Available online at www.sciencedirect.com

SCIENCE DIRECT®

Clinical Psychology Review 25 (2005) 215–239

CLINICAL PSYCHOLOGY REVIEW

Pursuit of the muscular ideal: Physical and psychological consequences and putative risk factors

Guy Cafri[a], J. Kevin Thompson[a,*], Lina Ricciardelli[b], Marita McCabe[b], Linda Smolak[c], Charles Yesalis[c]

[a]*Department of Psychology, University of South Florida, Tampa, FL 33620-8200, United States*
[b]*Deakin University, Melbourne, Australia*
[c]*Kenyon College, Pennsylvania State University, United States*

Received 25 November 2003; received in revised form 3 August 2004; accepted 20 September 2004

Abstract

Developing a lean muscular figure for the purposes of sports and/or appearance has become a central issue for males. Concern has been raised because the desire to develop such a body build may lead to the adoption of numerous health-threatening behaviors. Consequently, this review presents a comprehensive analysis of the physical and psychological consequences that result from the use of steroids (legal and illegal), ephedrine, and deleterious dieting strategies specific to males. Putative risk factors for these behaviors will be identified, and the clinical disorder associated with the extreme abuse of these behaviors, muscle dysmorphia, will be examined.

Keywords: Muscularity; Body image; Steroids; Risk factors; Eating disturbances

1. Introduction

Historically, the field of body image and eating disorders has been dominated by research that has focused on an examination of females (Thompson, Heinberg, Altabe, & Tantleff-Dunn, 1999). Although researchers have periodically focused on males (e.g., Andersen, 1990), it is only in the past 10 years that

* Corresponding author. Tel.: +1 813 9740367; fax: +1 813 9744617.
E-mail address: Thompson@cas.usf.edu (J.K. Thompson).

0272-7358/$ - see front matter © 2004 Elsevier Ltd. All rights reserved.
doi:10.1016/j.cpr.2004.09.003

a good deal of attention has been redirected at body image disturbance and related behavioral dysfunctions of boys and men (Cafri & Thompson, 2004). Importantly, research suggests that body change behaviors designed to enhance muscularity, whether for aesthetic or athletic reasons, have deleterious physical and psychological sequelae (Yesalis & Bahrke, 2002a). Additionally, emerging evidence indicates that certain biological and environmental variables may predispose some individuals to engage in these high-risk behaviors (e.g., McCabe & Ricciardelli, 2004a). In this review, we detail the physical and psychological consequences of three behaviors used by males to enhance muscularity: steroid use, ephedrine use, and dieting. Additionally, we address the harmful outcomes related to relatively novel behaviors, such as the use of prohormones. Furthermore, we discuss emerging work on the identification of putative risk factors and clinical dysfunction related to body-change behaviors. Throughout the review, we highlight methodological shortcomings and gaps in the literature that future research should address.

It is important to emphasize that the research and treatment of the behaviors described in this paper and their proposed risk factors fall appropriately within the domain of clinical psychology. The cognitive–behavioral nature of the pursuit of a muscular body suggests that clinical psychologists are effectively prepared to conduct research, assessment, and treatment in this area. Although it is quite apparent that psychologists are well qualified to treat the proposed clinical disorder arising from an extreme pursuit of muscularity, muscle dysmorphia (Pope, Gruber, Choi, Olivardia, & Phillips, 1997), they are also well trained to address other specific problems, such as abuse of muscle enhancing substances (Miller & Brown, 1997). The ultimate purpose of this paper is to better inform psychologists about the relatively novel phenomenon of the pursuit of muscularity.

2. Muscular enhancement strategies and their consequences

There are a variety of techniques used by men and boys to increase their muscularity. In this review, we discuss three of the most prevalent behaviors: steroid use, ephedrine use, and dieting. In the first section, we dichotomize steroid use into illicit steroids, commonly referred to as anabolic–androgenic steroids, and legal steroids that are less potent substances that are sold over-the-counter, often regarded as prohormones. The subsection on illicit anabolic–androgenic steroids presents a contemporary analysis of the most salient research findings related to physical and mental health effects. The subsection on the use of prohormones represents a novel addition to the literature, articulating the use of a group of steroids that are rarely discussed with reference to the pursuit of a muscular ideal. The section on ephedrine use presents a detailed account of physical and mental health effects related to this potent stimulant. Finally, we introduce several distinct types of dieting behaviors and outline their potential consequences. Research on these behaviors is lacking, and throughout the review, we propose potential directions for future research.

2.1. Steroid use

2.1.1. Illicit anabolic–androgenic steroids

Illicit anabolic–androgenic steroid (AAS) use is a serious problem in the U.S., with estimates of lifetime prevalence among males reaching approximately one million (Yesalis & Cowart, 1998; Yesalis, Kennedy, Kopstein, & Bahrke, 1993). AAS are the most notorious substances used by male athletes and

those lifting weights for aesthetic reasons, to increase muscular size and strength. The use of AAS in males is somewhat analogous to food restriction among eating disordered females, given that both represent the adoption of extreme behaviors to attain a particular body ideal. Given that estimates of AAS among adolescent males range from 3% to 12% (Buckley et al., 1988; Komoroski & Rickert, 1992; Middleman & DuRant, 1996; Middleman, Faulkner, Woods, Emans, & DuRant, 1995; Stilger & Yesalis, 1999; Yesalis, Barsukiewicz, Kopstein, & Bahrke, 1997) and that these drugs may be used to improve appearance, some have compared the rate of AAS use to that of bulimia nervosa in women (Spitzer, Hendersen, & Zivian, 1999). While making comparisons of base rates between AAS use and eating disorders is relevant in understanding the magnitude of AAS use as a clinical problem, it is important to note that steroid use may not be only related to body image problems, but also may be used in some cases primarily for the improvement of sports performance.

Although a detailed treatment of physiology related to AAS will not be presented because of the many texts that have already reviewed this subject extensively (e.g., Kochakian, 1976), we do discuss the effects of steroid consumption. One of the major physical effects of using AAS in sufficient doses is an increase in fat-free mass and strength (Alen, Hakkinen, & Komi, 1984; Hervy et al., 1981; Kulipers, Wijnen, Hartgens, & Willems, 1991), as well as a reduction in body fat (Kochakian, 1976). These bodily changes come with the danger of increasing risk for coronary artery disease. Low-density lipoproteins (LDL) and high-density lipoproteins (HDL) play important roles in the development of coronary artery disease because of their central functions in cholesterol transport. LDL is commonly regarded as unfavorable because it is implicated in cholesterol deposition, which encourages the hardening of the arteries. In contrast, HDL is regarded as beneficial because of its role in cholesterol removal, which prevents hardening of the arteries.

The effect of decreased HDL levels has been observed in studies utilizing the naturalistic observations of athletes and bodybuilders self-administering AAS (Costill, Pearson, & Fink, 1984; Hurley et al., 1984; Kantor, Bianchini, Bernier, Sady, & Thompson, 1985; Lenders et al., 1988; Pope & Katz, 1994; Strauss, Wright, & Finerman, 1982), as well as in experimental treatment studies (Kouri, Pope, & Oliva, 1996; Kulipers et al., 1991). Increased levels of LDL (Haupt, 1993; Hurley et al., 1984; Lenders et al., 1988) and elevated blood pressure (Lenders et al., 1988) have also been documented. It is noteworthy to mention that these effects have been observed almost exclusively among the orally administered AAS preparations (Friedl, 2000). It should further be noted that changes in HDL and LDL cholesterol levels observed in AAS users return to normal after the steroid is out of the body (Kulipers et al., 1991). However, since users go through a great number of long cycles when their HDL levels remain depressed, steroid use must be considered a serious health risk (Kouri et al., 1996).

Evidence from case studies lends support to the notion that AAS could play a role in the causal pathway of additional adverse health effects, including stroke, myocardial infarction, cardiomyopathy, and liver disease, although the frequency of occurrence of these outcomes is probably fairly low given the prevalence of AAS use (Friedl, 2000). While a number of other health concerns are often voiced, such as tendon ruptures and prostate cancer, little empirical evidence supports a causal connection with AAS use (Friedl, 2000; Haupt, 1993; Stannard & Bucknell, 1993). Other body changes resulting from AAS use occur as well, such as acne, gynecomastia (i.e., growth of subareolar, button-like plaque of tissue in males), and reduced final stature among adolescent users (Pope, Phillips, & Olivardia, 2000).

The psychological effects of AAS are also quite problematic. Both naturalistic and experimental studies using AAS have demonstrated significant mood changes, with clinically significant episodes experienced by some males. Notably, some authors have argued that naturalistic studies have been more

effective at demonstrating these outcomes because both dosage strength and frequency are higher (Pope & Katz, 1992), although a variety of other differences between naturalistic and experimental studies may explain the disparity in study outcomes. Naturalistic studies of AAS use have shown severe psychiatric effects, including most commonly psychotic and manic symptoms/episodes and depression (Pope & Katz, 1987, 1988, 1994). In extreme examples, evidence from case studies suggests that severe depression resulting from AAS withdrawal has led to suicide (Pope & Katz, 1990). An important limitation of naturalistic research is the lack of random assignment, which limits the ability to conclude that AAS cause these psychological problems. In research utilizing random assignment of participants to drug conditions, participants who are administered high doses show small significant increases in positive mood (euphoria, energy, sexual arousal), negative mood (irritability, mood swings, violent feelings, and hostility), or cognitive impairment (distractibility, forgetfulness, and confusion), with a few participants experiencing acute manic or hypomanic episodes (Pope, Kouri, & Hudson, 2000; Su et al., 1993; Yates, Perry, MacIndoe, Holman, & Ellingrod, 1999).

Aggression is a frequently self-reported outcome among self-administering AAS users. Naturalistic studies of AAS use have generally shown high levels of aggression (e.g., Strauss et al., 1982). In the extreme, case reports have indicated that aggression and hostility resulting from AAS are associated with near-homicidal and homicidal tendencies (Pope & Katz, 1990). A number of experimental studies failed to demonstrate a substantial connection between AAS use and aggression, but dosage level in most experimental cases is typically lower than those reported in naturalistic study (Bahrke, 2000). Consequently, further research is needed before the anecdotal data can be accepted as valid (Bahrke, 2000).

Dependence on AAS is also an outcome of concern. While there is no evidence of developing dependence with the legitimate therapeutic use of anabolic steroids, Brower (2002) reviewed 165 instances of anabolic steroid dependence among weightlifters and bodybuilders. For instance, one survey found that 57% of AAS users met the DSM-III-R criteria for dependence (Brower, Blow, Young, & Hill, 1991). Frequently, this dependence manifests itself by the individual's willingness to continue steroid use despite the presence of significant physical and psychiatric consequences. Clearly, future research is needed to discern the nature of these mechanisms before effective prevention and treatment programs are developed.

With respect to research on substances related to the pursuit of muscularity, there is a dearth of information on the effects that these have on the development of children and adolescents. This lacuna is especially worrisome in the domain of AAS research given their potent effects and potentially high levels of use among adolescents. These may lead to outcomes that are characteristic of adolescent substance abuse and dependence, such as impaired competence and psychosocial development, polydrug use, poor academic achievement and higher rates of academic failure, deviant peer group association, and delinquent behaviors (Chassin, Ritter, Trim, & King, 2003). Future research clearly needs to address the developmental effects related to the use of AAS.

2.1.2. Prohormones

Although prohormones have chemical structures that qualify them as steroid hormones, they are not illegal substances and in fact are sold in many nutrition stores as erogenic aides. The wide availability of these substances is very concerning, because as discussed below, these substances have certain harmful physical effects comparable to those of illegal steroids (i.e., AAS). The creation and use of prohormones by the general public is a relatively new phenomenon, with commercial availability beginning only

during the mid 1990's. The most commonly known and researched prohormone is androstenedione, but there are several other related substances that are available: 5-androstendione, 4-androstendiol, 5-androstendiol, 19-norandrost-4-enedione, 19-norandrost-5enediol, and 19-norandrost-4-enediol (Yesalis, 1999).[1] Moreover, it appears that new types of prohormones are regularly being created and sold with little or no regulation by the Food and Drug Administration or any other government agency. This lack of regulation has probably led at least some manufacturers of prohormones and other nutritional supplements to use ingredients in their products that are not designated on the labels. For instance, Delbeke, Van Eenoo, Thuyne, and Desmet (2003) recently found that one prohormone manufacturer was using other prohormones than those that were indicated, as well significant quantities of several illicit anabolic–androgenic steroids (e.g., boldenone). In the same study, it was also found that after testing two nutritional supplement products, one proclaiming to contain only a few amino acids (e.g., L-carnitine) and herbal extracts (e.g., guarana) and the other just pyruvate, both contained prohormones.

Information regarding the prevalence of prohormones is sparse, but the available data suggest use by a significant number of males. For instance, in a recent study of 269 adolescent males, the lifetime prevalence of prohormone use was found to be 4.5% (Cafri, Thompson, & Yesalis, 2004). In another study that targeted commercial health club attendees, the 3-year period prevalence of prohormones use among 334 males was found to be 18% (Kanayama, Gruber, Pope, Borowiecki, & Hudson, 2001). While these data need to be interpreted cautiously given the small sample sizes, they suggest that a concerning proportion of males are using these drugs.

Among prohormones, androstenedione has been researched most extensively, therefore this review will target this substance specifically. Androstenedione or "Andro," as it is more commonly known, is marketed as a product that can increase blood testosterone concentrations for the purposes of increased strength, lean mass, and sexual performance. Although a detailed review of the metabolism of androstenedione is beyond the scope of this article, a brief summary of the most salient physiological characteristics and effects will be provided. Androstenedione is an anabolic–androgenic steroid produced by the gonads (testes/ovaries), adrenal glands, or converted from dehydroepiandrosterone (DHEA) (Yen & Jaffe, 1978). While androstenedione readily converts to testosterone via the enzyme 17-dehydrogenase, it also converts to estrogens (i.e., estradiol and estrone) through the effects of the aromatase enzyme (Yen & Jaffe, 1978). Consequently, there are two types of end products that can result from androstenedione supplementation—testosterone and estrogens. Notably, both conversion processes are limited by enzyme availability, and enzyme availability is regulated by a natural feedback mechanism of the body to maintain homeostasis (Yesalis & Bahrke, 2002b). Therefore, there is a limit to how much additional testosterone can be produced from androstenedione supplementation, but modest increases can be expected (Yesalis & Bahrke, 2002b). Using total daily doses ranging from 72 mg to 300 mg of androstenedione or androstenediol for periods of 1 to 28 days, some studies have shown an increase in serum testosterone levels (Brown, Martini, Roberts, Vukovich, & King, 2002; Brown et al., 2001a, 2001b; Earnest, Olson, Broeder, Breuel, & Beckham, 2000; Leder et al., 2000, 2001; Uralets & Gillette, 1999), while other studies have not (Ballantyne, Phillips, MacDonald, Tarnopolsky, & Macdougall, 2000; Colker, Antonio, & Kalman, 2001; Rasmussen, Volpi, Gore, & Wolfe, 2000). Clearly, further

[1] Substances with the prefix of "andro" are prohormones or precursors of testosterone, whereas those with the prefix of "norandro" are precursors of nandrolone, another highly anabolic hormone (Uralets & Gillette, 1999). Notably, research indicates that precursors ending with the prefix of "diol" are more potent anabolic substances than those ending with "dione" (Uralets & Gillette, 1999).

research is necessary to examine the effects of higher daily dosages of androstenedione and androstenediol on testosterone levels.

Given that increased testosterone production is an outcome of androstenedione supplementation, similar adverse health effects that have been found from the use of AAS may be speculated to result from androstenedione. Along these lines, several studies have examined acute HDL levels after androstenedione administration and have found significant reductions (Brown et al., 2001a; Broeder et al., 2000; King et al., 1999). In addition, androstenedione supplementation may have adverse effects that are distinct from AAS use. For example, several studies have shown significant increases in blood estrogen levels (estrone and estradiol) in healthy males following androstenedione supplementation (Brown et al., 2001a, 2001b; Brown et al., 2002; King et al., 1999; Leder et al., 2000; Rasmussen et al., 2000). Elevated estrogen levels in males are associated with gynecomastia and other feminizing effects, as well as an increased risk of cardiovascular disease (Friedl, 2000). Androstenedione supplementation also results in increased levels of androstenedione (e.g., King et al., 1999), which constitutes a risk factor for prostate cancer (Barrett-Connor et al., 1990) and pancreatic cancer (Fernandez-del Castillo, Robles-Diaz, Diaz-Sanchez, & Altamirano, 1990).

While relatively little is known about the adverse physical health effects of androstenedione, virtually nothing is known about the psychological effects. For instance, it is known that the use of AAS leads to significant changes in mood and some cognitive impairment (e.g., Pope, Kouri et al., 2000). Would the same be true of prohormones if taken in sufficient quantities? This is an important area for future research. With respect to additional adverse physical health outcomes, it would be valuable to examine abnormal liver structure and function. Specifically, since the oral androstenedione-related decrease in HDL-C is likely the result of an increase in hepatic triglycerol lipase activity (as is the case among oral AAS), long-term use at high doses could adversely affect the liver (Friedl, 2000). Generally, there needs to be evaluation of the long-term effects of prolonged androstenedione supplementation. Finally, research needs to examine the physical and mental health effects of more potent preparations via higher daily dosages of androstenedione (500–1200 mg), other prohormones, and different methods of prohormone administration (sublingual sprays, gels, etc.) (Yesalis, 1999).

2.2. Ephedrine

Ephedrine is a substance that is quite distinct from steroids; it acts primarily as a stimulant of the sympathetic nervous system (Rawson & Clarkson, 2002). The actions of ephedrine are actually similar to amphetamines, to which it is actually chemically related (Karch, 2002). The appeal of ephedrine among people desiring to attain a muscular appearance is that fat loss results without a corresponding loss in muscle mass (Dullo, 1993). Clearly, the loss of fat is desirable for both men and women, which has led ephedrine to be used as an ingredient in many diet pill preparations, and thus used by millions of people. Notably, the adverse effects of ephedrine-containing products recently led the Food and Drug Administration and Health Canada to impose regulations that prohibit the sale of dietary supplements containing ephedrine alkaloids (FDA, 2004; Health Canada, 2002).

Ephedrine is an alkaloid that, in its herbal form, can be extracted from a species of the ephedra plant, referred to as *Ephedra sinicia* or by its Chinese name, Ma Huang. Herbal forms of ephedrine are typically combined with caffeine in many diet pill preparations (e.g., Xenadrine™) to maximize fat loss because the two substances act synergistically (e.g., Astrup, Buemann et al., 1992). While data on the prevalence of ephedrine use is sparse, the research that has been conducted suggests that a significant

number of males are using these drugs. For instance, in a recent study of 269 adolescent males, the lifetime prevalence of ephedrine use was found to be 6% (Cafri, Thompson, et al., 2004). In another study that targeted commercial health club attendees, the 3-year period prevalence of ephedrine use among 334 males was found to be 26% and among 177 females was found to be 13% (Kanayama et al., 2001). The results of these two studies suggest that a relatively large proportion of males and perhaps females are using these substances, which suggests a significant source of concern related to public health. However, the recent FDA action to ban the sale of products containing this substance will likely reduce the prevalence in the years to come.

Similar to the section on AAS, we do not evaluate the physiology of ephedrine supplementation because several comprehensive reviews already exist (e.g., Rawson & Clarkson, 2002) and instead focus on the effects of such substances. The acute effects of the ephedrine/caffeine combination on physiological functioning include increases in systolic blood pressure (Astrup, Toubro, Cannon, Hein, & Madsen, 1991; Astrup, Breum, Toubro, Hein, & Quaade, 1992; Astrup & Toubro, 1993; Liu, Toubro, Astrup, & Stock, 1995), heart rate (Astrup, Breum et al., 1992; Astrup & Toubro, 1993; Liu et al., 1995), and various other characteristics of excitatory central nervous system stimulation (Astrup, Breum et al., 1992; Breum, Pedersen, Ahlstrom, & Fimodt-Moller, 1994). However, there is evidence that after 8 weeks of continued use, some of these side effects subside (Astrup, Breum et al., 1992). The most often reported symptoms experienced by ephedrine users include physical and psychological problems such as headache, irritability, motor restlessness, nausea, sleeplessness, tachycardia, urinary disorders, vomiting, and dependence on the substance (PDR, 2000). Beyond these moderate adverse effects, ephedrine has also been associated through case study evidence with severe physical and psychological problems, including myocardial infarction, stroke, seizure, psychosis, and death (Rawson & Clarkson, 2002). Notably, the degree to which specific levels of ephedrine use are related to these outcomes is unknown, given the reliance on case study reports and the fact that the ephedrine content of herbal preparations (i.e., Ma Huang) may vary widely both between and within manufacturers (Rawson & Clarkson, 2002).

Information on the effects of ephedrine are lacking in notable areas. First, very little information is available on the psychological effects of ephedrine. While psychosis has been noted as a potential outcome, little is known of moderate changes in psychological functioning, as well as changes that may flow from the cessation of use (e.g., depression). More broadly, very little information is available on the physical or psychological effects produced as a result of the long-term use of ephedrine.

2.3. Eating to be more lean and muscular

Anorexia nervosa and bulimia nervosa are the two eating disorders that have historically received the greatest attention among researchers and clinicians (Thompson et al., 1999). Given that the focus in this review is on strategies to enhance muscularity, and anorexia and bulimia often result in a thin non-muscular body due to food restriction and purging behaviors, it is important to consider alternative eating behaviors that might be used to achieve a muscular body. There are two potentially harmful eating behaviors whose frequency of use have been well documented among males, dieting to lose weight and dieting to gain weight (e.g., Krowchuck, Kreiter, Woods, Sinal, & DuRant, 1998). More anecdotal work indicates that for some males, there may be a very systematic method of dieting, one that includes specific quantities and frequencies of macronutrient intake, cycling through different dieting phases, and extreme dieting practices that require restriction to a small group of foods based on their macronutrient composition (Gruber & Pope, 1998; McDonald, 1998; Pope et al., 1997). In the section that follows, we

detail the different dieting practices and speculate as to the possible physical and mental health implications.

While logically, it is feasible that the intent of weight gain practices is the addition of muscularity while the intent of weight loss is a reduction in body fat (McCreary & Sasse, 2002), no study has formally investigated the reasons for these dieting behaviors among males. Among adolescent and young adult males, dieting to increase weight and/or muscle size has been found to range from 21.2% to 47% (Krowchuck et al., 1998; Middleman, Vazquez, & DuRant, 1998; McCreary & Sasse, 2002; Neumark-Sztainer, Story, Falkner, Beuhring, & Resnick, 1999; Ricciardelli & McCabe, 2003), while 12.5% to 26% are dieting to decrease weight (Drewnowski, Kurth, & Krahn, 1995; Krowchuck et al., 1998; McCreary & Sasse, 2002; Neumark-Sztainer et al., 1999; Neumark-Sztainer & Hannan, 2000; Ross & Ivis, 1999; Serdula et al., 1993; Whitaker et al., 1989). Moreover, a recent study among Australian adolescents found that strategies to increase weight and muscularity were moderately correlated with strategies to lose weight, suggesting that these dieting behaviors may be used jointly (Ricciardelli & McCabe, 2002).

A variety of anecdotal sources, including qualitative data and "how to" books and magazines, provide accounts of specific eating behaviors that may be undertaken by males to achieve a more muscular physique. Bodybuilding magazines often contain articles about nutrition, which usually consist of content that addresses the need of bodybuilders to consume adequate amounts of protein (30 g or more, depending on body weight) several times a day (e.g., 5–6 times a day) (e.g., Alexander, 2004). Gruber and Pope (1998) describe such eating behaviors and associated psychological problems among bodybuilders they have observed, including behaviors like paying "...meticulous attention to diet; eating high-protein, low-fat meals 5–6 times per day; and clinically significant anxiety if they were not able to comply with their dietary regimen" (p. 259). In another type of systematic eating behavior described in many bodybuilding books and magazines (e.g., Weider & Reynolds, 1983), people alternate between two phases of food consumption with the aim of increasing muscularity while reducing body fat. In the first part, usually termed the anabolic phase, the aim is to put on muscle mass through a caloric intake that is above maintenance level. Of course, such a pattern of eating almost always results in gains of adipose tissue in addition to gains in muscle mass. To reduce the amount of adipose tissue, the person typically goes through a catabolic phase, in which the goal is to reduce body fat while retaining gains in lean muscle mass through eating a level of calories that is below maintenance levels.

At the extremes of bodybuilding, in particular for those who engage in competitions, it is often common to encounter intense dieting practices. We discuss one type of dieting that, based on anecdotal accounts, is fairly pervasive: cyclical ketogenic diets (CKD; Di Pasquale, 1995, 2000; Duchaine, 1996; McDonald, 1998). The claim of these diets is that they promote quicker fat loss than non-ketogenic diets with a maintenance or slight increase of muscle mass. There are a number of variations to the diet, but basically, it requires consuming only protein and fat for 5–7 days (this is identical to Atkins' (1992) Induction Diet, however, for a shorter duration), then eating a diet rich in carbohydrates, moderate protein, and limited fat for 1–4 days. The cycle repeats until the dieter is satisfied with the results. The physiological mechanisms underlying this diet are complex and lengthy and will not be reproduced here (see McDonald, 1998).

The potential physical and psychological health risks associated with the dieting practices described above are important to consider. With respect to dieting to increase weight or to increase muscle mass, a concern is excessive weight gain, which can lead to obesity, a significant risk factor for cardiovascular disease (McCreary & Sasse, 2002). Although weight lifting exercise is often used conjointly with dieting

to gain weight to increase muscle mass, which arguably improves the nature of the weight gain (i.e., the development of muscles rather than body fat), this is not necessarily the case. For instance, if a person eats significantly more than they expend on exercise, there can be gains in body fat and adverse effects on a person's blood–lipid profile. Also, if a person ceases their exercise regimen, but retains the behavior of eating excessively, similar adverse health effects would be expected.

Among males dieting to lose weight and cycling between diets of weight loss and regain, especially among bodybuilders, there is often concern regarding increased risk for anorexia nervosa and bulimia nervosa (Goldfield, Blouin, & Harper, 1998). Although there is some resemblance between eating behaviors adopted by bodybuilders and symptoms of anorexia and bulimia (e.g., cycling between weight gain and loss vs. binge–purge cycles in bulimia), the similarities are very superficial and the specific cognitions and behaviors underlying eating behaviors among weightlifters are usually different from those who suffer from eating disorders. Of more concern regarding dieting to lose weight is that such practices have been shown to prospectively predict weight gain and onset of obesity (Stice, Cameron, Killen, Hayward, & Taylor, 1999). Although the study conducted by Stice et al. (1999) was with females, similar outcomes may be conjectured for males. Finally, regarding the dangers of going through cycles of dieting to gain weight and dieting to lose weight, research with a variety of populations that experience rapid weight gain and loss (obese, wrestlers, etc.) suggest slowed metabolism, significant changes in renal functioning (electrolyte shifts and blood pH), and increases in blood pressure (Brownell, Steen, & Wilmore, 1987).

With respect to all the eating behaviors described above, especially those that require adherence to strict regimens, an important concern is the degree of investment in the dieting practice. Pope and colleagues describe males they have interviewed who often sacrifice their social and occupational functioning to comply with strict dietary regimens, such as not going out to dinner or on extended trips because the type and frequency of food cannot be controlled (Pope, Katz, & Hudson, 1993; Pope et al., 1997; Olivarida, 2001). The cyclical ketogenic diet described above is perhaps most concerning in this regard because there is a very narrow group of foods that a person is allowed to eat, necessitating substantial amounts of planning and attention to carry out the diet effectively. Additionally, due to the fact that CKDs are a type of ketogenic diet, they also raise concerns about unfavorable changes in serum lipid levels, fasting serum glucose and insulin levels, and increases in systolic blood pressure.[2]

There is a fundamental absence of knowledge about dieting behaviors used in the pursuit of a muscular ideal, consisting both of a lack of information regarding the nature and prevalence of dieting practices, as well as their adverse effects. Despite the limits of our knowledge about the effects of drug and diet use by males, there is sufficient evidence to warrant concern about negative physical and psychological outcomes.

2.4. Summary

Although we presented a thorough discussion of several potentially harmful behaviors used in the pursuit of muscularity, most of which related to substance use, it is critically important to acknowledge that it is unknown how long particular drugs will continue to be used in the future. Specifically, there are

[2] Although a recent meta-analysis of ketogenic diets did not find support for these adverse effects among standard ketogenic diets (Bravata et al., 2003), they cannot be discounted because CKDs have a cyclical component that makes them distinct from standard ketogenic diets.

a variety of legal, social, and technological changes in society that heavily influence the types of drugs that are used during any given time period. For instance, the Dietary Supplement Health and Education Act passed by Congress in 1994 facilitated marketing of supplements containing prohormones and ephedrine, which made them more widely available. A similar effect in a different context was the disclosure in 1998 by baseball superstar Mark McGwire that he used androstenedione, which probably led a greater number of people, particularly adolescents aspiring to become athletes, to use such substances. In contrast, the recent ban placed on the sale of dietary supplements containing ephedrine alkaloids by the Food and Drug Administration and Health Canada will likely reduce the use of ephedrine-containing products (FDA, 2004; Health Canada, 2002). We can only speculate what will be the next "hot" drug. For instance, now that there is less availability of ephedrine, individuals may seek out substitutes like illicit beta-receptor agonists (e.g., clenbuterol), which have similar but more potent positive effects (i.e., muscle anabolism and body fat catabolism) and negative effects (nausea, headaches, insomnia, muscle tremor, etc.) (Lynch, 2002). If the high cost of recombinant human growth hormone is reduced, will more people start to use such products in spite of harmful health consequences (e.g., acromegaly; Kraemer, Nindl, & Rubin, 2002)? Even illicit anabolic-androgenic steroids, which have enjoyed roughly five decades of use (Yesalis, Courson, & Wright, 2000), may eventually become obsolete in the face of new technologies to enhance muscle size, such as gene transfer therapy (Wadler, 2002). We recommend that given the transient nature of the types of substances that are used in the pursuit of a muscular ideal, as well as dieting practices, it is important for researchers and clinicians to remain up to date on new developments.

3. Putative risk factors

3.1. Methodological considerations

In this section, we review putative risk factors of some of the behaviors reviewed in the previous section. In order to better orient the reader, we have developed a model (Fig. 1) that diagrams the relations among variables examined in this section along with other variables thought to contribute to dysfunctional body change behaviors in boys and men. Although the model is somewhat empirically based, given that it is consistent with the findings of studies reviewed below and is derived from the Tripartite Influence Model of body image and eating disturbances developed with females (e.g., van den Berg, Thompson, Brandon, & Coovert, 2002), its purpose is to serve as a heuristic tool with respect to the research reviewed in this section. Prior to discussing the correlates of muscle-enhancing behaviors, it is important to discuss some of the methodological limitations that will put in perspective the review of research findings that follow.

The studies examining risk factors are marked by several methodological shortcomings that should be considered before the literature is reviewed. First, some studies combine several behaviors into one construct or index, precluding the possibility of drawing discrete predictive inferences. For instance, while the drive for muscularity behaviors subscale is a well constructed index of behaviors used to approximate a muscular ideal (McCreary, Sasse, Saucier, & Dorsch, 2004), it does not contain distinct subscales addressing particular behaviors, such as substance use, exercise frequency, and dieting behaviors. Second, the majority of the studies utilize cross-sectional designs (e.g., Cafri, Strauss, & Thompson, 2002; Ricciardelli & McCabe, 2001a, 2001b), which restricts the ability to draw conclusions

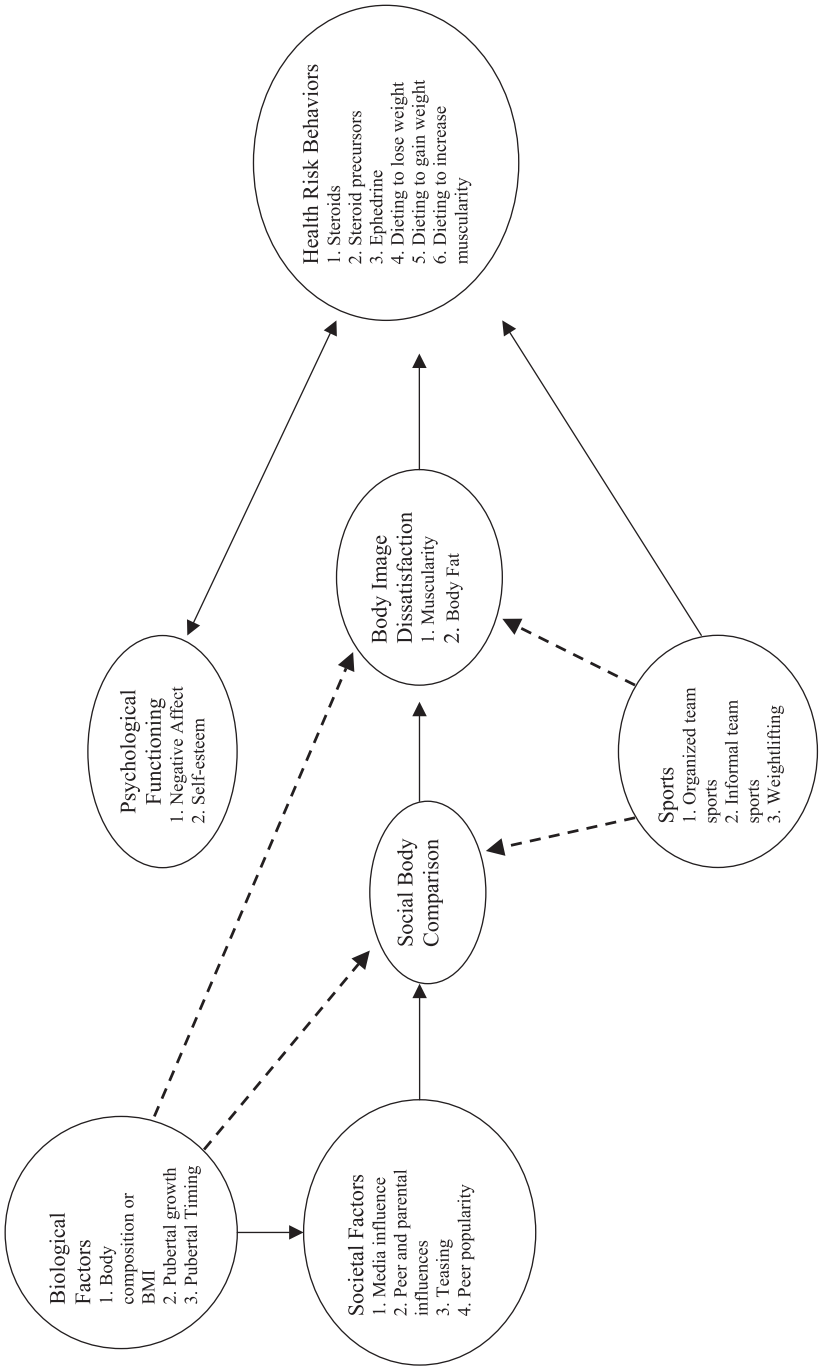

Fig. 1. A model of potential relations among factors that lead to body change strategies in males. The model is meant as a heuristic, with the present directional and mediation influences based on the somewhat limited work in the area. Solid lines reflect hypothesized relations with stronger support than the arrows that are broken.

about which factors constitute true risk factors (Kraemer et al., 1997). Third, many of the studies utilize adolescent samples; research is lacking with older groups of males. Fourth, as will become apparent from the literature reviewed in this section, a disproportionate number of studies focus on the assessment of weight or body fat loss strategies rather than weight or muscle gain strategies. Finally, many studies pertaining to body image and eating disturbance utilize measures that are inconsistent with how the constructs are interpreted and construed in this paper. Below, we briefly outline specific measurement issues related to assessment of body image and eating disturbance.

Body image is a construct that is frequently mismeasured among males, which recently led to the proposal of a set of guidelines to better direct measurement in this area (Cafri & Thompson, 2004). These guidelines included the following recommendations: evaluate a muscular appearance, assess relevant behaviors (e.g., muscle checking) if the scale is a cognitive–behavioral measure of body image, and include sites on the upper torso if the scale is site-specific (Cafri & Thompson, 2004). The measures of male body image included by Cafri and Thompson (2004) to be most consistent with these guidelines were the drive for muscularity scale (McCreary & Sasse, 2000),[3] the somatomorphic matrix (Gruber, Pope, Borowiecki, & Cohane, 1999), and a modification of the somatomorphic matrix proposed in the paper. Notably, several other measures would also be consistent with the aforementioned guidelines as well, including the muscle satisfaction subscale of the muscle appearance satisfaction scale (Mayville, Williamson, White, Netemeyer, & Drab, 2002), the Swansea muscularity attitudes questionnaire (Edwards & Launder, 2000), the drive for muscularity attitudes questionnaire (Morrison, Morrison, Hopkins, & Rowan, 2004), and the bodybuilder image grid scaled (Hildebrandt, Langenbucher, & Schlundt, 2004).

With respect to measuring dieting behaviors, the most notable problem has been the inclusion of criteria that include anorexic and bulimic symptoms when these indicators are probably not as relevant for men who desire a muscular ideal. In fact, if one compares the earlier description of eating patterns to gain muscularity with those descriptive of males who suffer from anorexia nervosa and bulimia nervosa (e.g., Andersen, 1990), the behaviors seem quite disparate. Two recent measures have also has been devised that specifically assess dieting behaviors geared to the attainment of a muscular body (McCabe & Vincent, 2002; Ricciardelli & McCabe, 2002).

3.2. Biological factors

Although body mass or its index, BMI, is known to be a risk factor for body dissatisfaction and dieting behaviors (Stice, 2002), a similar relationship between BMI and cognitions/behaviors related to the pursuit of muscularity has not been determined. While some research cited below suggests a significant role of body mass as a predictor of muscularity-related behaviors, small effects combined with contradictory findings and an overall lack of research in this area reduce confidence in those conclusions. BMI is thought to be related to the pursuit of muscularity because a low body mass would suggest small size and, thus, a desire to get bigger and more muscular, while a high BMI might suggest a person who is excessively obese and thus looking to reduce body fat. An alternative index would be one that is based on a person's percent body fat and fat-free mass, which can be obtained through the use of such methods as skin calipers or hydrostatic weighing. However, these methods can be time consuming,

[3] Importantly, the drive for muscularity body image subscale, rather than the drive for muscularity total scale would be most effective as a body image measure because it is not confounded with behaviors related to the pursuit of muscularity (McCreary et al., 2004).

costly, and require a significant degree of expertise to administer (Mcardle, Katch, & Katch, 1996). Therefore, although BMI is probably not the most appropriate method of assessing body type, it is an index that is easily obtainable and, thus, is likely to be used in future research applications. Below, we outline studies examining the relationship between BMI and body-change strategies.

Among adolescent males, several cross-sectional studies have found a higher BMI to be weakly associated with dieting and other weight loss behaviors (e.g., McCabe & Ricciardelli, 2003a; Neumark-Sztainer et al., 1999; Neumark-Sztainer & Hannan, 2000; Vincent & McCabe, 2000), and this relationship has also been confirmed by prospective research (Gardner, Stark, Friedman, & Jackson, 2000). In addition, lower BMI has been shown to be associated with steroid use, over-eating, and use of food supplements (e.g., Bahrke, 2000; Neumark-Sztainer et al., 1999). However, contradictory findings indicate that lower BMI may not be associated with body change strategies used for gaining weight and/or enhancing muscularity, either cross-sectionally (McCabe & Ricciardelli, 2001a) or longitudinally (Ricciardelli & McCabe, 2003).

Pubertal timing is also an important biological factor to consider because puberty generally signifies the start of bodily development that is marked by significant muscular growth. While one study found that boys who reported that they had reached puberty were significantly more likely than pre-pubertal boys to be trying to lose weight (O'Dea & Abraham, 1999), other studies have found no association between pubertal growth and strategies to lose weight or binge eat, either cross-sectionally (Leon, Fulkerson, Perry, & Early-Zald, 1995; McCabe & Ricciardelli, 2001b) or longitudinally (Ricciardelli & McCabe, 2003). With respect to behaviors related to the pursuit of muscularity, one study found that adolescent boys who reported that they had reached puberty were significantly more likely than pre-pubertal boys to be trying to build up their body (O'Dea & Abraham, 1999). In a recent 8-month longitudinal study, McCabe and Ricciardelli (2004b) found that both early maturing and late maturing boys engaged in body change strategies associated with the pursuit of muscularity. In another study, pubertal growth was found to be weakly associated with the use of food supplements and strategies to increase muscles when the variables were assessed cross-sectionally (McCabe & Ricciardelli, 2001b). However, there was no support for these relationships when the same variables were examined longitudinally (Ricciardelli & McCabe, 2003). Thus, it appears that pubertal timing is more important than pubertal growth per se.

3.3. Sociocultural influences

Sociocultural factors constitute a potentially important group of risk factors for the adoption of body change behaviors. Among females, research suggests that media influences are associated with body image dissatisfaction and associated eating pathology (Cafri, Yamamiya, Brannick, & Thompson, 2004; Stice, 2002; Groesz, Levine, & Murnen, 2002; Thompson et al., 1999). It is reasonable to assume that if these sociocultural influences are predictive of the drive for thinness in females, similar influences may play a role in the drive for muscularity among males. For these reasons, messages of body ideals transmitted to boys by their parents, peers, and the media have been frequently evaluated.

3.3.1. Risk factors for muscle-building strategies

Two cross-sectional studies have shown that perceived pressure to increase muscles from parents, peers, and media are associated with weight and muscle gain strategies in adolescent males (McCabe & Ricciardelli, 2003a; Ricciardelli & McCabe, 2001a). These relationships have also been verified in a

recent longitudinal study, which showed that perceived messages from parent and peers predicted strategies to increase weight and muscles in adolescent males over an 8-month period (McCabe & Ricciardelli, 2003b; Ricciardelli & McCabe, 2003). Additional findings from one of the cross-sectional studies showed that the impact of sociocultural messages was moderated by self-esteem and negative affect for adolescent males (Ricciardelli & McCabe, 2001a). More specifically, the results indicated that only males with lower self-esteem and higher negative affect who also perceived more pressure from fathers, female friends, and the media to gain muscles were more likely to engage in body change strategies to increase muscles (Ricciardelli & McCabe, 2001a).

Several authors have suggested that greater peer acceptance and popularity with both same-gender and opposite-gender peers may be achieved by attaining a more muscular body that demonstrates physical strength and athletic success (Eppright Sanfacon, Beck, & Bradley, 1997; Holland & Andre, 1994). One study found that steroid use was more common among adolescent males with low to average peer relations, although the effect size was weak (Kindlundh, Hagekull, Isacon, & Nyberg, 2001). Similarly, another study found that popularity with both same-gender and opposite-gender peers was weakly related to increased efforts to improve muscle size among adolescent males (McCabe, Ricciardelli, & Finemore, 2002).

3.3.2. Risk factors for weight loss strategies

Sociocultural factors are also related to weight loss strategies among adolescent males (e.g., Field et al., 2001; McCabe & Ricciardelli, 2003b; Vincent & McCabe, 2000). Cross-sectional studies have shown that parents and peers exert their influence via modeling and by directly encouraging body change strategies in both adolescent males and females (Ricciardelli & McCabe, 2001a, 2001b; McCabe & Ricciardelli, 2003a; Vincent & McCabe, 2000). For example, Vincent and McCabe (2000) found that dieting, other more extreme weight loss behaviors such as the use of laxatives and diuretics, and binge eating were weakly predicted by both perceived parental and peer encouragement to lose weight.

Two recent longitudinal studies have further shown that parents and peers play an important role in shaping weight loss strategies for adolescent males. One of these studies demonstrated that weight loss strategies in adolescent boys over an 8-month period were weakly predicted by both perceived parental and peer pressure to lose weight (McCabe & Ricciardelli, 2003b). The other study found that males who reported that it was important for their fathers that they not be fat were more likely to become constant dieters over a 1-year period (Field et al., 2001). Only one study was identified that examined actual messages from mothers and fathers and their influence on adolescent males. Wertheim, Martin, Prior, Sanson, and Smart (2002) found that mothers were more influential than fathers in encouraging dieting in both daughters and sons.

Studies have also examined the perceived role of the media on adolescent males' weight loss strategies (Field et al., 2001; Ricciardelli & McCabe, 2001a). In one cross-sectional survey, perceived media pressure to lose weight was found to be weakly associated with weight loss strategies in adolescent males (Ricciardelli & McCabe, 2001a). These findings have also been supported by two longitudinal studies. Field et al. (2001) reported that a strong motivation to look like same-sex figures in the media was contributed to preoccupation with feeling fat and wanting to be thinner. Similarly, Wichstrom (2000) found that adolescent males who strongly identified with media idols who had "perfect bodies" were more likely to develop disordered eating behaviors over a 12-month period as assessed by the EAT (Wichstrom, 2000).

3.4. Psychological variables and other individual factors

Self-esteem is likely a major determinant of body dissatisfaction, muscle-enhancement strategies, and eating problems among adolescent males. For instance, a large effect was found for the association between concurrent muscle dissatisfaction and poor self-esteem (Cafri et al., 2002), and a moderate effect size was found for the relation between a general index of cognitions and behaviors related to the pursuit of muscularity and poor self-esteem (McCreary & Sasse, 2000). Higher levels of steroid use have also been found to be more common among adolescent males with lower levels of self-esteem (Irving, Wall, Neumark-Sztainer, & Story, 2002; Kindlundh et al., 2001). Research has further demonstrated that self-esteem and peer group pressure interact, such that males with lower levels of self esteem are more likely to be influenced by peer group pressure to alter their bodies (Ricciardelli & McCabe, 2001a). Weak to moderate associations have been found between low self-esteem and concerns about eating (Mueller et al., 1995), binge eating (Ross & Ivis, 1999; Tomori & Rus-Makovec, 2000), dieting and the binge–purge cycle (French et al., 2001; Neumark-Sztainer & Hannan, 2000), and total scores on the EDI (Furnham & Calman, 1998; Keel, Kulkerson, Leon, & Fulkerson, 1998).

Research has indicated that negative affect is associated with strategies to increase muscles among adolescent boys (McCabe & Ricciardelli, 2003a), as well as a significant cross-sectional association between muscle dissatisfaction and symptoms of depression (Cafri et al., 2002). Negative affect also appears to interact with peer pressure, so that males with high levels of negative affect who are most susceptible to peer pressure (e.g., those who are least popular) are more likely to adopt health risk behaviors designed to increase their muscles (Ricciardelli & McCabe, 2001a). Moreover, a consistent cross-sectional relationship between negative affect and disordered eating has been demonstrated in adolescent males (Keel et al., 1998; Lock, Reisel, & Steiner, 2001; Neumark-Sztainer & Hannan, 2000; Neumark-Sztainer & Hannan, 2000; McCabe & Ricciardelli, 2003a; Mueller et al., 1995; Ricciardelli & McCabe, 2001b; Ross & Ivis, 1999; Tomori & Rus-Makovec, 2000), with weak to moderate effect sizes. Several studies have also found evidence linking negative affect to body dissatisfaction and binge eating among males (e.g., Leon, Fulkerson, Perry, Keel, & Klump, 1999; McCabe & Vincent, 2003).

Preliminary research indicates that poor body image is a very salient factor for boys and men, a finding that is consistent across a number of different cultures, including American (Cafri et al., 2002; Gruber et al., 1999; Pope et al., 2000), Canadian (McCreary & Sasse, 2000), Samoan (Lipinski & Pope, 2002), French, and Austrian (Pope et al., 2000). Most males desire between 15 and 27 lbs of additional muscle mass (Gruber et al., 1999; Pope et al., 2000). Moreover, muscle dissatisfaction has been significantly associated with higher levels of depression, lower self-esteem, and dissatisfaction with life (Cafri et al., 2002; McCreary & Sasse, 2000). Two recent experimental studies also indicate that media exposure may be a source from which this muscle dissatisfaction originates (Agilita & Tantleff-Dunn, 2004; Leit, Gray, & Pope, 2002).

Research also suggests that muscle-related body image disturbance may be a risk factor for the health risk behaviors previously described, with most of the research assessing AAS use specifically. In a study by Brower, Blow, and Hill (1994), three groups were assessed: low-risk AAS use, high-risk AAS use, and actual (current) AAS users. Seventy-five percent of the high-risk group felt “not big enough”, compared to 21% of the low-risk group and 38% of actual steroid users. This suggests that muscle size dissatisfaction may be a factor in the decision to start using AAS, but that satisfaction may improve among users. The results of other studies have supported the suggestion that steroid use improves body image (Komoroski & Rickert, 1992; Wichstrom & Pedersen, 2001). Furthermore, one study found that

body image dissatisfaction was among the most frequently reported symptoms of withdrawal experienced by steroid users (Brower et al., 1991).

In general, a weak to moderate relationship between body dissatisfaction and disordered eating has also been demonstrated in adolescent males (e.g., Keel, Fulkerson, & Leon, 1997; Keel et al., 1998; McCabe & Ricciardelli, 2003a; Ricciardelli & McCabe, 2001b; Richards, Casper, & Larson, 1990; Wertheim et al., 1992). McCreary and Sasse (2002) found that high school males dieting to gain weight had a higher drive for muscularity than males dieting to lose weight and those who had never dieted before.

Overall, little research has examined the relationship between eating behaviors and a muscular body image. Notably, no study has examined the role of muscle-related body image in the use of prohormones or ephedrine. Perhaps, muscle dysmorphia is the most extreme form of body dissatisfaction concerning muscle mass (Pope et al., 1997). Muscle dysmorphia also exemplifies the association between body dissatisfaction and the use of dangerous muscle building techniques; this area is discussed in detail later in the paper.

Sport and athletic activities can also play an important role in promoting physical, mental, and social development during childhood and adolescence, particularly for males (Cooper, 1969; Eppright et al., 1997; Weiss & Duncan, 1992; Weiss, Smith, & Theeboom, 1996). For adolescent males, participation in any kind of sport has been shown to be related to higher self-esteem (Holland & Andre, 1994), and adolescent males more than females perceive that the function of sport participation is to increase their social status and peer popularity (White, Duda, & Keller, 1998). There is ample evidence that males who participate in competitive sport enjoy a greater social status than do their non-participating peers (Seefeldt, Gilliam, Blievernicht, & Bruce, 1978). For example, Evans and Roberts (1987) found that athletically skilled males were more likely to attain a higher peer status, played more central positions in the game, and had more opportunities to develop and strengthen friendships. Other researchers have also noted that athletic ability is a characteristic that often distinguishes popular males from unpopular ones (e.g., Adler & Adler, 1998; Hymel, Bowker, & Woody, 1993). Consistent with the view that sporting involvement can promote positive self-esteem and peer popularity, Ferron, Narring, Cauderay, and Michaud (1999) showed that both adolescent males and females who participated frequently in sport activities had a more positive body image and were more satisfied with both physical appearance and their weight. Similarly, Richards et al. (1990) found that involvement in athletic activities was associated with better body image among adolescent males. Clearly, this line of evidence suggests that sports may serve a beneficial role in adolescent male social development and may in fact be a protective factor against body image disturbance and health-risking body-change behaviors.

In contrast, there is also evidence that supports the view that sports foster drug and dieting abuse toward the aim of improving athletic performance. Steroid use has received the most attention in this regard. Many studies have examined the association between sport and steroid use among adolescents (e.g., Bahrke, 2000; Drewnowski et al., 1995; Irving et al., 2002; Stilger & Yesalis, 1999; Wichstrom & Pedersen, 2001). Past studies and reviews show high levels of steroid use among top athletes, sub-elite athletes, and among college and high school athletes who participate in a wide range of sports, including football, basketball, swimming, track and field, weightlifting, wrestling, bodybuilding, self-defense, and martial arts (e.g., Bahrke, 2000; Blouin & Goldfield, 1995; Brower et al., 1994; Drewnowski et al., 1995; Stilger & Yesalis, 1999; Wichstrom & Pedersen, 2001). When different kinds of sports have been compared, the use of steroids is most often associated with involvement in power sports, such as

football, wrestling (Buckley et al., 1988), field events, weightlifting (Wichstrom & Pedersen, 2001), and bodybuilding (Blouin & Goldfield, 1995).

Other studies that have focused on athletes who have high levels of sporting involvement have found that the athletic environment heightens males' risk of developing eating disorders and disordered eating (Hausenblas & Carron, 1999; Mickalide, 1990; Striegel-Moore, Silberstein, & Rodin, 1986). Moreover, levels of disordered eating have been found to be particularly high among adolescent male runners (Parks & Read, 1997) and adolescent male wrestlers (Kiningham & Gorenflo, 2001; Oppliger, Landry, Foster, & Lambrecht, 1993). Similarly, Fogelholm and Hiilloskorpi (1999) found that the highest prevalence of extreme weight reduction attempts (e.g., forced sweating and restricted fluid intake or use of diuretics and laxatives or vomiting) was among adolescent and adult males who participated in sports that required weight restrictions (e.g., wrestling, taekwondo, judo, karate, and boxing).

4. Muscle dysmorphia

The clinical disorder that may result from the use of body-change behaviors aimed at improving the appearance of muscularity is muscle dysmorphia (MD), a proposed subtype of body dysmorphic disorder (Pope et al., 1997). According to Pope et al. (1997), sufferers of MD experience a kind of body dysmorphic disorder whereby they become "...pathologically preoccupied with their degree of muscularity, which may cause them to suffer severe subjective distress, impaired social and occupational functioning, and abuse of steroids and other substances" (p. 548). In addition to drug use, behaviors that are typically manifested include lifting weights, eating large amounts of food, and special diets (Pope et al., 1997). The strict regimen followed by people with MD in their lifting weights and dieting, as well as the time commitment that it requires, frequently leads to the forgoing of occupational opportunities and relationships with others (Pope et al., 1997).

It is pertinent to emphasize that case-study evidence indicates the necessary role of body image disturbance among those suffering from MD (Pope, Plillips et al., 2000). Not only does body image have a central role in the decision to adopt unhealthy behaviors aimed at developing a more muscular appearance, but this disturbance also leads to the adoption of behaviors aimed at concealing one's body from others (Pope, Plillips et al., 2000). Some examples of these behaviors are avoiding the beach and locker rooms, camouflaging one's body with clothes, wearing extra layers of clothing to enhance an appearance of size, and forgoing romantic relationships (Pope et al., 1997). Other behaviors that reflect body image disturbance in MD sufferers include persistent mirror checking, constant comparison with others, and reassurance-seeking behavior (Pope et al., 1997).

Recent research has provided support for the behavioral symptoms observed among sufferers of MD. In a case-control comparison study of weight lifting males, 24 with MD and 30 without, those with muscle dysmorphia reported significantly greater body image dissatisfaction, spent more time per day thinking about their muscularity, more frequently sacrificed social opportunities to workout, more often concealed their appearance and checked mirrors, and more often used steroids (Choi, Pope, & Olivardia, 2002; Olivardia, Pope, & Hudson, 2000). Additionally, the men with muscle dysmorphia had higher rates of current and past mood disorders, anxiety disorders, and eating disorders than did males without muscle dysmorphia (Olivardia et al., 2000).

Finally, it is notable to mention that estimates of MD based on case study evidence suggest that between 5% and 10% of weightlifters and 9% of men with body dysmorphic disorder have the disorder

(Olivarida, 2001). However, large-scale epidemiological studies more clearly establishing the prevalence of body dysmorphic disorders and MD have yet to be carried out (Cororve & Gleaves, 2001).

5. Conclusions

Body change behaviors geared toward the pursuit of a muscular ideal have received increased attention in recent years, due largely to the increasing prevalence of pathology at the clinical and subclinical levels. In an attempt to characterize certain pathological behaviors, we review the implications of the use of steroids, ephedrine, and certain eating behaviors. It was concluded that these three types of behaviors represent a significant risk to psychological and physical health. It was also shown that a wide range of biological, social, and psychological variables may place a person at risk for developing these behaviors, with a need for future studies to utilize more precise measures of behavioral outcomes, longitudinal designs, older groups of males, a greater focus on weight or muscle gain dieting behaviors, and more theoretically relevant measurement of body image and eating disturbance constructs. Finally, we noted how an excessive drive for muscularity may lead to the clinical disorder of muscle dysmorphia. Clearly, a great deal of research is still needed to determine the extent to which these behaviors are used, their health effects, and the role of risk factors in their development. Once more information is amassed, intervention and prevention strategies should be developed, with the intent of preventing the use of dysfunctional body change behaviors in the pursuit of the muscular ideal.

References

Adler, P. A., & Adler, P. (1998). *Peer power: Preadolescent culture and identity*. New Brunswick, NJ: Rutgers University Press.

Agilita, D., & Tantleff-Dunn, S. (2004). The impact of media exposure on males' body image. *Journal of Social and Clinical Psychology*, *23*, 7–22.

Alen, M., Hakkinen, K., & Komi, P. V. (1984). Changes in neuromuscular performance and muscle fiber characteristics of elite power athletes self-administering androgenic and anabolic steroids. *Acta Physiologica Scandinavica*, *122*, 535–544.

Alexander, D. (2004, February). Bulk up. *Muscle & Fitness*, 76–80.

Andersen, A. E. (1990). Diagnosis and treatment of males with eating disorders. In A. E. Andersen (Ed.), *Males with eating disorders* (pp. 133–162). New York: Brunner/Mazel.

Astrup, A., Breum, L., Toubro, S., Hein, P., & Quaade, F. (1992). The effect and safety of an ephedrine/caffeine compound compared to ephedrine, caffeine and placebo in obese subjects on an energy restricted diet. A double blind trial. *International Journal of Obesity Metabolism Related Disorders*, *16*, 269–277.

Astrup, A., Buemann, B., Christensen, N. J., Toubro, S., Thorbek, G., Victor, O. J., et al. (1992). The effect of ephedrine/caffeine mixture on energy expenditure and body composition in obese women. *Metabolism*, *41*, 686–688.

Astrup, A., & Toubro, S. (1993). Thermogenic, metabolic, and cardiovascular responses to ephedrine and caffeine in man. *International Journal of Obesity Metabolism Related Disorders*, *17*, 41–43.

Astrup, A., Toubro, S., Cannon, S., Hein, P., & Madsen, J. (1991). Thermogenic synergism between ephedrine and caffeine in healthy volunteers: a double-blind, placebo-controlled study. *Metabolism*, *40*, 323–329.

Atkins, R. C. (1992). *Dr. Atkins' new diet revolution*. New York, NY: Avon Books.

Bahrke, M. S. (2000). Physiology effects of endogeneous testosterone and anabolic–androgenic steroids. In C. E. Yesalis (Ed.), *Anabolic steroids in sports and exercise* (pp. 161–178). United States: Human Kinetics.

Ballantyne, C. S., Phillips, S. M., MacDonald, J. R., Tarnopolsky, M. A., & Macdougall, J. D. (2000). The acute effects of androstenedione supplementation in healthy young males. *Cancer Journal of Applied Physiology*, *25*(1), 68–78.

Barrett-Connor, E., Garland, C., McPhillips, J. B., Knaw, K. T., & Wingard, D. L. (1990). A prospective population-based study of androstenedione, estrogens, and prostatic cancer. *Cancer Research*, *50*, 169–173.

Blouin, A. G., & Goldfield, G. S. (1995). Body image and steroid use in male bodybuilders. *International Journal of Eating Disorders*, *18*, 159–165.

Bravata, D. M., Sanders, L., Huang, J., Krumholz, H. M., Olkin, I., Gardner, C. D., et al. (2003). Efficacy and safety of low carbohydrate diets. *Journal of the American Medical Association*, *289*, 1837–1850.

Breum, L., Pedersen, J. K., Ahlstrom, F., & Frimodt-Moller, J. (1994). Comparison of an ephedrine/caffeine combination and dexfenfluramine in the treatment of obesity. A double-blind multi-center trial in general practice. *International Journal of Obesity Metabolism Related Disorders*, *18*, 99–103.

Broeder, C. E., Quindry, J., Brittingham, K., Panton, L., Thompson, J., & Appakondu, S. (2000). The Andro Project: Physiological and hormonal influences of androstenedione supplementation in men 35 to 65 years old participating in a high-intensity resistance training program. *Archives of Internal Medicine*, *160*, 3093–3104.

Brower, K. (2002). Anabolic steroid use and dependence. *Current Psychiatry Reports*, *4*, 377–387.

Brower, K. J., Blow, F. C., & Hill, E. M. (1994). Risk factors for anabolic–androgenic steroid use in men. *Journal of Psychiatric Research*, *18*, 159–165.

Brower, K. J., Blow, F. C., Young, J. P., & Hill, E. M. (1991). Symptoms and correlates of anabolic–androgenic steroid dependence. *British Journal of Addiction*, *86*, 759–768.

Brown, G. A., Martini, E. R., Roberts, B. S., Vukovich, M. D., & King, D. S. (2002). Acute hormonal response to sublingual androstenediol intake in young men. *Journal of Applied Physiology*, *92*, 142–146.

Brown, G. A., Vukovich, M. D., Martini, E. R., Kohut, M. C., Franke, W. D., Jackson, D. A., et al. (2001a). Effects of androstenedione-herbal supplementation on serum sex hormone concentrations in 30- to 59-year-old men. *International Journal of Vitamin Nutrition Research*, *71*, 293–301.

Brown, G. A., Vukovich, M. D., Martini, E. R., Kohut, M. C., Franke, W. D., Jackson, D. A., et al. (2001b). Endocrine and lipid responses to chronic androstenediol–herbal supplementation in 30 to 58 year old men. *Journal of the American College Nutrition*, *20*, 520–528.

Brownell, K. D., Steen, S. N., & Wilmore, J. (1987). Weight regulation practices in athletes: Analysis of metabolic health effects. *Medicine and Science in Sports and Exercise*, *19*, 546–566.

Buckley, W. R., Yesalis, C. E., Friedl, K. E., Anderson, W. A., Streith, A. L., & Wright, J. E. (1988). Estimated prevalence of anabolic steroid use among male high school seniors. *Journal of the American Medical Association*, *260*, 3441–3445.

Cafri, G., Strauss, J., & Thompson, J. K. (2002). Male body image: Satisfaction and its relationship to well-being using the somatomorphic matrix. *International Journal of Men's Health*, *1*, 215–231.

Cafri, G., & Thompson, J. K. (2004). Measuring male body image: A review of the current methodology. *Psychology of Men and Masculinity*, *5*, 18–29.

Cafri, G., Thompson, J. K., & Yesalis, C. E. (2004, July). A first look at the use of testosterone precursors and ephedrine among adolescent males: Is this a new kind of substance abuse? *Poster Presented at the Annual American Psychological Association Conference, Hawaii*.

Cafri, G., Yamamiya, Y., Brannick, M., & Thompson, J. K. (2004). The influence of sociocultural factors on body image: A meta-analysis. Manuscript Submitted for Publication.

Chassin, L., Ritter, J., Trim, R. S., & King, K. M. (2003). Adolescent substance use disorders. In E. J. Mash, & R. A. Barkley (Eds.), *Child Psychopathology* (2nd ed.) (pp. 199–230). New York, NY: Guilford Press.

Choi, P. Y. L., Pope, H. G., & Olivardia, R. (2002). Muscle dysmorphia: A new syndrome in weightlifters. *British Journal of Sports Medicine*, *36*, 375–377.

Colker, C. M., Antonio, J., & Kalman, D. (2001). The metabolism of orally ingested 19-nor-4-androstene-3,17-dione and 19-nor-4-androstene-3,17-diol in healthy, resistance-t trained men. *Journal of Strength and Conditioning Research*, *15*, 144–147.

Cooper, L. (1969). Athletics, activity, and personality: A review of the literature. *Research Quarterly*, *40*, 17–22.

Cororve, M. B., & Gleaves, D. H. (2001). Body dysmorphic disorder: A review of conceptualizations, assessment, and treatment strategies. *Clinical Psychology Review*, *21*, 949–970.

Costill, D. L., Pearson, D. R., & Fink, W. J. (1984). Anabolic steroid use among athletes: Changes in HDL-C levels. *Physician and Sportsmedicine*, *12*, 113–117.

Delbeke, F. T., Van Eenoo, P., Van Thuyne, W., & Desmet, N. (2003). Prohormones and sport. *Steroid and Biochemistry*, *83*, 245–251.

Di Pasquale, M. (1995). *The anabolic diet*. Falls River, MA: Optimum Training Systems.

Di Pasquale, M. (2000). *The Metabolic Diet*. River Falls, MA: Optimum Training Systems.
Drewnowski, A., Kurth, C. L., & Krahn, D. D. (1995). Effects of body image on dieting, exercise and steroid use in adolescent males. *International Journal of Eating Disorders*, *17*, 381–386.
Duchaine, D. (1996). *Underground bodyopus: Militant weight loss and recompisition*. Nevada: Xipe Press.
Dullo, A. G. (1993). Ephedrine, xanthines and prostaglandin-inhibitors: Actions and interactions in the stimulation of thermogenesis. *International Journal of Obesity Related Metabolism Disorders*, *17*, 35–40.
Earnest, C., Olson, M. A., Broeder, C. E., Breuel, K. F., & Beckham, S. G. (2000). In vivo 4-androstene-3,17-dione and 4-androstene-3,17-diol supplementation in young men. *European Journal of Applied Physiology*, *81*, 229–232.
Edwards, S., & Launder, C. (2000). Investigating muscularity concerns in male body image: Development of the Swansea Muscularity Attitudes Questionnaire. *International Journal of Eating Disorders*, *28*, 120–124.
Eppright, T. D., Sanfacon, J. A., Beck, N. C., & Bradley, J. S. (1997). Sport psychiatry in childhood and adolescence: An overview. *Child Psychiatry and Human Development*, *28*, 71–88.
Evans, J., & Roberts, G. C. (1987). Physical competence and the development of children's peer relations. *Quest*, *39*, 23–35.
Fernandez-del Castillo, C., Robles-Diaz, G., Diaz-Sanchez, V., & Altamirano, A. (1990). Pancreatic cancer and androgen metabolism: High androstenedione and low testosterone serum levels. *Pancreas*, *5*, 515–518.
Ferron, C., Narring, F., Cauderay, M., & Michuad, P. A. (1999). Sport activity in adolescence: Associations with health perceptions and experimental behaviours. *Health Education Research*, *14*, 225–233.
Field, A. E., Camargo, C. A., Taylor, C. B., Berkey, C. S., Roberts, S. B., & Colditz, G. A. (2001). Peer, parent, and media influences on the development of weight concerns and frequent dieting among preadolescent and adolescent girls and boys. *Pediatrics*, *107*, 54–60.
Fogelholm, M., & Hiilloskorpi, H. (1999). Weight and diet concerns in Finnish female and male athletes. *Medicine and Science in Sports and Exercise*, *31*, 229–235.
Food and Drug Administration. (2004). FDA issues regulation prohibiting sale of dietary supplements containing ephedrine alkaloids and reiterates its advice that consumers stop using these products. Retrieved from http://www.cfsan.fda.gov/~lrd/fpephed6.html on February 6th.
French, S. A., Leffert, N., Story, M., Neumark-Sztainer, D., Hannan, P., & Benson, P. L. (2001). Adolescent binge/purge and weight loss behaviors: Associations with developmental assets. *Journal of Adolescent Health*, *28*, 211–221.
Friedl, K. E. (2000). Effects of anabolic steroids on physical health. In C. E. Yesalis (Ed.), *Anabolic steroids in sports and exercise* (pp. 109–137). United States: Human Kinetics.
Furnham, A., & Calman, A. (1998). Eating disturbance, self-esteem, reasons for exercising and body weight dissatisfaction in adolescent males. *European Eating Disorders Review*, *6*, 58–72.
Gardner, R. M., Stark, K., Friedman, B. N., & Jackson, N. A. (2000). Predictors of eating disorder scores in children ages 6 through 14: a longitudinal study. *Journal of Psychosomatic Research*, *49*, 199–205.
Goldfield, G. S., Harper, D. W., & Blouin, A. G. (1998). Are bodybuilders at risk for an eating disorder? *Eating Disorders*, *6*, 133–157.
Groesz, L. M., Levine, M. P., & Murnen, S. K. (2002). The effect of experimental presentation of thin media images on body satisfaction: A meta-analytic review. *International Journal of Eating Disorders*, *31*, 1–16.
Gruber, A. J., & Pope, H. G. (1998). Ephedrine abuse among 36 female weightlifters. *The American Journal on Addictions*, *7*, 256–261.
Gruber, A. J., Pope, H. G., Borowiecki, J., & Cohane, G. (1999). The development of the somatomorphic matrix: A bi-axial instrument for measuring body image in men and women. In T. S. Olds, J. Dollman, & K. I. Norton (Eds.), *Kinanthropometry VI*. Sydney: International Society for the Advancement of Kinanthropometry.
Haupt, H. A. (1993). Anabolic steroids and growth hormone. *American Journal of Sports Medicine*, *21*, 468–475.
Hausenblas, H. A., & Carron, A. V. (1999). Eating disorder indices and athletes: An integration. *Journal of Sport and Exercise Psychology*, *21*, 230–258.
Health Canada. (2004). Health Canada—Warnings/Advisories—Ephedra/Ephedrine. Retrieved from http://www.hcsc.gc.ca/english/protection/warnings/2002/2002_01e.html on June 8th.
Hervy, G. R., Knibbs, A. V., Burkinshaw, L., Morgan, D. B., Jones, P. R., Chettle, D. R., et al. (1981). Effects of methandienone on the performance and body composition of men undergoing athletic training. *Clinical Science*, *60*, 457–461.
Hildebrandt, T., Langenbucher, J., & Schlundt, D. G. (2004). Muscularity concerns Among men: Development of attitudinal and perceptual measures. *Body Image*, *1*, 169–181.

Holland, A., & Andre, T. (1994). Athletic participation and the social status of adolescent males and females. *Youth and Society*, *25*, 388–407.

Hurley, B. F., Seals, D. R., Hagberg, J. M., Goldberg, A. C., Ostrove, S. M., Holloszy, J. O., et al. (1984). High density-lipoprotein cholesterol in body builders vs. powerlifters. *Journal of the American Medical Association*, *252*, 507–513.

Hymel, S., Bowker, A., & Woody, E. (1993). Aggressive versus withdrawn unpopular children: Variations in peer and self-perceptions in multiple domains. *Child Development*, *64*, 879–896.

Irving, L. M., Wall, M., Neumark-Sztainer, D., & Story, M. (2002). Steroid use among adolescents: Findings from project EAT. *Journal of Adolescent Health*, *30*, 243–252.

Kanayama, G., Gruber, A. J., Pope, H. G., Borowiecki, J. J., & Hudson, J. I. (2001). Over-the-counter drug use in gymnasiums: An underrecognized substance abuse problem? *Psychotherapy and Psychosomatics*, *70*, 137–140.

Kantor, M. A., Bianchini, A., Bernier, D., Saday, S. P., & Thompson, P. D. (1985). Androgens reduce HDL_2-cholesterol and increase hepatic triglyceride lipase activity. *Medicine and Science in Sports and Exercise*, *17*, 462–465.

Karch, S. B. (2002). Amphetamines. In C. E. Yesalis, & M. S. Bahrke (Eds.), *Performance Enhancing Substances in Sports and Exercise*. Champaign, IL: Human Kinetics.

Keel, P. K., Fulkerson, J. A., & Leon, G. R. (1997). Disordered eating precursors in pre- and early adolescent girls and boys. *Journal of Youth and Adolescence*, *26*, 203–216.

Keel, P. K., Klump, K. L., Leon, G. R., & Fulkerson, J. A. (1998). Disordered eating in adolescent males from a school-based sample. *International Journal of Eating Disorders*, *23*, 125–132.

Kindlundh, A. M. S., Hagekull, B., Isacson, D. G. L., & Nyberg, F. (2001). Adolescent use of anabolic–androgenic steroids and relations to self-reports of social, personality and health aspects. *European Journal of Public Health*, *11*, 322–328.

King, D. S., Sharp, R. L., Vukovich, M. D., Brown, G. A., Reifenrath, T. A., Uhl, N. L., et al. (1999). Effect of oral androstenedione on serum testosterone and adaptation to resistance training in young men: a randomized controlled trial. *Journal of the American Medical Association*, *281*, 2020.

Kiningham, R. B., & Gorenflo, D. W. (2001). Weight loss methods of high school wrestlers. *Medicine and Science in Sports and Exercise*, *33*, 810–813.

Kochakian, C. D. (1976). Metabolic effects of anabolic–androgenic steroids in experimental animals. In C. D. Kochakian (Ed.), *Anabolic–Androgenic steroids* (pp. 5–39). New York, NY: Springer-Verlag.

Komoroski, E. V., & Rickert, V. I. (1992). Adolescent body image and attitudes to anabolic steroid use. *Sports Medicine*, *146*, 823–828.

Kouri, E., Pope, H. G., & Oliva, P. S. (1996). Changes in lipoprotein-lipid levels in normal men following administration of increasing doses of testosterone cypionate. *Clinical Journal of Sport Medicine*, *6*, 152–157.

Kraemer, H. C., Kazdin, A. E., Offord, D. R., Kessler, R. C., Jensen, P. S., & Kupfer, D. J. (1997). Coming to terms with the terms of risk. *Archives of General Psychiatry*, *54*, 337–343.

Kraemer, W. J., Nindl, B. C., & Rubin, M. R. (2002). Growth hormone: Physiological effects of exogenous administration. In C. E. Yealis, & M. Bahrke (Eds.), *Performance enhancing substances in sport and exercise* (pp. 65–78). Champaign: Human Kinetics.

Krowchuck, D. P., Kreiter, S. R., Woods, C. R., Sinal, S. H., & DuRant, R. H. (1998). Problem dieting behaviors among young adolescents. *Archives of Pediatrics and Adolescent Medicine*, *152*, 884–889.

Kulipers, H., Wijnen, J. A. G., Hartgens, F., & Willems, S. M. M. (1991). Influence of anabolic steroids on body composition, blood pressure, lipid profile, and liver functions in bodybuilders. *International Journal of Sports Medicine*, *12*, 413–418.

Leder, B. Z., Catlin, D. H., Longcope, C., Ahrens, B., Schoenfeld, D. A., & Finkelstein, J. S. (2001). Metabolism of orally administered androstenedione in young men. *Journal of Clinical Endocrinology and Metabolism*, *86*, 3654–3658.

Leder, B. Z., Longcope, C., Catlin, D. H., Ahrens, B., Schoenfeld, D. A., & Finkelstein, J. S. (2000). Oral androstenedione administration and serum testosterone concentrations in young men. *Journal of the American Medical Association*, *283*, 779–782.

Leit, R. A., Gray, J. J., & Pope, H. G. (2002). The media's representation of the ideal male body: A cause for muscle dysmorphia? *International Journal of Eating Disorders*, *31*, 334–338.

Lenders, J. W. M., Demacker, P. N., Vos, J. A., Hoitsma, A. J., van 't Laar, A., Thien, T., et al. (1988). Deleterious effects of anabolic steroids on serum lipoproteins, blood pressure, and liver function in amateur bodybuilders. *International Journal of Sports Medicine*, *9*, 19–23.

Leon, G. R., Fulkerson, J. A., Perry, C. L., Keel, P. K., & Klump, K. L. (1999). Three to four year prospective evaluation of personality and behavioral risk factors for later disordered eating in adolescent girls and boys. *Journal of Youth and Adolescence*, *28*, 181–196.

Leon, G. R., Fulkerson, J. F., Perry, C. L., & Early-Zald, M. (1995). Prospective analysis of personality and behavioral vulnerabilities and gender influences in the later development of disordered eating. *Journal of Abnormal Psychology*, *104*, 140–149.

Lipinski, J., & Pope, H. (2002). Body ideal in young Samoan men: A comparison with men in North America and Europe. *International Journal of Men's Health*, *1*, 163–171.

Liu, Y. L., Toubro, S., Astrup, A., & Stock, M. J. (1995). Contribution of beta 3-adrenoceptor activation to ephedrine-induced thermogenesis in humans. *International Journal of Obesity Related Metabolism Disorders*, *19*, 678–685.

Lock, J., Reisel, B., & Steiner, H. (2001). Associated health risks of adolescents with disordered eating: How different are they from their peers? Results from a high school survey. *Child Psychiatry and Human Development*, *31*, 249–265.

Lynch, G. S. (2002). Beta-2 agonists. In C. E. Yealis, & M. Bahrke (Eds.), *Performance enhancing substances in sport and exercise* (pp. 47–64). Champaign, IL: Human Kinetics.

Mayville, S. B., Williamson, D. A., White, M. A., Netemeyer, R., & Drab, D. L. (2002). Development of the muscle appearance satisfaction scale: A self-report measure for the assessment of muscle dysmorphia symptoms. *Assessment*, *9*, 351–360.

Mcardle, W. D., Katch, F. I., & Katch, V. L. (1996). *Exercise physiology: Energy, nutrition, and human performance*. Philadelphia, PA: Lippincott, Williams & Wilkins.

McCabe, M. P., & Ricciardelli, L. A. (2001a). Parent, peer, and media influences on body image and strategies to both increase and decrease body size among adolescent boys and girls. *Adolescence*, *36*, 225–240.

McCabe, M. P., & Ricciardelli, L. A. (2001b). Body image, strategies to change muscles and weight, and puberty: Do they impact on positive and negative affect among adolescent boys and girls? *Eating Behaviors*, *2*, 129–149.

McCabe, M. P., & Ricciardelli, L. A. (2003a). Sociocultural influences on body image and body changes among adolescent boys and girls. *Journal of Social Psychology*, *143*, 5–26.

McCabe, M. P., & Ricciardelli, L. A. (2003b). A longitudinal study of body change strategies among adolescent males. *Journal of Youth and Adolescence*, *32*, 105–113.

McCabe, M. P., & Ricciardelli, L. A. (2004a). Weight and shape concerns of boys and men. In J. K. Thompson (Ed.), *Handbook of eating disorder and obesity* (pp. 606–634). Hoboken, NJ: Wiley & Sons.

McCabe, M. P., & Ricciardelli, L. A. (2004b). A longitudinal study of pubertal timing and health risk behaviors among adolescent boys and girls. *Adolescence*, *35*, 145–166.

McCabe, M. P., & Vincent, M. (2003). The role of biodevelopmental and psychological factors in disordered eating in adolescents. *European Eating Disorders Review*, *11*, 315–328.

McCabe, M. P., & Vincent, M. A. (2002). Development and validation of Body Modification Scales and Excessive Exercise Scales for adolescents. *Assessment*, *9*, 131–141.

McCabe, M. P., Ricciardelli, L. A., & Finemore, J. (2002). The role of puberty, media, and popularity with peers as strategies to increase weight, decrease weight and increase muscle tone among adolescent boys and girls. *Journal of Psychosomatic Research*, *52*, 145–153.

McCreary, D. R., & Sasse, D. K. (2000). An exploration of the drive for muscularity in adolescent boys and girls. *Journal of American College Health*, *48*, 297–304.

McCreary, D. R., & Sasse, D. K. (2002). Gender differences in high school students' dieting behavior and their correlates. *International Journal of Men's Health*, *1*, 195–213.

McCreary, D. R., Sasse, D. K., Saucier, D. M., & Dorsch, K. D. (2004). Measuring the drive for muscularity: Factorial validity of the drive for muscularity scale in men and women. *Psychology of Men and Masculinity*, *5*, 49–58.

McDonald, L. (1998). *The ketogenic diet: A complete guide for the dieter and practitioner*. Kearney, NE: Morris Publishing.

Mickalide, A. (1990). Sociocultural factors influencing weight among males. In A. Andersen (Ed.), *Males with Eating Disorders* (pp. 30–39). New York, NY: Burnner/Mazel.

Middleman, A. B., & DuRant, R. H. (1996). Anabolic steroid use and associated health risk behaviors. *Sports Medicine*, *21*, 251–255.

Middleman, A. B., Faulkner, A. H., Woods, E. R., Emans, S. J., & DuRant, R. H. (1995). High risk behaviors among high school students in Massachusetts who use anabolic steroids. *Pediatrics*, *96*, 268–272.

Middleman, A. B., Vazquez, I., & DuRant, R. H. (1998). Eating patterns, physical activity, and attempts to change weight among adolescents. *Journal of Adolescent Health*, *22*, 37–42.

Miller, W. R., & Brown, S. A. (1997). Why psychologists should treat alcohol and drug problems. *American Psychologist*, *52*, 1269–1279.

Morrison, T. G., Morrison, M. A., Hopkins, C., & Rowan, E. T. (2004). Muscle mania: Development of a new scale examining the drive for muscularity in Canadian Males. *Psychology of Men and Masculinity*, *5*, 30–39.

Mueller, C., Field, T., Yando, R., Harding, J., Gonzalez, K. P., & Bendell, D. (1995). Under eating and over eating concerns among adolescents. *Journal of Child Psychology and Psychiatry*, *36*, 1019–1025.

Neumark-Sztainer, D., & Hannan, P. J. (2000). Weight-related behaviors among adolescent girls and boys: Results from a national survey. *Archives of Pediatrics and Adolescent Medicine*, *154*, 569–577.

Neumark-Sztainer, D., Story, M., Falkner, N. H., Beuhring, T., & Resnick, M. D. (1999). Sociodemographic and personal characteristics of adolescents engaged in weight loss and weight/muscle gain behaviors: Who is doing what? *Preventive Medicine*, *28*, 40–50.

O'Dea, J. A., & Abraham, S. (1999). Onset of disordered eating attitudes and behaviors in early adolescence: Interplay of pubertal status, gender, weight, and age. *Adolescence*, *34*, 671–679.

Olivarida, R. (2001). Mirror, mirror on the wall, who's the largest of them all? The features and phenomenology of muscle dysmorphia. *Harvard Review of Psychiatry*, *9*, 254–259.

Olivardia, R., Pope, H. G., & Hudson, J. I. (2000). Muscle dysmorphia in male weightlifters: A case-control study. *American Journal of Psychiatry*, *157*, 1291–1296.

Oppliger, R., Landry, G., Foster, S., & Lambrecht, A. (1993). Bulimic behaviors among interscholastic wrestlers: A statewide survey. *Pediatrics*, *91*, 826–831.

Parks, P. S. M., & Read, M. H. (1997). Adolescent male athletes: Body image, diet and exercise. *Adolescence*, *32*, 593–602.

Physicians' desk reference. (2000) (54th edition). Montvale, NJ: Medical Economics.

Pope, H. G., Gruber, A., Choi, P., Olivardia, R., & Phillips, K. (1997). An underrecognized form of body dysmorphic disorder. *Psychosomatics*, *38*, 548–557.

Pope, H. G., Gruber, A., Magweth, B., Bureau, B., deCol, C., Jovent, R., et al. (2000). Body image perception among men in three countries. *American Journal of Psychiatry*, *157*, 1297–1301.

Pope, H. G., & Katz, D. L. (1987). Bodybuilders' psychosis. *Lancet*, *I*, 863.

Pope, H. G., & Katz, D. L. (1988). Affective and psychotic symptoms associated with anabolic steroid use. *American Journal of Psychiatry*, *145*, 487–490.

Pope, H. G., & Katz, D. L. (1990). Homicide and near-homicide by anabolic steroid use. *Journal of Clinical Psychiatry*, *51*, 28–31.

Pope, H. G., & Katz, D. L. (1992). Psychiatric effects of anabolic steroids. *Psychiatric Annals*, *22*, 24–29.

Pope, H. G., & Katz, D. L. (1994). Psychiatric and medical effects of anabolic–androgenic steroid use: A controlled study of 160 athletes. *Archives of General Psychiatry*, *51*, 375–382.

Pope, H. G., Katz, D. L., & Hudson, J. I. (1993). Anorexia nervosa and "reverse anorexia" among 108 male bodybuilders. *Comprehensive Psychiatry*, *34*, 406–409.

Pope, H. G., Kouri, E. M., & Hudson, J. I. (2000). The effects of supraphysiological doses of testosterone on mood aggression in normal men. *Archives of General Psychiatry*, *57*, 133–140.

Pope, H. G., Phillips, K. A., & Olivardia, R. (2000). *The Adonis complex: The secret crisis of male body obsession*. New York: The Free Press.

Rasmussen, B. B., Volpi, E., Gore, D. C., & Wolfe, R. R. (2000). Androstenedione does not stimulate muscle protein anabolism in young healthy men. *Journal of Clinical Endocrinology and Metabolism*, *85*, 55–59.

Rawson, E. S., & Clarkson, P. M. (2002). Ephedrine as an ergogenic aid. In C. E. Yealis, & M. Bahrke (Eds.), *Performance enhancing substances in sport and exercise* (pp. 289–298). Champaign: Human Kinetics.

Ricciardelli, L. A., & McCabe, M. P. (2001a). Moderators of sociocultural influences on body dissatisfaction, strategies to decrease weight and strategies to increase muscle tone among adolescent boys and girls. *Sex Roles*, *44*, 189–207.

Ricciardelli, L. A., & McCabe, M. P. (2001b). Dietary restraint and negative affect as mediators of body dissatisfaction and bulimic behavior in adolescent girls and boys. *Behaviour Research and Therapy*, *39*, 1317–1328.

Ricciardelli, L. A., & McCabe, M. P. (2002). Psychometric evaluation of the Body Change Inventory: An assessment instrument for adolescent boys and girls. *Eating Behaviors*, *3*, 45–59.

Ricciardelli, L. A., & McCabe, M. P. (2003). A longitudinal analysis of the role of psychosocial factors in predicting body change strategies among adolescent boys. *Sex Roles*, *48*, 349–360.

Richards, M. H., Casper, R. C., & Larson, R. (1990). Weight and eating concerns among pre- and young adolescent boys and girls. *Journal of Adolescent Health Care*, *11*, 203–209.

Ross, H. E., & Ivis, F. (1999). Binge eating and substance use among male and female adolescents. *International Journal of Eating Disorders*, *26*, 245–260.

Seefeldt, V. D., Gilliam, T., Blievernicht, D., & Bruce, R. (1978). Scope of youth sport programs in the state of Michigan. In F. Smoll, & R. Smith (Eds.), *Psychological Perspectives in Youth Sports* (pp. 17–68). Washington: Hemisphere Publishing.

Serdula, M. K., Collins, M. E., Williamson, D. F., Anda, R. F., Pamuk, E., & Byers, T. E. (1993). Weight control practices of U.S. adolescents and adults. *Annals of Internal Medicine*, *119*, 667–671.

Spitzer, B. A., Henderson, K. A., & Zivian, M. T. (1999). Gender differences in population versus media body sizes: A comparison over four decades. *Sex Roles*, *40*, 545–565.

Stannard, J. P., & Bucknell, A. L. (1993). Rupture of the triceps tendon associated with steroid injections. *American Journal of Sports Medicine*, *21*, 482–486.

Stice, E. (2002). Risk and maintenance factors for eating pathology: A meta-analytic review. *Psychological Bulletin*, *128*, 825–848.

Stice, E., Cameron, R. P., Killen, J. D., Hayward, C., & Taylor, C. B. (1999). Naturalisticweight-reduction efforts prospectively predict growth in relative weight and onset of obesity among female adolescents. *Journal of Consulting and Clinical Psychology*, *67*, 967–974.

Stilger, V. G., & Yesalis, C. E. (1999). Anabolic–androgenic steroid use among high school football players. *Journal of Community Health*, *24*, 131–145.

Strauss, R. H., Wright, J. E., & Finerman, G. A. M. (1982). Anabolic steroid use and health status among 42 weight trained male athletes. *Medicine and Science in Sports and Exercise*, *14*, 119.

Striegel-Moore, R. H., Silberstein, L. R., & Rodin, J. (1986). Toward an understanding of risk factors for bulimia. *American Psychologist*, *41*, 246–263.

Su, T. -P., Pagliaro, M., Ollo, C., Pickar, D., Wolkowitz, O., & Rubinow, D. R. (1993). Neuropsychiatric effects of anabolic steroids in male normal volunteers. *Journal of the American Medical Association*, *269*, 2760–2764.

Thompson, J. K., Heinberg, L., Altabe, M., & Tantleff-Dunn, S. (1999). *Exacting beauty*. Washington, DC: American Psychological Association.

Tomori, M., & Rus-Makovec, M. (2000). Eating behavior, depression, and self-esteem in high school students. *Journal of Adolescent Health*, *26*, 361–367.

Uralets, V. P., & Gillette, P. A. (1999). Over-the-counter anabolic steroids 4-Androsten-3, 17-dione; 4-Androsten-3beta, 17beta-diol; and 19-nor-4-Androsten-3, 17-dione: Excretion studies in men. *Journal of Analytical Toxicology*, *23*, 357–366.

van den Berg, P., Thompson, J. K., Brandon, T., & Coovert, S. (2002). The tripartite influence model of body image and eating disturbance: A covariance structure modeling investigation. *Journal of Psychosomatic Research*, *53*, 1007–1020.

Vincent, M. A., & McCabe, M. P. (2000). Gender differences among adolescents in family, and peers influences on body dissatisfaction, weight loss, and binge eating behaviors. *Journal of Youth and Adolescence*, *29*, 205–221.

Wadler, G. I. (2002). Future and designer drugs: Emerging science and technologies. In C. E. Yealis, & M. Bahrke (Eds.), *Performance enhancing substances in sport and exercise* (pp. 305–321). Champaign, IL: Human Kinetics.

Weider, J., & Reynolds, B. (1983). *The Weider system of bodybuilding*. Chicago: Contemporary Books.

Weiss, M. R., & Duncan, S. C. (1992). The relationship between physical competence and peer acceptance in the context of children's sports participation. *Journal of Sport and Exercise Psychology*, *14*, 177–191.

Weiss, M. R., Smith, A. L., & Theeboom, M. (1996). "That's what friends are for" Children's and teenager' perceptions of peer relationships in the sport domain. *Journal of Sport and Exercise Psychology*, *18*, 347–379.

Wertheim, E. H., Martin, G., Prior, M., Sanson, A., & Smart, D. (2002). Parental influences in the transmission of eating and weight related values and behaviors. *Eating Disorders: The Journal of Treatment and Prevention*, *10*, 321–334.

Wertheim, E. H., Paxton, S. J., Maude, D., Szmukler, G. I., Gibbons, K., & Hiller, L. (1992). Psychosocial predictors of weight loss behaviors and binge eating in adolescent girls and boys. *International Journal of Eating Disorders*, *12*, 151–160.

Whitaker, A., Davies, M., Shaffer, D., Johnson, J., Abramam, S., Walsh, B. T., et al. (1989). The struggle to be thin: A survey of anorexic and bulimic symptoms in a non-referred adolescent population. *Psychological Medicine*, *19*, 143–163.

White, S. A., Duda, J. L., & Keller, M. R. (1998). The relationship between goal orientation and perceived purposes of sport among youth sport participants. *Journal of Sport Behavior*, *21*, 475–483.

Wichstrom, L. (2000). Psychological and behavioral factors unpredictive of disordered eating: a prospective study of the general adolescent population in Norway. *International Journal of Eating Disorders*, *28*, 33–42.

Wichstrom, L., & Pedersen, W. (2001). Use of anabolic–androgenic steroids in adolescence: Winning, looking good or being bad? *Journal of Studies on Alcohol*, *62*, 5–13.

Yates, R., Perry, P. J., MacIndoe, J., Holman, T., & Ellingrod, V. (1999). Psychosexual effects of three doses of testosterone in cycling and normal men. *Biological Psychiatry*, *45*, 254–260.

Yen, S., & Jaffe, R. (1978). *Reproductive endocrinology*. Philadelphia: Saunders.

Yesalis, C. E. (1999). Medical, legal and societal implications of androstenedione use. *Journal of the American Medical Association*, *281*, 2044.

Yesalis, C. E., & Bahrke, M. (Eds.) (2002a). *Performance Enhancing Substances in Sport and Exercise*. Champaign, IL: Human Kinetics.

Yesalis, C. E., & Bahrke, M. (2002b). Anabolic–androgenic steroids and related substances. *Current Sports Medicine Reports*, *4*, 246–252.

Yesalis, C., & Cowart, V. (1998). *The steroids game*. United States: Human Kinetics.

Yesalis, C., Kennedy, N., Kopstein, A., & Bahrke, M. (1993). Anabolic–androgenic steroid use in the United States. *Journal of the American Medical Association*, *270*, 1217–1221.

Yesalis, C. E., Barsukiewicz, C. K., Kopstein, A. N., & Bahrke, M. S. (1997). Trends in anabolic–androgenic steroid use among adolescents. *Archives of Pediatrics and Adolescent Medicine*, *151*, 1197–1206.

Yesalis, C. E., Courson, S. P., & Wright, J. E. (2000). History of anabolic steroid use in sport and exercise. In C. E. Yesalis (Ed.), *Anabolic steroids in sports and exercise* (pp. 51–71). United States: Human Kinetics.