to measure drug use, physical activity, body image, steroid and ephedrine use, and dietary supplement attitudes and use. Completing the survey took approximately 45 minutes.

Measures

The College Student Supplement Survey included questions to assess patterns of physical activity (PA) including aerobic PA, and weight lifting, body image, and patterns of dietary supplements, steroid and other drug use. Skip patterns were included to allow respondents to skip over non-applicable questions. For example, participants were asked, "Have you ever used any of the following items or substances? Cigarettes/Tobacco; Alcohol; Marijuana; Synthetic marijuana." Students who answered, "No" or "Prefer not to answer", received a score of 0 on all questions related to cigarettes/tobacco, alcohol, marijuana, and synthetic marijuana use, without having to select these options themselves.

Body Mass Index (BMI) was calculated using the formula: weight (in pounds) / [height (in inches)]^2 x 703 (Center for Disease Control and Prevention [CDC], 2015).

While BMI does not measure body fat specifically, it is correlated with other body fat measures such as skinfold thickness measurements, as well as metabolic diseases associates with body fatness (CDC, 2015). Anyone with a BMI below 18.5 is considered underweight; 18.5-24.9 is considered normal weight; 25-29.9 is considered overweight; and 30 and above is considered obese.

Weight lifting physical activity and reasons for lifting weights were also evaluated using questions from the *Michigan Weight Lifter's Survey* (Brower, et al., 1994; Dunn, et al., 2009). Participants were asked, "Do you lift weights as a part of your fitness routine?" Participants who indicated that they lifted weights as part of their fitness routine were asked about the amount of time they spent each week performing weight lifting physical activity by asking "How many hours do you spend each week lifting weights?" Participants who previously indicated they did not lift weights as part of their fitness routine received a score of 0.

Aerobic physical activity was evaluated using the questions from the *Behavioral Risk Factor Surveillance System* (BRFSS) (CDC, 2011) following the guidelines created by the CDC to measure both moderate and vigorous physical activity in adults. Participants were asked, "We are interested in two types of physical activity vigorous and moderate. Vigorous activities cause large increases of breathing and heart rate while moderate cause small increases in breathing and heart rate. Do not include any time spent weight training in your total times. If you did not engage in moderate physical activity, select 0. If you did not engage in vigorous physical activity, select 0. If you prefer not to answer this question, select 0. The amount of time you spent in each type of physical activities or exercises would include... ?" Participants indicated how many days per week

and minutes per day they performed moderate and vigorous physical activity. The amount of minutes spent per day on each type of aerobic physical activity was multiplied by the amount of days per week spent on each type of physical activity to obtain the amount of minutes per week spent on each type of physical activity. The values calculated for minutes per week of moderate aerobic physical activity and minutes per week of vigorous aerobic physical activity were added together to calculate the total amount of minutes spent per week on aerobic physical activity, and this value was divided by 60 to obtain the number of hours spent each week on aerobic physical activity.

Total amount of physical activity. Total hours spent performing aerobic physical activity per week and weight lifting physical activity per week were summed to obtain the total amount of hours spent performing physical activity per week.

Participation in organized sports. Participants were asked whether or not they played for an organized sports team. Those who answered yes selected at which level they played at, "For my university team", "For an on-campus intramural team", "For an off-campus club team". Because there were no significant differences in DS use, PA, and body image, substance use and BMI between the different levels ($p < .05$), this variable was recoded into a binary variable.

Dietary supplement use. Supplement use was assessed using a modified version of the *Dietary Supplement and Caffeine Intake Survey of US Army Active-Duty Personnel* (Carvey, Farina & Lieberman, 2012). Students were asked if they had used supplements in the past 30 days; those who had use DS were asked to indicate, from a list of thirty-two dietary supplements related to general health (GHDS), which supplements they have used in the past month by selecting how often they took them: Never, Once a month, Once a

week, 2-3 times per week, 4-5 times per week, 6 times per week, Daily, or Two or more times per week. This was also the case for seventeen weight loss dietary supplements (WLDS), twenty-two muscle building dietary supplements (MBDS), and fourteen energy enhancing dietary supplements (EEDS). A score for each supplement type was calculated by adding one point for each specific DS category used, and adding points for frequency of used (e.g. 0 - Never, 1 - Once a month, 2 - Once a week, 3 - 2-3 times per week, 4 - 4-5 times per week, 5 - 6 times per week, 7 - Daily, or 8 - Two or more times per week) (ranges: GHDS: 0-256 ; WLDS: 0-136 ; MBDS: 0-176; EEDS: 0-112) A 30-day dietary supplement use score was created by summing the scores for all of the supplement types (range: 0 - 227).

Steroid and ephedrine use and attitudes. Steroid use and attitudes were assessed using three yes or no questions from the *Michigan Weight Lifter's Survey* (Brower, Blow, & Hill, 1994; Dunn, et al., 2009). Participants were asked, "Have you ever used steroids for training purposes?"; "Would you ever consider using steroids in the future?"; "Do you know someone who uses steroids?" Ephedrine use was assessed using a yes or no question from section 3 of the *National Collegiate Athletic Association Study of Substance Use of College Student-Athletes* (DeHass, 2006): "Have you ever used ephedrine (Ephedra or Ma Huang) for training purposes?" Participants could select, "Yes" and receive a score of 1, "No" and receive a score of 0, or "Prefer not to answer", which was coded as missing data.

Lifetime substance use. Use of drugs, tobacco, alcohol and other substances was assessed using the 2017 *State and Local Youth Risk Behavior Survey* (CDC, 2017). Lifetime substance use scores were calculated by asking students, "Have you ever

tried/used" for the following items: cigarettes; electronic vapor products; other tobacco products; cigars/cigarillos/little cigars; alcohol; marijuana; synthetic marijuana; amphetamines; ecstasy (MDMA); psychedelics; crack/cocaine; heroin; methamphetamines; prescription medication (without legal a prescription); intravenous drugs. Participants who said yes scored a 1 and those who said no scored a 0 for each of the items. Data for participants who selected "Prefer not to answer" was coded as missing. A score for lifetime substance use was calculated by adding these items, the scores ranged from 0 to 15.

30-Day substance use. Scores for 30-day (current) substance use were calculated by asking, "During the past 30 days, on how many days did you use" for the following items: electronic vapor products; other tobacco products; cigars/cigarillos/little cigars; marijuana; synthetic marijuana; amphetamines; ecstasy (MDMA); psychedelics; crack/cocaine; heroin; methamphetamines; prescription medication (without legal a prescription); intravenous drugs. Participants who choose "Never used", or "Have used, but not in the past 30 days" scored 0. Data for participants who selected "Prefer not to answer" was coded as missing. Otherwise, participants could select "1 or 2 days" (1), "3 to 5 days" (2), "6 to 9 days" (3), "10 to 19 days" (4) "20 to 29 days" (5) or "All 30 days" (6). Possible scores for each of these individual items ranged from 0-6. Scores for 30-day cigarette use were calculated by multiplying the amount of days participants reported smoking cigarettes in the past 30 days ["0 days" (0), "1 or 2 days" (1), "3 to 5 days" (2), "6 to 9 days" (3), "10 to 19 days" (4) "20 to 29 days" (5) or "All 30 days" (6)] by the amount of cigarettes smoked per day ["Less than 1 cigarette per day" (0), "1 cigarette per day" (1), "2 to 5 cigarettes per day" (2), "6 to 10 cigarettes per day" (3), "11 to 20

cigarettes per day" (4), "More than 20 cigarettes per day" (5)]. Data for participants who selected "Prefer not to answer" for either or both of these two questions was coded as missing. Possible scores for 30-day cigarette use ranged from 0-30. Scores for 30-day alcohol use were calculated by multiplying the amount of days participants reported drinking alcohol in the past 30 days ["1 or 2 days" (1), "3 to 5 days" (2), "6 to 9 days" (3), "10 to 19 days" (4) "20 to 29 days" (5) or "All 30 days" (6)] by the amount of days students reported binge drinking, that is having 4 or more drinks in a row for females or 5 or more drinks in a row for males ["0 days" (0), "1 day" (1), "2 days" (2), "3 to 5 days" (3), "6 to 9 days" (4), "10 to 19 days" (5), "20 or more days" (6)]. Data for participants who selected "Prefer not to answer" for either or both of these questions were coded as missing. Possible scores for 30-day alcohol use ranged from 0-36. A total score for 30-day substance use was calculated by summing the score of each of these 15 items, creating a 30-day substance use score (range: 0-144).

Body Image attitudes were assessed using the *Contour Drawing Rating Scale* (CDRS) (Thompson & Gray, 1995). Participants were shown the image in Figure 2. Females used the nine figures at the top of the scale, and males used the nine figures at the bottom of the scale. The numbers 1-17 listed below each of the rows represented body sizes, with larger sizes representing the larger body types. Participants first replied to the question, "Select the value that is closest to your present size. That is, the size you are at the moment". The value that was selected for the second question, "Select the value that is closest to the size you would like to be", was subtracted from their first answer. Negative scores reflected a desire to be bigger, while positive scores reflected a desire to be smaller. A larger absolute value meant that there was a greater discrepancy between

what a participant thought their body looked like versus what they wanted their body to look like, meaning a greater CDRS scores reflected greater body dissatisfaction. Therefore, CDRS scores were recoded into magnitude scores as well (range: 0-16).

Missing data

Only 10 students refused to answer questions regarding steroid use; however, there were significant differences in lifetime, and 30-day substance use scores between those who responded and those who did not respond to questions related to ephedrine use, steroid use steroid use intent and knowing someone who uses steroids. These differences can be seen in Table 1. Therefore, participants who selected "prefer not to answer" for ephedrine use ($n = 3$) and steroid use ($n = 2$) steroid use intent ($N = 10$) and knowing someone who uses steroids ($n = 6$) were excluded from analyses testing hypothesis 1, and participants who selected "prefer not to answer" for steroid use intent ($n = 10$) and knowing someone who uses steroids ($n = 6$) were excluded from analyses testing hypothesis 2.

Data from fourteen students who selected "Prefer not to answer" for one or both of the two initial branching questions related to substance use (i.e. Have you ever used any of the following items or substances? Cigarettes/Tobacco, Alcohol, Marijuana, Synthetic marijuana; Have you ever used any of the following items or substances? Amphetamines, Ecstasy (MDMA), Psychedelics, Crack/Cocaine, Heroin, Methamphetamines, Prescription Medication (without legal a prescription), Intravenous drugs) were deleted. Twelve participants did not fully answer questions related to 30-day and lifetime substance use, and were excluded from analyses testing hypothesis 2 and 3.

Data Analysis

Statistical analysis was conducted using SPSS Statistics for Macintosh, Version 23.0 (IBM Corp, 2015). Means, standard deviations, modes, medians, and frequencies were calculated. Gender differences were tested using t-tests for continuous variables; the alpha level was .05. All tests were two-tailed; we did not correct for multiple comparisons. The relationships between variables in hypothesis 1 were tested using linear and logistic regression analyses. Hierarchical linear regression was used to measure steroid use intent in hypothesis 2. The mediated moderation was tested using the Process macro for SPSS version 2.16 (Hayes, 2013). Thus, effect sizes are reported as odds ratios for logistic regressions.

RESULTS

Participants

The mean age of participants was 20.6 ± 2.8 years with a mean BMI of 23.8 ± 4.5. A majority of students (61.8%) were within the normal weight range (BMI, 18.5-24.9 kg/m2). More than half (57.0%) of the students ($N = 667$) were female. All students reported performing some form of aerobic exercise, and 64.2% of students lifted weights as part of their fitness routine. Nearly one third (30.1%) of students reported some current DS use (in the past 30 days), with 20.3% of females and 43.2% of males reporting current DS use. More than half (59.7%) of the participants reported substance use in the past 30 days, and two-thirds (66.4%) reported some form of substance use in their lifetime (Table 2).

H_{1A}: There are significant gender differences in physical activity, BMI, DS use, ephedrine use, steroid use, and intent on using steroids.

As Table 2 shows, there were significant differences between males and females. Males spent significantly more time performing physical activity overall than females, $t(665) = 10.00$, $p < .001$; this was the case for both lifting weights, ($p < .001$), and performing aerobic physical activity, ($p = .003$).

The 30 - day DS use score had a mean of 17.48 ± 35.00. Males used significantly more of all DS types (30-day use scores) than females ($p < .001$); including DS for general health (GHDS) ($p = .001$), weight loss (WLDS) ($p = .001$), muscle building (MBDS) ($p < .001$), and energy enhancement (EEDS) ($p < .001$). The 30 - day substance use score had a median of 2 and ranged from 0 to 38, and lifetime substance use had a median of 2 and ranged from 0 to 13. Compared to females, males also reported significantly more lifetime substance-use ($p < .001$), as well as current substance use (30-day, $p < .001$) (Table 2). Correlations for total physical activity, BMI, total DS use, lifetime ephedrine use, lifetime steroid use, intent on using steroids, and CDRS magnitude scores can be seen in Table 3.

Greater BMI predicted greater EEDS use ($F(1, 285) = 5.36$, $p = .02$) in males, and greater WLDS use in females ($F(1, 378) = 5.89$, $p = .02$). Sixty-six percent of the females who took dietary supplements had a BMI in the category of normal weight or underweight. In males, a greater BMI was associated to greater 30-day DS use ($F(1, 285) = 3.50$, $p = .06$) and more WLDS use ($F(1, 285) = 3.32$, $p = .07$) but did not reach statistical significance (Table 4).

Logistic regression analyses were performed to look at effects of 30-day DS use on ephedrine use, steroid use and steroid use intent by gender. DS use was associated with intention to use steroids for both males and females. Every 1-unit increase in the DS

use score increased the risk to intend on using steroids by 2% in males (OR=1.02, $p <$ .001, 95% CI: 1.01-1.02), and 3% in females (OR=1.03, p = .001, 95% CI: 1.01-1.06). The multiple logistic regression model looking at the likelihood of steroid use intent was not significant for any of type of DS.

DS use was associated with lifetime use of ephedrine for both males and females. There was a 2% increase risk to have used ephedrine in their lifetime per 1-unit increase in DS use scores for males (OR=1.02, p = .005, 95% CI: 1.01-1.03), and 3% for females (OR=1.03, p = .006, 95% CI: 1.01-1.05). The multiple logistic regression model looking at the likelihood of ephedrine use showed that for males, every 1-unit increase in EEDS use scores increased the chance of ephedrine use in their lifetime by 17% (OR=1.17, p = .02 95% CI: 1.03-1.33). There were no significant associations between the different DS types and ephedrine use in females.

Only 2.4% of males reported having used AAS in their lifetime, while no female reported AAS use. Logistic regression models looking at the effect of 30-day DS use as a risk factor for AAS use were not significant for either gender (data not shown).

H_{1B}: There are significant gender differences in scores on body image, which will have an effect on physical activity, DS use, ephedrine use, steroid use, and intent on using steroids in the future.

Figure 3 shows the CDRS scores for body ideal (X) against scores for body size (Y) for males and females. The overall average CDRS discrepancy score for body dissatisfaction was 1.53 ± 2.98 (range –16 to +16). The mean discrepancy or dissatisfaction CDRS score was 2.50 ± 2.22. Satisfaction with body image (CDRS score = 0) was similar for males (51%) and females (49%). However, as shown in Figures 3,

females showed higher levels of body dissatisfaction, scoring significantly higher than males on CDRS magnitude scores ($t(659) = -4.97$, $p < .001$). Only 8.2% percent of females wanted to be bigger, while 47.9% of the males wanted to be thinner. Figure 4 shows the distribution of CDRS discrepancy scores for males and females. In addition, of those who had a desire to be bigger, 75.4% were male. Of those who had a desire to be smaller, 68.8% were female.

Greater body dissatisfaction (CDRS magnitude scores) predicted lower levels of total PA in males ($t(1, 280) = -2.53$, $p = .01$) and females ($t(1, 377) = -1.99$, $p = .05$). In other words, those who exercised less were less satisfied with their body image. When looking specifically by gender and type of PA (i.e. aerobic vs weight lifting), greater CDRS magnitude scores significantly predicted lower weight lifting in males ($t(1, 280) = -2.61$, $p = .01$), and lower aerobic physical activity in females ($t(1, 377) = -2.06$, $p = .04$).

Logistic regression analyses were performed to look at effects of body image on ephedrine use, steroid use and steroid use intent by gender. In females, every 1-unit increase in CDRS magnitude scores increased the chance that they had used ephedrine in their lifetime by 57% (OR=1.57, $p = .003$, 95% CI: 1.17-2.11). Logistic regression models looking the effect of body image increasing the likelihood of steroid use and steroid use intent were not significant for either gender. Linear regression analysis showed that CDRS magnitude scores predicted greater WLDS use in females ($t(1, 377) = 3.17$, $p = .002$) and EEDS use in females ($t(1, 377) = 3.05$, $p = .002$).

H_2: DS use, substance use, BMI, PA, participation in a sport and knowing someone who uses steroids will increase the risk of someone using steroids in the future. The relationships will vary by gender.

In the hierarchical logistic regression (Table 5) predicting AAS use intent, total PA, BMI, and gender were entered as predictors in step 1, participating in a sport was entered in at step 2, knowing someone who used steroids was entered as a predictor in step 3, 30-day substance use was entered as a predictor in step 4 and total DS (i.e., GHDS, WLDS, MBDS and EEDS) use was entered as a predictor in step 5. The analysis showed that controlling for total PA, BMI, Participation in Sport and current (30-day) substance and DS use, males who know someone who use steroids and use EEDS were more likely to report intention to use AAS in the future.

In the first block, gender ($p < .001$) was a significant predictor of steroid use intent, Nagelkerke $R^2 = .29$, $\chi 2 = 79.15$, $p < .001$, OR: 29.48 95% CI: 6.45-134.77. Participating in a sport did not contribute significantly to the model, Nagelkerke $R^2 = .29$, $\chi 2 = .70$, $p = .40$. In the third block, knowing someone who used steroids increased the likelihood of intending on using AAS in the future more than 5 times (Nagelkerke R2 = .38, $\chi 2 = 26.62$, p <.001, OR: 5.57, 95% CI: 2.57-12.05). In block four, 30-day substance use did not contribute to the model, Nagelkerke $R^2 = .38$, $\chi 2 = .80$, $p = .37$. In the fifth block, EEDS use significantly increased the risk of steroid use in the future, Nagelkerke $R^2 = .43$, $\chi 2 = 14.58$, $p < .001$, OR: 1.04, 95% CI: 1.04-1.12. Total and other individual DS use (i.e., GHDS, WLDS and MBDS) were removed from the final model.

H_3: Physical activity will mediate the relationship between DS use and substance use, and this relationship will be moderated by body image. The relationships will vary by gender.

Gender Effect

A hierarchical linear regression was first used to test the relationship between lifetime substance use, total PA, total DS use and CDRS magnitude scores (Table 6). Lifetime substance use was considered the dependent variable and total PA, total DS use and CDRS magnitude scores were entered as predictors. Total PA ($t(3, 645) = 4.07$, $p < .001$) and total DS ($t(3, 645) = 3.60$, $p < .001$) use were both significant predictors of lifetime substance use. CDRS magnitude scores were moderately significant (($t(3, 645) = 1,94$, $p = .053$) predictors of lifetime substance use, and were therefore excluded from the model looking at both genders. Mediation analysis was conducted with total DS use as a predictor of lifetime substance use, and total PA entered as the mediator (Figure 5).

First, the results of a regression in which total DS use was entered as a predictor of lifetime substance use established a direct association of DS use on lifetime substance use, $c = .02$, $SE = .003$, $t(1, 653) = 5.70$, $p < .001$. Second, total DS use was a predictor of total physical activity, $a = .04$, $SE = .003$, $t(1, 653) = 11.60$, $p < .001$. Multiple regression analysis showed that physical activity was a predictor of lifetime substance use controlling for total DS use, $b = .13$, $SE = .04$, $t(1, 653) = 3.72$, $p = .002$. In the third step, the direct effect of total DS use on lifetime substance use was shown as significant when controlling for physical activity, $c' = .01$, $SE = .003$, $t(2, 652) = 3.70$, $p = .002$, demonstrating partial mediation. The significance of the indirect effect, $ab = .005$, was confirmed using a Sobel test, $z = 3.53$, $p = .0004$.

Males

A hierarchical linear regression was used to test the relationship between lifetime substance use, total PA, total DS use and CDRS magnitude scores in males (Table 6).

Lifetime substance use was the dependent variable and total PA, total DS use and CDRS magnitude scores were entered as predictors. Total PA ($t(3, 272) = 2.48$, $p = .01$) and total DS ($t(3, 272) = 2.52$, $p = .01$) use were both significant predictors of lifetime substance use. CDRS magnitude scores were not significant predictors of lifetime substance use, and were therefore excluded from the moderation analysis looking at males. Mediation analysis was conducted with total DS use as a predictor of lifetime substance use, and total PA entered as a mediator (Figure 6).

The results of a regression in which total DS use was entered as a predictor of lifetime substance use showed a direct effect of DS use on lifetime substance use, $c = .02$, $SE = .004$, $t(1, 279) = 3.67$, $p = .003$. Total DS use was a predictor of total PA, the proposed mediator, $a = .03$, $SE = .005$, $t(1, 279) = 7.02$, $p < .001$. Multiple regression analysis showed that physical activity was a predictor of lifetime substance use controlling for total DS use, $b = .12$, $SE = .05$, $t(2, 278) = 2.25$, $p = .03$. The direct effect of total DS use on lifetime substance use was significant when controlling for total PA, $c' = .01$, $SE = .005$, $t(2, 278) = 2.53$, $p = .012$, showing partial mediation. The significance of the indirect effect, $ab = .004$, was confirmed using a Sobel test, $z = 2.12$, $p = .03$.

Females

A hierarchical linear regression was used to test the relationship between lifetime substance use, total PA, total DS use and CDRS magnitude scores in females (Table 6). Lifetime substance use was considered the dependent variable and total PA, total DS use and CDRS magnitude scores were entered as predictors. CDRS magnitude scores ($t(3, 369) = 2.02$, $p = .04$) and total DS ($t(3, 369) = 1.99$, $p = .05$) use were both significant predictors of lifetime substance use. Total PA was not significant predictors of lifetime

substance use, and was therefore excluded from the mediation analysis looking at females. Mediation analysis was conducted with total DS use as a predictor of lifetime substance use, and CDRS magnitude scores entered as the mediator (Figure 7).

The regression analysis showed that total DS use predicted lifetime substance use (direct effect), $c = 0.01$, $SE = 0.005$, $t(2, 370) = 2.88$, $p = .004$. Total DS use was not a significant predictor of CDRS magnitude scores (the proposed mediator), $a = 0.008$, $SE = 0.005$, $t(1, 371) = 1.70$, $p = .09$, but CDRS scores were conservatively maintained in the model. The direct effect of total DS use on lifetime substance use was also significant when controlling for physical activity, $c' = 0.01$, $SE = 0.005$, $t(2, 370) = 2.72$, $p = .007$.

DISCUSSION

This study sought to explore the relationship between current dietary supplement use and use of other substances including APED, steroids, and other substances. We also examined the role physical activity, gender, and BMI on the relationship between the use of DS and other substances.

Compared to females, males reported higher use of all four types of dietary supplements (i.e., general health, weight loss, muscle building and energy enhancing) as well as more current and lifetime use of substances. Further, energy enhancing dietary supplement use specifically increased the likelihood of ephedrine use in males. This is comparable to a study done by Backhouse, et al. (2013), which showed that dietary supplement users were more open to the use of substances banned by the World-Anti-Doping Agency.

While the link between dietary supplement use and AAS use has been seen in other studies (Hildebrandt, et al., 2010; Yager & O'Dea, 2014; Backhouse, et al., 2013;

Hoffman, et al., 2008; Buckman, et al., 2013), DS use was not related to steroid use in our sample. However, dietary supplement use increased the risk of intention to use steroids in the future and increased the likelihood of having used ephedrine for both males and females. Specifically, male EEDS users who know someone who use steroids were more likely to report intention to use AAS in the future. These findings suggest that there may be common underlying factors motivating young adults to engage in both dietary supplement use and illegal and dangerous APED use; in particular, males seem more likely to engage in dangerous behaviors, putting themselves at high risk for negative health and legal consequences related to substance abuse. The fact that dietary supplement use was not associated with previous AAS use in this sample may have been due to the fact that such a small number of participants (1%) reported AAS use. Findings in the literature regarding DS use by gender have been inconsistent, with higher use among young males reported by some researchers (Marques-Vidal, 2004; Bell, Dorsch, McCreary, & Hovey, 2004); but not all (Sotoudeh, et al, 2015; Wardenaar, van den Dool, Ceelen, Witkamp, & Mensink, 2016; Sundgot-Borget, Berglund, & Torstveit, 2003; Bailey et al., 2013; Knapik et al., 2013).

Females using more dietary supplements report the primary reason to be a desire to improve or maintain their health Sotoudeh, et al, 2015; Wardenaar, van den Dool, Ceelen, Witkamp, & Mensink, 2016; Sundgot-Borget, Berglund, & Torstveit, 2003; Bailey et al., 2013; Knapik et al., 2013), while males report using DS in order to increase power, endurance, and increase muscle size (Giannopoulou, et al., 2013).

Interestingly and congruent with the body image of females, BMI was a significant predictor of use of weight loss dietary supplement in females, even though

more than half (66%) of females who admitted to using weight loss dietary supplements had a BMI below 25 (i.e. healthy weight or underweight). Also consistent with the literature, BMI predicted use of energy enhancing dietary supplements in males (Wardenaar, et al, 2016; McDowall, 2007).

Consistent with previous research, satisfaction with body image was similar for males (51%) and females (49%). However, also consistent with previous research, females showed higher levels of body dissatisfaction and a desire to be smaller. As it has been shown before, few females (8.2%) wanted to be bigger, while males wanted to be both thinner and more muscular (Furnham, Badmin & Sneade, 2002; Bucchianeri, Arikian, Hannan, Eisenberg & Neumark-Sztainer, 2013). A greater dissatisfaction in body image predicted lower rates of physical activity in both genders. Specifically, greater dissatisfaction in body image predicted less weight lifting activity in males and showed a moderately significant, negative association with aerobic physical activity in females. Negative body image did not seem to be related to dangerous exercise behaviors in the young adults in our sample. The inverse relationship between the two variables suggest that physical activity may instead act as a protective factor. These results differ from findings of other studies looking at gender differences on the effects of negative body image on a drive for muscularity in males, which leads to more muscle enhancing behaviors (Kelley, et al., 2010; Arbour, & Martin-Ginis, 2005; Cramblitt & Pritchard, 2013; Peixoto-Labre, 2002; Eisenberg, et al., 2012) and on a drive for thinness in females, which leads to dangerous weight loss behaviors (Boepple & Thompson, 2016; Kelley, et al., 2010; Prichard & Tiggemann, 2007). The differences between previous studies and the results of the present study may be due to our recruitment strategy.

Students in our sample might be body-conscious individuals who exercise more often, and may be more satisfied with their appearance because they are actively engaged in achieving their fitness and appearance goals (Davis, Elliott, Dionne & Mitchell, 1991; Davis & Cowles, 1991). This argument would also explain why the relationship between body image and exercise type varied by gender. Males who are actively engaged in achieving the muscular body ideal must participate specifically in muscle building exercise, while females should participate in aerobic exercise to achieve a thin body ideal (Davis & Cowles, 1991), hence these behaviors can actually lead to greater body satisfaction (Davis, et al., 1991).

An increase in body image dissatisfaction increased females' risk of using ephedra in their lifetime, and was associated with greater use of weight loss and energy enhancing dietary supplements. Ephedra is a central nervous system stimulant that is often used to aid in weight loss or performance enhancement (McDuff & Baron, 2005; Hildebrandt, 2007), therefore the results show a clear relationship between negative body image and weight-loss related APED use in females. Similarly, Piexoto-Labre (2002) argued that Social Comparison Theory motivates young males to utilize images of males in the bodybuilding industry as socially desirability indices, later leading them to engage in extreme behaviors to obtain their desired body type.

Although much of the research on the dangers of the fitness industry on body image focuses on exposure to media (Peixoto-Labre, 2002; Peixoto-Labre, 2004; Arbour, & Martin-Ginis, 2005; Cramblitt & Pritchard, 2013; Shoger, 2008; Krawiec, 2016; Boepple & Thompson, 2016), this study instead used physical activity, participation in a sport, knowing someone who uses steroids and current DS use as measures of potential

risk factors. In this sample, 15% of males and 0.5% of females reported they intended on using steroids in the future. Gender, dietary supplement use, specifically energy enhancing supplement use, and knowing someone who used steroids were significant predictors of intent to use steroid in the future. These results are consistent with previous research (Dun et al., 2009) showing that male weightlifters were more likely to use AAS if they had a close friend who used AAS. Social Cognitive Theory explains how the participants in this study may have been influenced by the actions of others in the fitness industry through social prompting (Bandura, 2001; Bandura, 2002). A mentioned earlier, there seems to be an underlying link between illegal APED use and dietary supplement use. Exposure to the fitness culture and the extreme body types promoted by this industry may be increasing both dietary supplement use and AAS use.

Unlike previous research which suggests athletes are at a higher risk of steroid use (Sundgot-Borget, et al., 2003), participating in a sport was not a significant predictor of intentions to use AAS. While the pressure to perform may have still put the athletes at a higher risk to use AAS (Ehrnborg & Rosen, 2009; Wood, 2008), these students may have been less likely to use AAS due to regular drug testing performed by the team, as well as greater access to education on the dangers of AAS use through coaches or trainers. These results also suggest that college students may be using DS for aesthetic, as opposed to performance – related, purposes.

The results also varied from previous research looking at the relationship between steroid and other substance use (DuRant, Escobedo & Health, 1995; Buckman, et al., 2013; McDuff & Baron, 2005; McCabe, et al., 2007; Kanayama, Pope, Cohane, & Hudson, 2003; Raevuori, et al., 2006) in that current substance use was not a significant

predictor of steroid use intent. This difference may have been because AAS users may use more of a specific drug that may improve performance, such as amphetamines or cocaine (Dunn, et al., 2009) as opposed to all types of substances. This argument is strengthened by the fact that only the use of energy-enhancing dietary supplements, which have similar properties to drugs such as amphetamine (Eudy, et al., 2013), increased the risk of future AAS use.

Physical activity partially mediated the relationship between current dietary supplement use and lifetime substance use. Contrary to our hypothesis, body image did not moderate this relationship when looking at both genders. When looking at males, physical activity partially mediated the relationship between current dietary supplement use and lifetime substance use; body image was not at all related to substance use. However, the opposite was seen in females; dietary supplement use and body image, not physical activity, were significant predictors of substance use. It is important to note that some studies show a negative relationship between substance use and dietary supplement use (Bailey, et al., 2013; Dickinson & MacKay, 2014) as well as physical activity and substance use (Pate, Heath, Dowda, & Trost, 1996; Kwan, Bobko, Faulkner, Donnelly & Cairney, 2014; Delisle, Werch, Wong, Bian & Weiler, 2010; Dickinson & MacKay, 2014). Similar gender differences were reported by Sotoudeh et al. (2003), who showed that dietary supplement use was related to physical activity in males but not females. These results may be due to differences in the types of physical activity performed by males as opposed to females, as well as gender differences in the types of dietary supplements most commonly used by each gender.

LIMITATIONS

This study was based on self-reported data rather than direct observation. Causal relationships cannot be determined due to the cross sectional design of the study. There were significant differences in steroid use, ephedrine use, steroid use intent and knowing someone who used steroids between those who replied to questions about drug use and those who selected "prefer not to answer". Although the survey was anonymous, participants may have chosen not to answer questions about drug use due to the social desirability effect. The length of the survey may have also contributed to participants' choice to select "prefer not to answer".

Young adults are motivated to seek a certain look through images provided by popular media. This study aimed to look at the relationship between the various actions that have been shown to stem from viewing this media. Future research should also measure exposure to various forms of media focused on the fitness industry in either a natural setting (ex: asking about how many social media platforms they use, how often they use them, and what percentage of the content on these platforms is fitness related) and in a lab-based setting (ex: asking participants to engage with fitness-related media and measuring the effects of this exposure).

Future research should also ascertain the students' health status and possible side effects experienced due to dietary supplement use. While participants were given a list of commonly used dietary supplements, future studies could include an open-ended section in order to capture substances that are either banned by the FDA or have known side effects.

Low scores on substance use may be due to the fact that many students who begin using hard drugs such as heroin or cocaine are more likely to drop out of school and would therefore be excluded from our sample; future samples should include participants outside of the academic setting.

CONCLUSION

The evidence from this study shows a connection between dietary supplement use and other dangerous health behaviors, including current and future illegal APED use and other substance use. The high prevalence of DS use, the availability of supplements with a high nutrient content, and the risk of multi-substance use make this a concern for the long term health of the students. This trend highlights the need to develop educational programs to inform young adults about the potential risks and benefits of DS use and misuse.

Physical activity seems to act as both a protective factor and risk factor for these dangerous behaviors, and clear gender differences emerge along the lines of body image theories, specifically the drive for thinness in females and the drive for muscularity in males. Future research should also explore strategies to address the complex issues of body dissatisfaction among young adults as well as interventions to promote healthy living.

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APPENDIX A

PASSIVE CONSENT

In order to participate in this study, you must be between the ages of 18 and 34, and participate in regular physical activity at the Sun Devil Fitness Center at least once per week (outside of your regular job or house work).

The survey will take about 45 minutes to complete. Completing the survey will give you a chance to win 1 of 52 $10 electronic VISA gift cards. After completing the survey, you will be redirected to a separate SurveyMonkey page, where you will fill in your contact information, and will be entered into an online raffle. Your contact information will not be connected to your answers in the survey. If you are a winner in the raffle drawing, your gift card will be emailed to you by the end of the Fall 2016 Semester.

Your participation in this anonymous survey is completely voluntary. If you chose to withdraw at any time, you may do so without penalty. You may also refuse to answer questions that make you uncomfortable. Some questions ask about illegal activities, such as illegal drug and alcohol use, and steroid use. By participating in this study, you are helping us to learn about young adults' health-related behavior as well as possible risk and protective factors including physical activity (i.e., level, pattern and routine), knowledge and consumption of dietary supplements and other substances, sleep quality, and self-image. All of this information may be used to create a program to improve the health of students.

After completing the survey, you will find some additional information about the study. You may request a copy of the study results, noting that results may not be analyzed until a few months after the survey is closed. Participants' personal information will not be used in any presentations or publications resulting from this study.

Filling out the survey will be considered your consent to participate.

If you have any questions, please contact me Agnes Bucko by email at abucko@asu.edu or Dr. Perla Vargas at Perla.Vargas@asu.edu or 602-543-8224. If you feel this study has placed you at risk, or if you have questions about your rights as participant in this research. Please contact the Chair of the Human Subjects Institutional Review Board, through the office of Research Integrity and Assurance, at (480) 965-6788

APPENDIX B

IRB EXEMPTION LETTER

ASU Knowledge Enterprise Development

EXEMPTION GRANTED

Perla Vargas
Social and Behavioral Sciences, School of
602/543-8224
Perla.Vargas@asu.edu

Dear Perla Vargas:

On 10/12/2016 the ASU IRB reviewed the following protocol:

Type of Review:	Initial Study
Title:	Risk and Protective Factors Associated to Dietary Supplement Use in College Students
Investigator:	Perla Vargas
IRB ID:	STUDY00005097
Funding:	Name: Sun Devil Athletics - Administration
Grant Title:	
Grant ID:	
Documents Reviewed:	• SDFCGrant App_FINAL.docx, Category: Sponsor Attachment; • Supplement Use in College Students SurveyV6.pdf, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions); • Debriefing Statement.pdf, Category: Other (to reflect anything not captured above); • Recruitment Script.pdf, Category: Recruitment Materials; • Passive_Consent.pdf, Category: Consent Form; • SDFC_IRB_PROTOCOLupdate2.docx, Category: IRB Protocol;

The IRB determined that the protocol is considered exempt pursuant to Federal Regulations 45CFR46 (2) Tests, surveys, interviews, or observation on 10/11/2016.

In conducting this protocol you are required to follow the requirements listed in the INVESTIGATOR MANUAL (HRP-103).

APPENDIX C

TABLE 1

Differences in scores on 30 day and lifetime substance use scores for variables missing data

Variable	30 day substance use score		t-score	Lifetime substance use score		t-score
	Missing	Not Missing		Missing	Not Missing	
Lifetime ephedrine use	0	9.88 ± 7.30	2.27^{+}	0	5.87 ± 4.19	2.35^{+}
Lifetime steroid use	0	8.17 ± 5.12	2.14	0	5.83 ± 4.07	1.92
Steroid use intent	1.60 ± 3.03	7.43 ± 7.78	2.32^{+}	1.70 ± 2.21	4.22 ± 3.04	2.47^{+}
Know someone who uses steroids	1.50 ±3.67	6.41 ± 7.52	1.59	1.00 ± 1.55	3.76 ± 3.25	2.07^{+}

Note: $^{**}p < .001$, $^{*}p < .01$, $^{+}p < .05$; Missing ephedrine use $n = 3$; Missing steroid use $n = 2$; Missing steroid use intent $n = 10$; Missing knowing someone who uses steroids $n = 6$

APPENDIX D

TABLE 2

Differences (t-test) in Demographic characteristics, BMI, physical activity, and substance use (DS, AAS, and substance) by gender (N = 680)

Variable	All (*M* and *SD*)	Females *N* = 380 (*M* and *SD*)	Males *N* = 287 (*M* and *SD*)	*t*-test
Age	20.57 ± 2.77	20.17 ± 2.47	21.10 ± 3.05	4.38**
BMI	23.76 ± 4.52	23.38 ± 4.85	24.26 ±3.99	2.49*
- % Underweight	6.4	8.2	4.2	
- % Normal weight	61.8	65.8	56.4	
- % Overweight	24.4	18.9	31.7	
- % Obese	7.3	7.1	7.7	
Hours spent WL / week	2.80 ± 3.04	1.86 ± 2.30	4.05 ± 3.44	9.87**
- % WLPA	64.2	55.3	76	
Hours spent AE / week	0.88 ± 0.77	0.80 ± 0.65	0.98 ± 0.90	2.94*
- % AEPA	100	100	100	
Hours spent total PA / week	3.68 ± 3.25	2.66 ± 2.47	5.03 ± 3.64	10.00**
- % Total PA	100	100	100	
% Participate in organized sports team	15.6	11.6	20.9	
30-day DS use score	17.48 ± 35.00	11.08 ± 28.79	25.95 ± 41.26	5.55**
% 30-day DS use	30.1	20.3	43.2	
- GHDS	8.19 ± 19.65	5.95 ± 17.02	11.17 ± 22.36	3.42**
- WLDS	1.64 ± 4.34	1.14 ± 3.57	2.31 ± 5.11	3.46**
- MBDS	4.30 ± 9.15	1.92 ± 5.33	7.45 ± 11.83	8.09**
- EEDS	3.34 ± 6.62	2.07 ± 5.35	5.03 ± 7.79	5.81**
- % GHDS	28.8	20.0	40.4	
- %WLDS	23.1	16.3	32.1	
- % MBDS	27.6	16.8	41.8	
- % EEDS	28.5	19.2	40.8	
30-day substance use score	4.07 ± 5.89	3.26 ± 4.83	5.16 ± 6.92	4.15**
% 30-day substance use	59.7	57.8	62.3	
Lifetime substance use score	2.66 ± 2.80	2.22 ± 2.47	3.25 ± 3.10	4.72**
% lifetime substance use	66.4	62.8	71.2	
Have used AAS	1.0	-	2.4	
Have used ephedrine	1.3	0.5	2.4	
Intend on using steroids in future	6.9	0.5	15.3	
Know someone who uses AAS	27.6	23.4	33.1	

Note: **$p < .001$, $p < .01$; BMI – Body Mass Index; WL - Weight Lifting, AE – Aerobic Exercise, PA – Physical Activity, DS – Dietary Supplement, AAS - Anabolic-Androgenic Steroids, GHDS – General Health Dietary Supplement; WLDS – Weight Loss Dietary

Supplement; MBDS – Muscle Building Dietary Supplement; EEDS – Energy Enhancing Dietary Supplement

APPENDIX E

TABLE 3

Correlations for variables in Hypothesis 1

Variable	1	2	3	4	5	6	7
Total physical activity							
BMI	.03						
Gender	-.36**	-.10^{+}					
Lifetime steroid use	.11**	.10^{+}	-.12*				
Lifetime ephedrine use	.09†	.07	-.08†	.24**			
Steroid use intent	.25**	.06	-.30**	.03	.07		
Total DS use score	.41**	.08†	-.21**	.12	.21**	.33**	
CDRS magnitude	-.17**	.37**	.18**	-.01	.10*	-.05	-.02

Note: **$p < .001$, *$p < .01$, $^{\dagger}p < .05$; BMI – Body Mass Index

APPENDIX F

TABLE 4

Linear regression for BMI predicting DS use

	Male					Female				
	Total DS	GHDS	WLDS	MBDS	EEDS	Total DS	GHDS	WLDS	MBDS	EEDS
B	1.14	0.51	0.14	0.22	0.27	0.13	0.01	0.09	-0.05	0.07
SE B	0.61	0.33	0.08	0.17	0.12	0.29	0.18	0.04	0.06	0.06
β	0.11	0.09	0.11	0.08	0.14	0.02	0.003	0.12	-0.04	0.07
t	1.87	1.55	1.82	1.28	2.32	0.43	0.05	2.43	-0.82	1.28
p	.06	.12	0.07	.20	.02†	.67	.96	0.02†	.41	.20
F	3.50	2.40	3.32	1.63	5.36	0.17	0.003	5.89	0.67	1.65

Note: †$p < .05$; *B* – y-intercept; *SE B* – Standard error of y-intercept; *β* – Beta; The following are outcome variables: DS – Dietary Supplement; GHDS – General Health Dietary Supplement; WLDS – Weight Loss Dietary Supplement; MBDS – Muscle Building Dietary Supplement; EEDS – Energy Enhancing Dietary Supplement

APPENDIX G

TABLE 5

Hypothesis 2 – Hierarchical multiple logistic regression for intention to use AAS.

		95% CI for OR		
	Adjusted OR	Lower	Upper	Sig
Step 1				
Total PA	1.06	0.96	1.17	.23
BMI	0.97	0.88	1.07	.49
Male gender	29.48	6.45	134.77	<.001
Step 2				
Participation in Sport	1.55	0.69	3.52	.29
Step 3				
Know someone who uses steroids	5.57	2.57	12.05	<.001
Step 4				
30 day substance use	0.99	0.95	1.05	.91
Step 5				
EEDS use	1.08	1.04	1.24	<.001

Note: **$p < .001$; *B* – y-intercept; *SE B* – Standard error of y-intercept; β – Beta. OR – Odds Ration, CI Confidence Interval, PA – Physical Activity, BMI – Body Mass Index, AAS - Anabolic-Androgenic Steroids, EEDS – Energy Enhancing Dietary Supplement

APPENDIX H

TABLE 6

Linear regression measuring predictors of lifetime substance use including physical activity, DS use and body dissatisfaction as measured by the CDRS

Variable	*B*	*SE B*	*β*	*t*	*p*	*df*
Total PA	0.15	0.04	0.17	4.07	< .001	3, 645
Total DS use	0.01	0.003	0.15	3.60	< .001	3, 645
CDRS magnitude	0.09	0.05	0.08	1.94	.053	3, 645
Males						
Total PA	0.14	0.06	0.16	2.48	.01	3, 272
Total DS use	0.01	0.005	0.16	2.52	.01	3, 272
CDRS magnitude	0.14	0.103	0.08	1.37	.17	3, 272
Females						
Total PA	0.09	0.06	0.09	1.62	.11	3, 369
Total DS use	0.01	0.005	0.11	1.99	.05	3, 369
CDRS magnitude	0.11	0.05	0.11	2.02	.04	3, 369

PA – Physical activity; DS – Dietary Supplement; CDRS – Contour Drawing Ratings Scale; *B* – y-intercept; *SE B* – Standard error of y-intercept; *β* – Beta

APPENDIX I

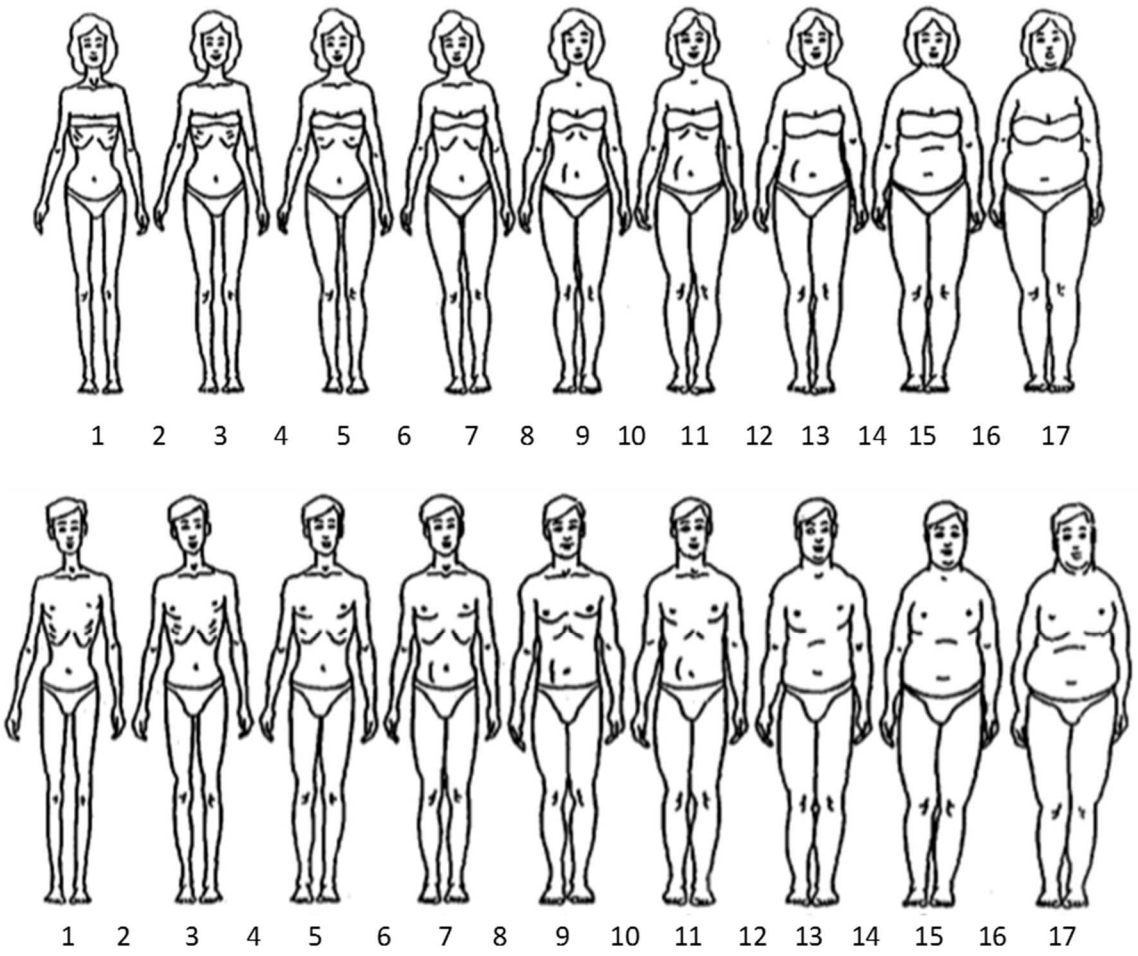
FIGURE 1



Image from 2017 issue of *Muscle and Fitness*

APPENDIX J

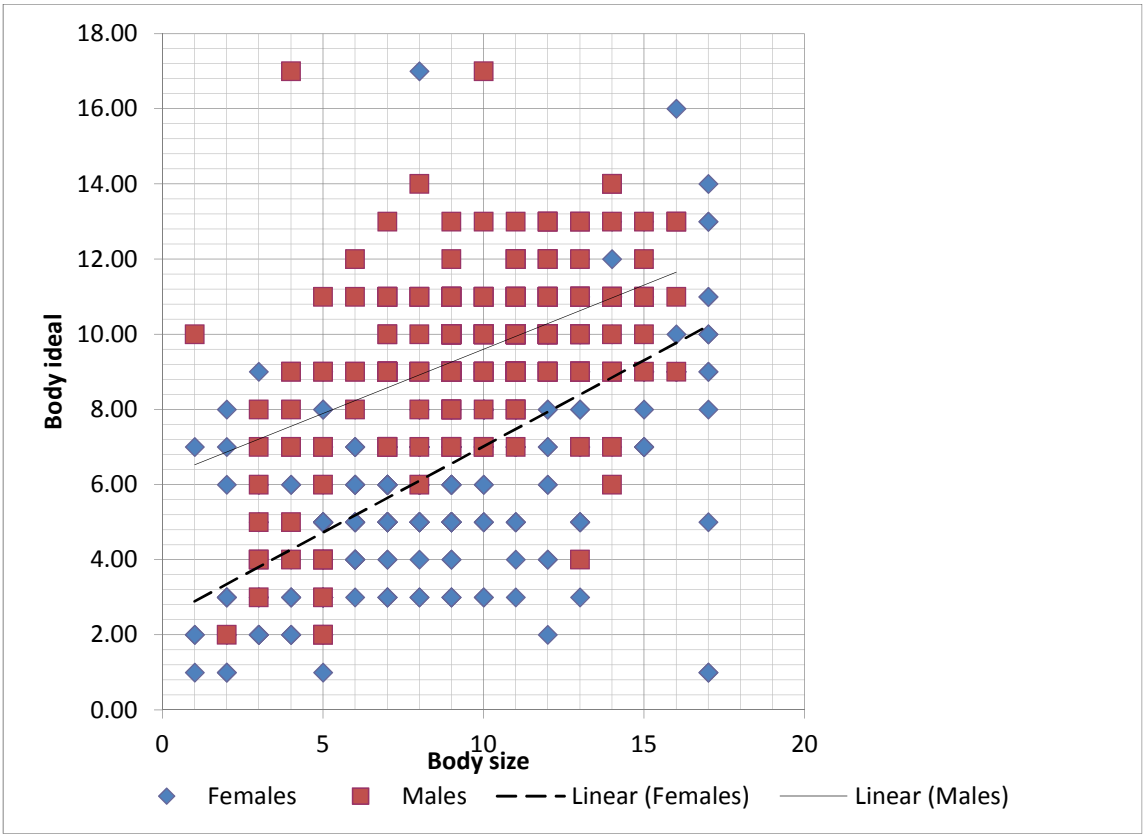
FIGURE 2



Contour Drawing Ratings Scale (CDRS)

APPENDIX K

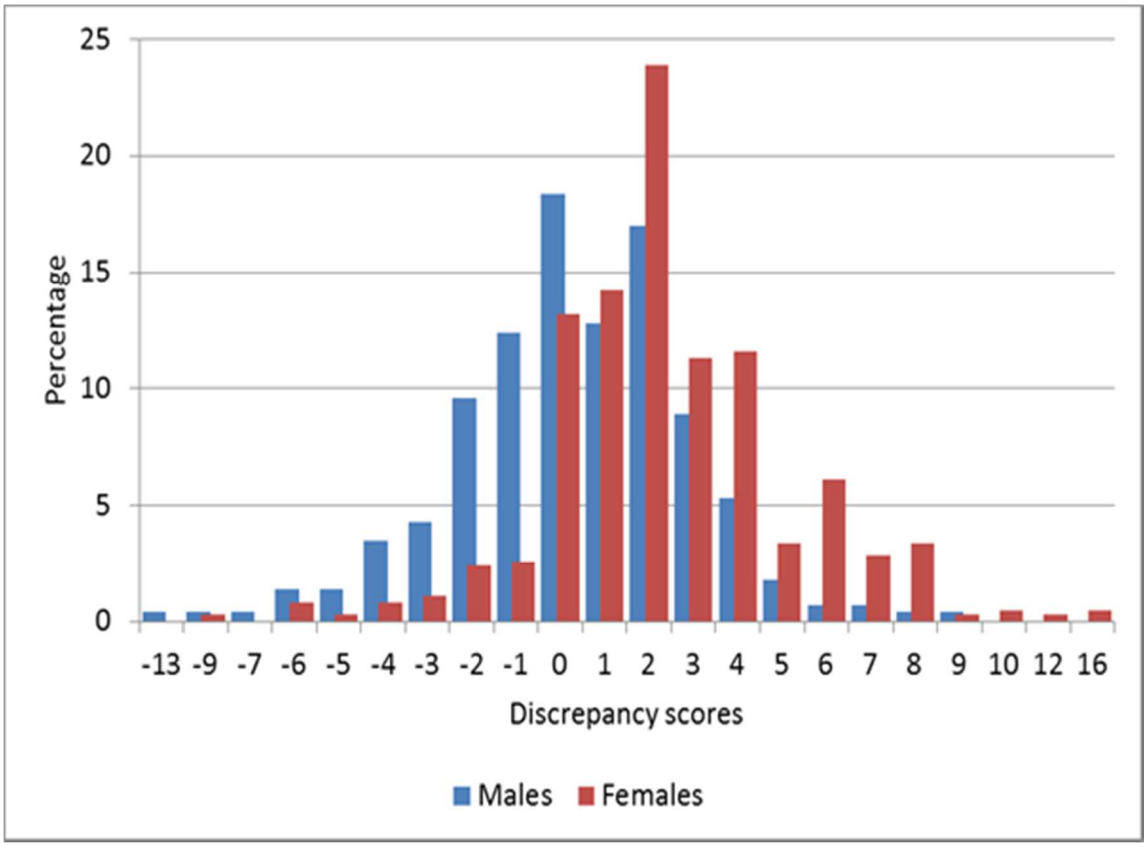
FIGURE 3



Scatter plot of CDRS scores of body ideal (Y) against body size for males and females

APPENDIX L

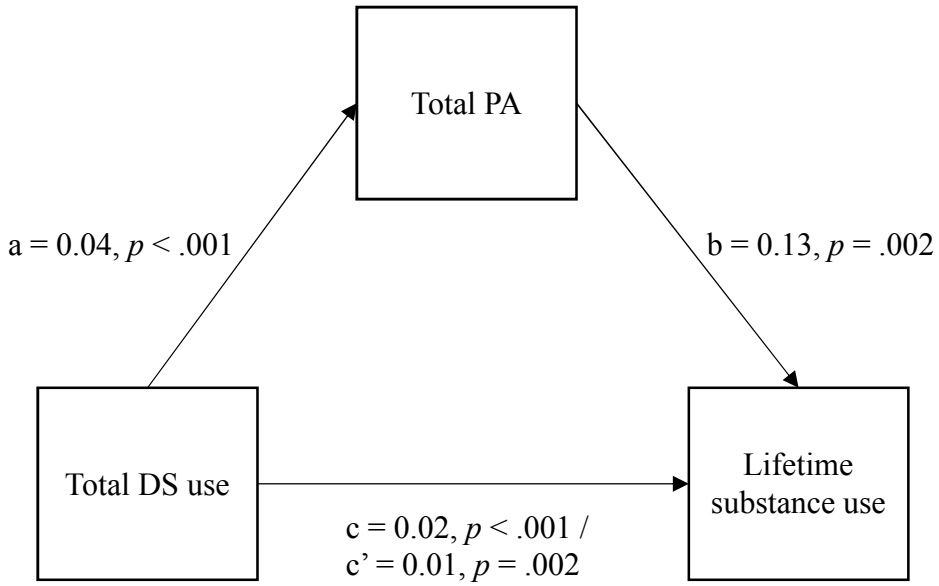
FIGURE 4



Distribution of CDRS scores by percentage for males and females

APPENDIX M

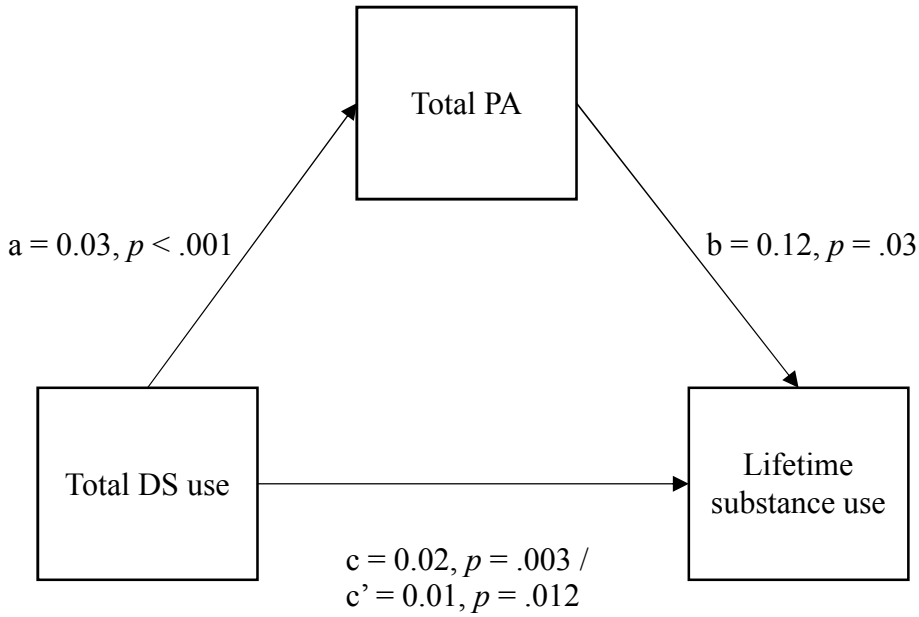
FIGURE 5



Physical activity mediating the relationship between DS use and lifetime substance use in both genders

APPENDIX N

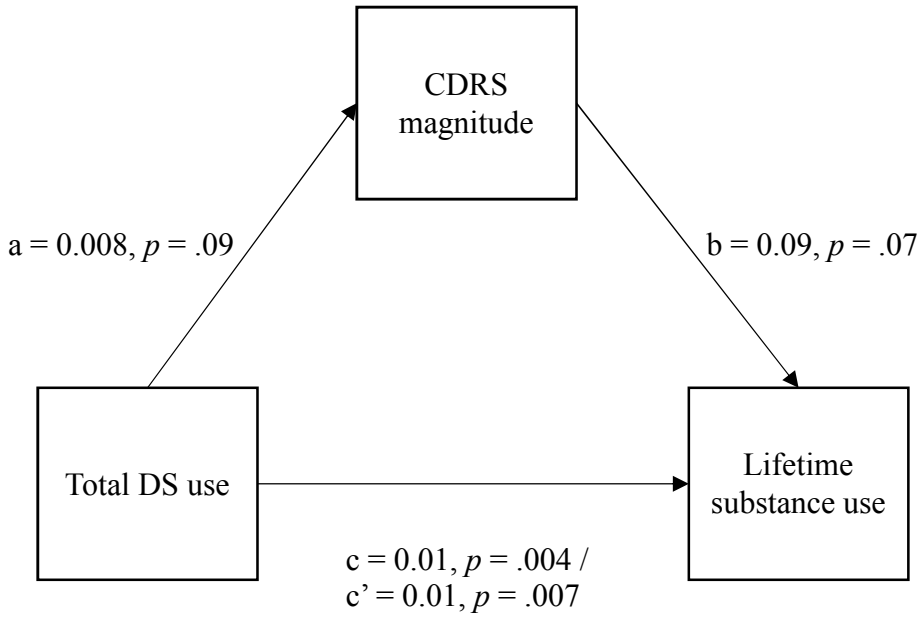
FIGURE 6



Physical activity mediating the relationship between DS use and lifetime substance use in males

APPENDIX O

FIGURE 7



CDRS magnitude mediating the relationship between DS use and lifetime substance use in females