Acute Effects of Resistance Exercise in Men with Symptoms of Muscle Dysmorphia

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Abstract

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Introduction: This dissertation explored the acute effects of varying resistance exercise intensities in men with symptoms of muscle dysmorphia (MD). MD is a complex and disabling disorder; yet, despite the negative health effects MD can have, few treatment methods exist, with many barriers. Exercise has the potential to overcome many of the barriers to MD treatment and has shown to have positive effects in people with related disorders; yet, these effects have not been tested in men with MD. Methods: Twenty-one men were recruited and completed four on-site sessions. Sessions 1 and 2 included a battery of psychological and physiological measures. Sessions 3 and 4 were single sessions of moderate (70% of 10-RM) and high (100% of 10-RM) intensity RE in a counterbalanced order separated by at least 48-hours. Acute changes in body image, affective valence, perceived activation, perceived muscle size, and exercise enjoyment, were assessed before (PRE), during (MID), immediately after (POST), and 30-minutes after (DELAY) each session. Results: Repeated measures analysis of variance (ANOVA) showed significant effects of time for state body image ($F = 8.05, p < .01, \eta^2 = .17$), affective valence ($F = 5.12, p = .01, \eta^2 = .28$), perceived activation ($F = 48.47, p < .001, \eta^2 = .79$), perceived muscle size ($F = 8.79, p < .01, \eta^2 = .31$), and exercise enjoyment ($F = 6.84, p < .01, \eta^2 = .15$). There were significant effects of condition (i.e., intensity) for perceived activation ($F = 9.13, p < .01, \eta^2 = .19$) only. There was a significant condition x time interaction for perceived activation ($F = 3.49, p = .03, \eta^2 = .22$) and exercise enjoyment ($F = 3.12, p = .05, \eta^2 = .07$). Post-hoc analyses revealed a significant increase in state body image during both sessions ($ps > .05$), but a significant decrease in state body image emerged from POST to DELAY ($p < .05$) during the moderate intensity session only. Additionally, during the moderate intensity session affective valence significantly decreased from MID and POST to DELAY ($ps <
There were no significant changes in affective valence at any time point during the high intensity session ($p > .05$). During the moderate intensity session, perceived activation significantly increased from PRE to MID, and POST ($p < .01$), but significantly decreased from PRE, MID, and POST, to DELAY ($p < .01$). During the high intensity session, perceived activation significantly increased from PRE to MID ($p < .01$), and from PRE and MID, to POST ($p < .01$). Also, during the high intensity session perceived activation significantly decreased from PRE, MID, and POST, to DELAY ($p < .01$). Perceived muscle size significantly increased from PRE to POST ($p < .01$), and significantly decreased from POST to DELAY ($p < .01$).

Further, results suggest that participants enjoyed the high intensity RE session significantly more compared to the moderate intensity session ($p < .01$). **Conclusion:** Results suggest that men with MD symptoms have a more favorable response to high vs. moderate intensity RE. These results support the literature suggesting that RE intensity likely plays an important role in perceived body image and muscle size among men with MD symptoms. Further research testing the effects of different RE variables (e.g., frequency, duration) is warranted to establish an optimal RE protocol to maximize body satisfaction in this population.
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Dedication

This dissertation is dedicated to you, Dad.
CHAPTER 1
INTRODUCTION
The proliferation of research on male body image in recent years is likely reflective of the increasing prevalence of men’s dissatisfaction with their body, which has increased from 43% in 1997 (Garner, 1997) to 61% in 2014 (Fiske, Fallon, Blissmer, & Redding, 2014). For the majority of males, this body dissatisfaction stems from a perceived lack of muscularity (Frederick et al., 2007), and is often a result of the internalization of the societal promoted ideal muscular male physique (Olivardia, Pope Jr, Borowiecki lll, & Cohane, 2004; Parent & Moradi, 2011). Internalization of these muscular physiques is shown to influence men’s view of their own bodies, and can lead to a drive for muscularity (DFM) (Murnen & Karazsia, 2017). DFM reflects one’s attitudes (e.g., dissatisfaction with muscle size) and behaviors (e.g., resistance exercise; RE, and nutritional supplement and anabolic steroid use) towards increasing muscle size and exists on a low-to-high continuum (Hale, Roth, DeLong, & Briggs, 2010). For example, low levels of DFM can be reflective of a healthy lifestyle due to the known beneficial effects of regular RE on physical and mental health (Tod & Lavallee, 2013; Winett & Carpinelli, 2001). By comparison, high DFM can lead to poor mental health and risky behaviors, and can play a significant role in the development of muscle dysmorphia (MD) (Edwards, Tod, & Molnar, 2014).

**Characteristics of Muscle Dysmorphia**

MD is a disabling psychiatric disorder characterized by a pathological preoccupation with a perceived lack of muscularity despite an existing physique that is average (or above average) in muscle size (Pope, Jr., Katz, & Hudson, 1993). The condition is currently included in the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed., DSM-5) as a specifier for body dysmorphic disorder, and under the umbrella of obsessive compulsive disorders (American Psychiatric Association, 2013). In the context of MD, the obsession is the pursuit of increasing muscle size and the compulsions include the compensatory behaviors (e.g., RE, dieting) to achieve an ideal physique. Yet, the DSM-5 does not include diagnostic criteria for MD (American Psychiatric Association, 2013). As a result, researchers and clinicians have relied on
criteria first proposed by Pope, Jr., Gruber, Choi, Olivardia, & Phillips, (1997) over 20 years ago to help identify men with (sub)clinical MD symptoms. These criteria can be seen in Table 1.

The preoccupation with increasing muscle size can lead to poor mental health, most notably depression, anxiety, mood disorders, and eating disorders (Choi, Pope, & Olivardia, 2002; Foster, Shorter, & Griffiths, 2014; Olivardia, 2001). In fact, one study found that 58% of men with MD have been diagnosed with a major depressive disorder compared to 20% of the men without MD (Olivardia, Pope, & Hudson, 2000). Another study found that 74% of men with MD have been diagnosed with a major mood disorder compared to 29% of the men without MD, and that 43% of men with MD had reported being diagnosed with an anxiety disorder compared to 7% of men without MD (Cafri, Olivardia, & Thompson, 2008). One study also found that 29% of men with MD have had or currently have an eating disorder (Olivardia, 2001). Lastly, (Pope et al., 2005) reported that 86% of their sample of men with MD had a history of body dysmorphic disorder that was unrelated to muscle size. Currently, however, some researchers suggest that there may be a bidirectional relationship between MD and mental health, such that men develop poor mental health because of MD, but that men with poor mental health may also be more susceptible to develop MD (Olivardia et al., 2000).

MD also manifests behaviorally across a multitude of compensatory behaviors (i.e., behaviors to compensate for feeling insufficiently muscular) such as excessive RE despite being sick or injured, disordered eating patterns (e.g., high protein, low fat), and the use of anabolic steroids and nutritional supplements (Olivardia, Pope Jr, & Hudson, 2014). Even a mild disruption from this routine can result in distress (Murray, Rieger, Touyz, & De la Garza García, 2010). Other behaviorally strategies are camouflaging, which includes wearing clothes that are excessively baggy, or wearing layers of clothes despite high temperatures (Olivardia, 2007). In some cases, those with MD may avoid social situations entirely in fear of being negatively judged by others (Tod, Edwards, & Cranswick, 2016). Appearance-checking behaviors are also common among those with MD, and can include examining one’s muscular size in mirrors.
through flexing, or obsessively seeking external reassurance (e.g., “Do my shoulders look big?”) (Cunningham et al., 2017). As an example, one study reported that men with MD lift weights for up to 3 hours daily, obsess over being insufficiently muscular for more than 5 hours a day, and mirror-check up to 13 times each day (Olivardia, 2001). Another study found that upwards of 46% of men with MD report having used or are currently using anabolic steroids compared to just 7% of men without MD (Pope et al., 2005).

**Demographics**

MD predominately affects men between the ages of 18 and 35 years, although cases of MD in younger and older men, and in females, have been identified (Mitchell et al., 2016; Tod et al., 2016). The prevalence of MD is not fully clear, but a recent review suggested that between 13.6% and 44% of men may be affected or at least have MD symptoms, with the majority of these men being regular weight lifters (dos Santos Filho, Tirico, Stefano, Touyz, & Claudino, 2016). Individuals with MD also tend to be White and single, and sexual orientation does not appear to be related to MD (Cunningham et al., 2017).

**Theoretical Perspectives on the Development of Muscle Dysmorphia**

The development and progression of MD can be attributed to multiple sociocultural influences such as the mass media, parents, and peers (Grieve, 2007; Olivardia, 2001), psychological factors such as low self-esteem and negative affect (Grieve, 2007), and physiological factors like body composition, and pubertal timing and growth (Schneider, Rollitz, Voracek, & Hennig-Fast, 2016). In addition, the Sociocultural Theory, the Social Comparison Theory, and the Objectification Theory are three theoretical frameworks proposed to help explain the development of MD (Grieve, 2007; Moradi, 2010; Olivardia, 2001).

*Sociocultural Theory*
The Sociocultural Theory suggests that MD may develop through the internalization of the ideal physique (Olivardia, 2001), and pressure from parents and peers who place a strong emphasis on having an ideal body (McCabe & Ricciardelli, 2001). Men who are exposed to advertisements, movies, muscle magazines, and action figures may be at an increased risk for MD, as these outlets relentlessly portray the desirability, masculinity, and dominance of attaining a muscular physique (Pope, Phillips, & Olivardia, 2000). Some individuals may internalize the advantages of having a muscular physique (e.g., increased masculinity) (Olivardia et al., 2004), and the disadvantages of having a small, less-muscular physique (e.g., low desirability) (Anderson, Grunert, Katz, & Lovascio, 2010; Baghurst, Hollander, Nardella, & Haff, 2006). Subsequently, these individuals may engage in the risky behaviors mentioned above to attain a physique deemed ideal (Agliata & Tantleff-Dunn, 2004; Olivardia et al., 2004).

**Social Comparison Theory**

The Social Comparison Theory suggests that individuals compare themselves to either those who are considered to be further from an ideal (downward comparison), which is hypothesized to enhance positive self-perceptions, or those who are considered to be closer to an ideal (upward comparison), which is hypothesized to decrease positive self-perceptions (Morrison, Kalin, & Morrison, 2004; Taylor & Lobel, 1989). In this manner, MD would develop in response to repeated exposure to muscular men (e.g., portrayed in different media outlets) such that the number of opportunities men have to compare their bodies to that of the muscular ideal could ultimately lead to muscular-related body dissatisfaction (Grieve, 2007).

**Objectification Theory**

The Objectification Theory suggests that the sociocultural pressure to achieve an ideal muscular physique may act as potential risk factor for MD (Moradi, 2010). Although research indicates that women are objectified more than men, this theory suggests that certain
interpersonal and social interactions can lead men to internalize the cultural expectation of the ideal muscular body, which can lead to self-objectification (Fredrickson & Roberts, 1997). Eventually, self-objectification may manifest itself into constant body awareness and monitoring, potentially increasing social physique anxiety, body dissatisfaction, and engagement in risky behaviors that are used to maintain or achieve the ideal muscular physique (Choi, Pope Jr, & Olivardia, 2002; Moradi, 2010).

Treatment Methods

Despite the deleterious effects of MD on physical and mental health, there are no treatment methods that exist that are designed specifically to help individuals with MD (Murray & Griffiths, 2015). As a result, clinicians have adapted treatment methods from the eating disorder and body dysmorphic disorder literature given their pathological similarities with MD (Cunningham et al., 2017; Grieve, Truba, & Bowersox, 2009). To this end, many different treatment methods have been used for MD including family-based treatment, pharmacotherapy, and cognitive behavioral therapy (CBT).

Family-Based Treatment

Family-based treatment is one of the most widely advocated treatment methods for anorexia nervosa, and uses familial resources to monitor eating behavior while providing a supportive environment for recovery (Murray & Griffiths, 2015). Given the similarities in pathology between eating disorder and MD, this form of treatment has been used for MD. For example, Murray and Griffiths (2015) published a case report of an adolescent boy with MD who was treated with an adapted form of family-based treatment. The parents were encouraged to monitor eating behaviors to ensure the consumption of a balanced diet, and to limit excessive exercise routines. Over the course of 7 months, the patient, who initially met full diagnostic criteria for MD, was fully recovered. Although encouraging, significantly more research and
large-scale clinical trials are needed to replicate these findings to better understand how this type of treatment can be used for MD.

**Pharmacotherapy**

Overall, there is a lack of reliable data on the effects of pharmacotherapy on MD, as there are so few rigorous clinical trials testing its efficacy (Pope et al., 2000). Yet, some research has found selective serotonin reuptake inhibitors (SSRIs) to be effective at reducing obsessional thinking and compulsive behaviors in patients with body dysmorphic disorder (Phillips & Hollander, 2008), and in patients with severe forms of MD (Phillips, 2002).

**Cognitive Behavioral Therapy**

Several different CBT techniques have been implicated as having potential utility to help individuals with MD. These techniques have the ultimate goal of identifying, evaluating, and restructuring automatic negative thoughts related to feeling insufficiently muscular. One technique includes a distress-without-response model which helps individuals tolerate distressing thoughts about a perceived lack of muscularity without engaging in compensatory behaviors (Greenberg, Blashill, Ragan, & Wilhelm, in press). Reducing these behaviors is crucial given that they serve as maintaining factors in the disorder and have the potential to cause harm to physical health.

Another CBT technique that may be effective is to restructure perceptions of masculinity. The goal of this technique is to reduce distorted perceptions of masculinity and its perceived linked to one’s level of muscle size (Greenberg et al., in press). As treatment progresses, perceptions of what it means to be masculine or have the “perfect” physique may decrease, eventually mitigating negative thoughts about being insufficiently muscular (Blashill, 2011).

Lastly, research indicates that men with MD display high levels perfectionism, which may account for the relentless pursuit of a more muscular physique (i.e., the perfect body) (Olivardia
By restructuring and eventually reducing perfectionistic thinking, individuals with MD may become aware that the pursuit of the ideal body is futile (Olivardia, 2001). Ultimately, this technique may help normalize standards of what it means it have the “perfect” or “ideal” body and reduce risky compensatory behaviors and negative perception of one’s body.

**Barriers to Treatment**

The lack of effective treatment options for MD is likely the largest barrier to treatment, and may be exacerbated by the avoidant behavior often exhibited by those with MD (e.g., avoiding doctor’s offices, participating in research studies; Grieve et al., 2009). In addition, exercising and monitoring diet are often seen as “healthy” behaviors, which may prevent the identification of pre-clinical symptoms allowing the disorder to go unrecognized and untreated (Hitzeroth, Wessels, Zungu-Dirwayi, Oosthuizen, & Stein, 2001). On the one hand, this limits the ability of researchers and clinicians to develop effective treatment protocols specific to MD, and on the other, precludes the ability to accurately determine prevalence rates of the disorder.

A second barrier includes a clinician’s advice to discontinue the risky behaviors (e.g., excessive RT, anabolic steroid use) that support the disorder (Olivardia, 2007). Although discontinuation of these behaviors has been standard practice in existing MD treatment models, it can result in an unexpected decline in mental health because these individuals realize that this discontinuation will lead to a reduction in muscle size. This can ultimately result in treatment avoidance or poor treatment adherence (Olivardia, 2007).

Third, many individuals deny having a problem and instead believe that the pros of their excessive behaviors outweigh the cons. These beliefs are then subsequently reinforced when these individuals receive external validation and praise for their “healthy” behaviors (Griffiths, Mond, Murray, & Touyz, 2015). These self-serving beliefs can prevent awareness of the disorder (Pope et al., 2000). In fact, one study with college men and women found a linear relationship between such beliefs and the endorsement of MD symptoms (e.g., eating “healthy”,...
exercising) (Griffiths, Mond, Murray, & Touyz, 2015). Thus, the fact that individuals with MD may be viewed positively because of their ability to maintain this regimented lifestyle perpetuates the perception that treatment is not needed.

Lastly, there is a significant amount of stigma when men seek mental health treatment, even more so when it pertains to body image (Griffiths, Mond, Li, et al., 2015). Since poor body image has traditionally been seen as a female issue, and since stereotypes suggest that masculine men are not “supposed” to be concerned with their bodies, men with MD may avoid treatment because of the perceived shame of admitting their dissatisfaction with their body (Shepherd & Rickard, 2012). Some research has found that men often seek treatment for a co-occurring condition (e.g., depression), with the optimism that their overall mental health will improve. If, however, MD goes unrecognized during these visits, poor mental health and the accompanied risky behaviors may persist. Fortunately, MD researchers have begun to advocate for measures of MD to be incorporated into existing screening protocols for a variety of mental health outcomes (Pope et al., 2005).

Overall, these barriers prevent the development and dissemination of effective treatment methods specific to MD. However, given the debilitating effects of MD it remains vital for research to further explore techniques that could be effective at treating the disorder.

**Rationale for Exercise as an Adjunctive Therapy for Muscle Dysmorphia**

Although many treatment programs view RE as a symptom of MD rather than a potential healing factor, its efficacy as an adjunct to existing treatment methods has been tested within a similar pathological paradigm (i.e., eating disorder), yielding promising results (Murray & Griffiths, 2015). In fact, three systematic reviews on the effects of exercise in patients with eating disorders; two with anorexia and bulimia nervosa (Moola, Gairdner, & Amara, 2013; Vancampfort et al., 2014), and one with binge eating disorder (Vancampfort et al., 2013), concluded that the addition of exercise (both aerobic and RE) contributed to a reduction in
eating disorder pathology, depressive symptoms, and improved quality of life and other psychosocial variables (e.g., self-esteem). Perhaps most importantly, it was noted in these reviews that supervised exercise increased patient’s willingness to seek and adhere to treatment (Moola et al., 2013). If these findings could be replicated in individuals with MD it would help circumvent a major obstacle in treating MD which is the reluctance to engage in treatment.

Relapse is another obstacle that could be avoided by incorporating exercise into MD treatment models. Studies from the eating disorder literature have found that many patients in treatment programs without exercise revert back to their excessive exercise routines post treatment (Carter, Blackmore, Sutandar-Pinnock, & Woodside, 2004; Zunker, Mitchell, & Wonderlich, 2011). In addition, many individuals with eating disorders and MD have distorted beliefs of how much exercise is needed to reach their respective physique goals. Thus, by incorporating an exercise program into treatment, individuals can acquire knowledge on how much is needed to reach their goals. In fact, two studies within the eating disorder literature support this notion. For example, one study found that treatment programs that included exercise resulted in a reduction in distorted beliefs about exercise (Moola et al., 2013), and the second study found that exercise significantly reduced commitment to exercise in an outpatient sample of individuals with eating disorders (Schlegel, Hartmann, Fuchs, & Zeeck, 2015).

Additional rationale to include exercise into an MD treatment model is the abundance of literature showing the long-term positive effects of exercise on many of the mental health outcomes that affect individuals with MD, including depression (Cooney, Dwan, & Mead, 2014), anxiety (Salmon, 2001), body dissatisfaction (SantaBarbara, Whitworth, & Ciccolo, 2017), self-esteem (Ekeland, Heian, & Hagen, 2005), and negative affect (Ekkekakis, Parfitt, & Petruzzello, 2011). In addition, two studies that explored the acute effects of RE on MD symptoms (i.e., drive for size, functional impairment, appearance intolerance, perceived muscle size) in men who lift
weights yielded positive results, showing a reduction in these symptoms from after RE compared to after no exercise (Thomas, Tod, & Lavallee, 2011).

**Conclusion**

However, given the negative effects of MD, research elucidating potential methods to help treat MD is needed. There is a strong rationale to explore the effects of exercise, particularly RE, as an adjunct to current treatment models given the positive findings in the eating disorder literature. In addition, implementing RE into existing treatment models may help decrease reluctance to enter treatment, the chances of relapse, and may provide these individuals with knowledge on how to safely pursue and reach their physique goals without excessive exercise. The addition of RE may also help improve mental health through a reduction in depression, body dissatisfaction, anxiety, negative affect, and an improvement in self-esteem.
Table 1. Proposed Diagnostic Criteria for Muscle Dysmorphia.

A. Preoccupation with the idea that one’s body is not sufficiently lean and muscular. Characteristic association behaviors include long hours of lifting weights and excessive attention to diet.

B. The preoccupation is manifested by at least two of the following four criteria:

1. The individual frequently gives up important social, occupational, or recreational activities because of a compulsive need to maintain his or her workout or diet schedule.
2. The individual avoids situations where his or her body is exposed to others or endures such situations only with marked distress or intense anxiety.
3. The preoccupation about the inadequacy of body size or musculature causes clinically significant distress or impairment in social, occupational, or other important areas of functioning.
4. The individual continues to work out, diet, or use ergogenic (performance-enhancing) substances despite the knowledge of adverse physical or psychological consequences.

C. The primary focus of the preoccupation and behaviors is on being too small or inadequately muscular, as distinguished from fear of being fat as in anorexia nervosa, or a primary preoccupation only with other aspects of appearance as in other forms of body dysmorphic disorder.

Ref: (Pope, Jr. et al., 1997)
CHAPTER 2
PILOT STUDY
Acute Effects of Resistance Exercise in Men with and without Symptoms of Muscle Dysmorphia
Introduction

The existing research on the effects of exercise on body image has focused almost exclusively on its long-term effects using aerobic exercise (i.e., cycling, walking) in female samples (Campbell & Hausenblas, 2009; SantaBarbara et al., 2017). As a result, the effects of exercise on body image in men, and the acute and long-term effects of RE on body image overall, are unclear. In addition, no research has explored the effects of RE in men with MD symptoms.

Current research suggests that RE is a compensatory behavior for men with MD. RE is performed to acutely improve body image and negative affective states associated with feeling insufficiently muscular (Murray, Griffiths, Rieger, & Touyz, 2014; Tod & Lavallee, 2013). In fact, a conceptual model that can help explain the short-term regulation of these variables suggests that negative cognitions surrounding one’s body shape and size spark the use of RE to alleviate these feelings. For example, the acute physiological feedback (i.e., muscular pain) and perceived changes in muscle size (i.e., from temporary muscle swelling) associated with high-intensity RE may act as experiential evidence that one’s body is moving closer to the muscular ideal, which may temporarily relieve body image concerns and improve affective states (Waldorf, Erkens, Vocks, McCreary, & Cordes, 2016). As a result, individuals may repeatedly engage in RE, which may eventually establish a cycle where the short-term regulation of body image and affective states become tied to the acute physiological feedback associated with this routine (Waldorf et al., 2016). By comparison, even a mild disruption from this routine (i.e., low-intensity) may act as experiential evidence that one’s body is moving further away from the muscular ideal, ultimately intensifying poor body image and negative affective states (Pope Jr, Gruber, Choi, Olivardia, & Phillips, 1997; Waldorf et al., 2016). In these instances, men may subsequently compensate with more intense bouts of RE, which may reinforce perceptions that the acute physiological feedback from high-intensity RE is critical to increasing muscle size.
The hypothesized relationship between RE and MD symptoms is presented as a conceptual model in Figure 1.

Still, no studies have explored the acute effects of RE on state body image and affective states in men with (sub)clinical MD symptoms. Such findings within this sample would support the hypotheses that suggest that RE intensity is an important factor in improving these variables. Research with other populations (e.g., recreational weight lifters) has consistently shown improvements in affective states (Arent, Landers, Matt, & Etnier, 2005; Ekkekakis, 2013; Greene & Petruzzello, 2015; Cavarretta, Hall, & Bixby, 2018) and body image (Waldorf et al., 2016) after single sessions of moderate intensity RE, but none of these studies have targeted or directly assessed their participants for any degree of MD symptoms. This is an important distinction: before RE can be tested as an adjunctive therapy for MD, researchers must first elucidate what RE variables (e.g., intensity, volume) are most effective at improving body image and affective states in this population. With this information, an RE routine could be developed to mitigate the risk for the physical health consequences associated with excessive RE such as a decline in physiological functioning (e.g., elevated cortisol, decline in immunity) (Schwellnus et al., 2016) and an increased risk for physical injury (e.g., muscle tears) (Meeusen et al., 2013). This routine would ultimately be safer and less-risky, and could reduce the functional impairment that is, in part, a by-product of long hours performing RE.

As such, the purpose of this exploratory pilot study was to examine the psychological effects of a low intensity bout of RE after a period of RE abstinence in a sample of men with MD symptoms. Low-intensity RE was chosen because it is a departure from the customary high-intensity routine of men with MD. A period of abstinence was used to ensure the sample had not recently exercised and experienced any changes in body image of affect from exercising.

**Research Question 1**
How do the acute effects of low-intensity RE on state body image compare between men with and without MD symptoms?

**Hypothesis**

Low-intensity RE will have a beneficial effect on state body image in men without MD symptoms and will have either no effect or a negative effect on men with MD symptoms.

**Research Question 2**

How do the acute effects of low-intensity RE on affective states (i.e., affective valence and perceived activation) compare between men with and without MD symptoms?

**Hypothesis**

Low-intensity RE will have a beneficial effect on affective states in men without MD symptoms and will have either no effect or a negative effect on men with MD symptoms.

**Research Question 3**

What are the delayed effects (i.e., 30 minutes post RE) of low-intensity RE on state body image and affective states in men with MD symptoms compared to men without MD symptoms?

**Hypothesis**

Low-intensity RE will have a longer-lasting beneficial effect on state body image, and affective states for men without MD symptoms when compared to men with MD symptoms.

**Research Question 4**

How do men with and without MD symptoms differ on a battery of mental health and body image measures?
Hypothesis

Men with MD symptoms will score significantly worse on all baseline measures of mental health and body image when compared to men without MD symptoms.

Methods

Participants

Twenty age-matched men with \((n = 10)\) and without \((n = 10)\) MD symptoms were recruited. Inclusion required that all men were between the ages of 18 and 35 years, and currently performing RE for \(\geq 3\) days per week for \(> 45\) minutes each time. Participants who had any medical contraindication to exercise based on the guidelines from the American College of Sports Medicine (Thompson, Arena, Riebe, & Pescatello, 2013), and who were currently in or seeking mental health treatment, were excluded.

Procedures

Participants were recruited with flyers posted in local fitness centers. The phrase “muscle dysmorphia” was not used in the advertisements or description of the study. Interested participants assessed as eligible over the phone were scheduled for their first of three sessions. At Session 1, eligibility was reassessed, and a series of psychological and physiological assessments were conducted. At Session 2, additional psychological and physiological assessments were conducted including upper and lower body muscular strength. Upon completion, participants were scheduled for their experimental session (i.e., Session 3), which was at least 48-hours later. All participants were told to refrain from exercising in the 48-hours prior to Session 3. All were paid $50 for completing the entire three-session protocol. This study was approved by the College’s Institutional Review Board.
Measures

Demographics

This questionnaire assessed the participant’s age, race, education, employment, income, and sexual orientation.

Height, Weight, Body Composition

Standard procedures were used to measure height and weight. Participants removed their shoes and height was measured with a stadiometer. Body weight was measured using a calibrated electronic scale. Body composition was assessed using whole-body air-displacement plethysmography (BodPod, COSmed, Inc., Concord, CA, USA) with estimated thoracic gas volume according to the manufacture’s guidelines. The validity of air-displacement plethysmography for men has been established (Baracos et al., 2012).

Screening for Muscle Dysmorphia Symptoms

Four statements formed into questions were used to screen for MD symptoms, and to designate participants into a MD or non-MD group (see Figure 1 criterion 2) (Pope, Jr. et al., 1997). These criteria have recently been used to identify and compare those with and without MD symptoms (Schneider, Agthe, Yanagida, Voracek, & Hennig-Fast, 2017).

Muscle Dysmorphia Symptom Severity

The Muscle Dysmorphic Inventory (MDI) assessed MD symptom severity (Wolke & Sapouna, 2008). The MDI is a 16-item, 5-point Likert-type scale with scores ranging from 0 to 64 with higher scores indicating a greater MD symptom severity. Previous research has shown that the MDI is a valid way to assess MD symptom severity in men who perform RE (Rhea, Lantz, & Cornelius, 2004).
**Bodybuilding Dependence**

The Bodybuilding Dependence Scale (BDS) assessed exercise dependence related to bodybuilding. The BDS is a 9-item, 7-point Likert-type scale with scores ranging from 7 to 63 with higher scores indicating more bodybuilding dependence (Hurst, Hale, Smith, & Collins, 2000). Three different factors are associated with this scale: 1) Mastery (Questions 1 and 2); 2) Social dependence (Questions 3, 4, and 5); and 3) Training dependence (Questions 5, 6, 7, 8, and 9). Previous research has shown that the BDS is a valid way to assess bodybuilding dependence in a sample of men who perform RE (Smith, Hale, & Collins, 1998).

**Depressive Symptoms**

The 10-item Center for Epidemiological Studies Depression Scale (CES-D 10) assessed depressive symptoms (Björgvinsson, Kertz, Bigda-Peyton, McCoy, & Aderka, 2013). The CES-D 10 asks participants to rate how depressed they have been feeling over the past week (i.e., last seven days) with scores ranging from 0 to 30 with higher scores indicating more depressive symptoms.

**Symptoms of Anxiety**

The State-Trait Anxiety Inventory Trait Version (STAI-Y2) assessed levels of anxiety (Bieling, Antony, & Swinson, 1998). The STAI-Y2 trait version consists of 20 items that asks participants to rate how they generally feel on a scale with scores ranging from 20 to 80 with higher scores indicating higher levels of anxiety.

**Social Physique Anxiety**

The Social Physique Anxiety Scale (SPAS) assessed levels of physique anxiety in social environments (Hart, Leary, & Rejeski, 1989). The SPAS is a 12-item, Likert-type scale with scores ranging from 12 to 60 with higher scores indicating more social physique anxiety.
Questions 1, 2, 5, 8, and 11 are reversed scored. The SPAS has strong psychometric properties (Hart et al., 1989), and has been used to assess social physique anxiety in men who perform RE (Hurst et al., 2000; Thomas, Tod, Edwards, & McGuigan, 2014).

**State Body Image**

State body image was assessed using the Body Image States Scale (BISS) (Cash, Fleming, Alindogan, Steadman, & Whitehead, 2002). The BISS is a 6-item, 9-point, bipolar, Likert-type scale. Half of the questions (1, 3, and 5) are presented in a negative to positive direction, and the other half (2, 4, and 6) are presented in a positive to negative direction. Scores were coded from 1 “Extremely dissatisfied” to 9 “Extremely satisfied” and ranged from 6 to 54 with higher scores indicating a more favorable state body image. The BISS is a reliable and valid way to assess state body image (Cash et al., 2002), and has been used to measure acute changes in body image in men before and after RE (Waldorf et al., 2016). The BISS was administered at PRE, POST, and DELAY.

**Affective State**

A dimensional model of exercise-related affect was used to assess changes in affective states during and after RE (Ekkekakis & Petruzzello, 2002). Specifically, the Feeling Scale (FS) (Hardy & Rejeski, 1989) is a single-item measure of affective valence (pleasure/displeasure). The FS is an 11-point bi-polar measure with scores ranging from -5 “very bad” to 0 “neutral” to +5 “very good”. The Felt Arousal Scale (FAS) (Svebak & Murgatroyd, 1985) is a single-item measure of perceived activation (i.e., arousal). The FAS is a 6-point measure with scores ranging from 1 “low arousal” to 6 “high arousal”. The FS and FAS have good reliability and been used in similar populations to measure affect and arousal before and after RE (Arent, Landers, Matt, & Etnier, 2005; Ekkekakis, 2013; Greene & Petruzzello, 2015). The FS and FAS were administered at PRE, POST, and DELAY.
Affective valence and perceived activation can be used to highlight changes in exercise-related affective states before and after RE via the circumplex model, and are single-item assessments to avoid disruption during exercise (Ekkekakis et al., 2011). In this model, the horizontal dimension is affective valence (FS) and the vertical dimension is perceived activation (FAS), and can be divided into four quadrants:

1) Upper right quadrant: high activation pleasure (e.g., energy, and vigor)
2) Lower right quadrant: low activation pleasure (e.g., calmness, relaxation)
3) Upper left quadrant: high activation displeasure (e.g., tension, distress)
4) Lower left quadrant: low activation displeasure (e.g., tiredness, boredom)

**Rating of Perceived Exertion**

The single-item Ratings of Perceived Exertion (RPE) (Borg, 1982) scale assessed ratings of perceived exertion after RE. Participants were asked how hard they were currently working with responses ranging from 0 “Rest” to 10 “Maximal”.

**Muscular Strength**

The National Strength and Conditioning Association’s guidelines for determining 10-repetition maximum (10-RM) muscular strength were followed (Haff, Triplett, & National Strength & Conditioning Association (U.S.), 2015). The exercises assessed were the chest press, leg extension, shoulder press, and biceps curl. Prior to testing, participants warmed up on a stationary bicycle for 5 minutes, followed by progressively heavier warm-up sets for each exercise. During testing, if a successful RM attempt was made, the load was increased by 5% to 10% for upper body exercises (i.e., chest press, shoulder press, and biceps curl), and 10% to 20% for the lower body (i.e., leg extension).

**Experimental Session**
The experimental session lasted approximately 60 minutes. Upon arrival, and after participants had been sitting for at least 5 minutes, heart rate and blood pressure were assessed, and all participants completed their PRE-assessments. Then, participants warmed up on a stationary bicycle for 5 minutes and then completed the exercise. During the delay, participants sat quietly in the weight room out of sight of any mirrors and read a non-fitness related magazine (e.g., National Geographic). The weight room used for this study is used primarily for research, and no outside observers or exercisers were present at any point during the study, nor was there any music or access to electronic devices. Body image and affective states were assessed before (PRE), immediately after (POST), and 30-minutes after RE (DELAY).

Data Analysis

Descriptive statistics describing the demographic characteristics of the sample are divided by group and presented in Table 2. Mean group differences on all psychological and physiological measures were analyzed using independent samples t-tests and are presented in Table 3. A series of repeated-measures analysis of variance (ANOVA) were used to analyze changes in body image and affective states over group by time. The statistical significance level was set a priori at p < .05 and paired-samples t-tests were used for all post-hoc tests. Effect sizes are reported as Cohen’s d and can be interpreted as .20 = small, .50 = medium, and .80 = large (Borenstein, 2009). All analyses were conducted using IBM SPSS 25.

Results

A total of 192 individuals were screened for eligibility over the phone, resulting in 33 in-person screenings and 20 enrolled participants (i.e., 10 in each group). Demographic details of both groups are presented in Table 2.
**Trait Psychological Assessments**

Compared to men in the non-MD group, men in the MD group had significantly higher levels of depressive symptoms \((M = 11.40, SD = 3.16 \text{ vs. } M = 6.50, SD = .68; t(18) = 3.19, p = .01)\) and anxiety \((M = 48.60, SD = 7.16 \text{ vs. } M = 36.30, SD = 6.21; t(18) = 4.10, p < .01)\). In addition, men in the MD group had greater MD symptom-severity \((M = 30.80, SD = 5.65 \text{ vs. } M = 18.50, SD = 5.54; t(18) = 4.91, p < .001)\), and higher levels of bodybuilding dependence \((M = 44.40, SD = 4.76 \text{ vs. } M = 29.90, SD = 3.81; t(18) = 7.51, p < .001)\), social physique anxiety \((M = 37.90, SD = 7.40 \text{ vs. } M = 26.00, SD = 6.35; t(18) = 3.86, p < .01)\), and restraint eating \((M = 17.30, SD = 6.41 \text{ vs. } M = 9.50, SD = 3.68; t(18) = 3.33, p < .01)\). Additional details are presented in Table 3.

**Physiological Assessments**

There were no differences in 10-RM muscular strength for the chest press \((p = .06)\), leg extension \((p = .19)\), or shoulder press \((p = .16)\). There was, however, a significant difference in 10-RM biceps curl muscular strength in favor of the MD group \((M = 31.00, SD = 3.94 \text{ vs. } M = 25.50, SD = 7.05; t(18) = 1.95, p = .05)\). No significant differences between groups were found for height \((p = .49)\), weight \((p = .49)\), body fat \((p = .36)\), or RPE \((p = .76)\). Additional details are presented in Table 3.

**State Body Image**

Results for state body image showed a significant effect of time \((F = 6.57, p < .01, \eta^2 = .27)\), and group \((F = 8.04, p < .01, \eta^2 = .31)\), but not group x time \((F = .70, p = .50, \eta^2 = .04)\). For the non-MD group, post hoc analyses revealed that BISS scores significantly increased from PRE \((M = 3.50, SD = .45)\) to POST \((M = 3.90, SD = .38); t(9) = 3.45, p = .01, d = .99\), but not from PRE to DELAY-30 \((p = .78)\). Of note, BISS scores significantly decreased from POST \((M = 3.90, SD = .38)\) to DELAY-30 \((M = 3.50, SD = .49); t(9) = 3.14, p = .01, d = 1.04\). State body
image did not significantly change at any time point for the MD group (ps > .05). Results are presented in Table 4 and Figure 2.

**Affective Valence**

Results for affective valence (i.e., FS scores) showed a significant effect of time ($F = 4.61, p = .02, \eta^2 = .20$). However, there were no significant effects of group ($F = 2.33, p = .11, \eta^2 = .12$), or group x time ($F = .57, p = .57, \eta^2 = .03$). For the non-MD group, post hoc analyses revealed no changes in FS scores at any time point (ps > .05). For men in the MD group, there were no significant changes in FS scores from PRE to POST ($p = .21$) or from PRE to DELAY ($p = .21$). However, FS scores significantly decreased from POST ($M = 3.10, SD = 1.29$) to DELAY ($M = 2.10, SD = .88$); $t(9) = 3.00, p = .02, d = .90$. Results are presented in Table 5 and Figure 3.

**Perceived Activation**

Results for perceived activation (i.e., FAS scores) showed a significant effect of time ($F = 43.80, p < .001, \eta^2 = .71$). However, there were no significant effects of group ($F = .59, p = .45, \eta^2 = .03$), or group x time ($F = 3.02 p = .07, \eta^2 = .14$). For the non-MD group, post hoc analyses revealed that FAS scores significantly increased from PRE ($M = 2.60, SD = 1.07$) to POST ($M = 4.30, SD = .82$); $t(9) = 7.97, p < .001, d = 1.78$, but not from PRE to DELAY ($p = .10$). Of note, FAS scores significantly decreased from POST ($M = 4.30, SD = .82$) to DELAY ($M = 2.20, SD = 1.23$); $t(9) = 9.00, p < .001, d = 2.0$. For the MD group, there were no changes in FAS scores from PRE to POST ($p = .09$); however, FAS scores significantly decreased from PRE ($M = 2.90, SD = 1.10$) to DELAY ($M = 1.70, SD = .95$); $t(9) = 2.57, p = .03, d = 1.17$, and from POST ($M = 3.60, SD = .97$) to DELAY ($M = 1.70, SD = .95$); $t(9) = 8.14, p < .001, d = 1.98$. Results are presented in Table 6 and Figure 4.
Exercise-Related Affective Stress

The circumplex model was also used to further highlight changes in exercise-related affective states before and after RE (Ekkekakis, Parfitt, & Petruzzello, 2011). Specifically, both groups began and ended the session in a low-activated pleasure state. At post, however, the non-MD group shifted into a high-activated pleasure state while the MD group remained in a low-activated pleasure state.

Discussion

This pilot study is the first to explore and compare the acute effects of RE on state body image and affective states in men with and without MD symptoms. In doing so, it provides new and valuable insight into the acute effects of RE in men with MD symptoms, and how RE could be incorporated to augment existing MD treatment methods.

State Body Image

Overall, the results supported our hypotheses for research question one, and indicated that the MD group had a less favorable body image response to the low-intensity RE compared to the non-MD group. More specifically, when comparing the effects of RE on state body image between the two groups, increases were found in the non-MD group only. For those in the MD group, this particular intensity may not have provided the experiential evidence (i.e., muscle pain, swelling) that one’s body is moving closer to the muscular ideal. It is also possible that the RE sessions consisted of exercises not normally performed by men in the MD group, which further supports the idea that a disruption from the normal routine can alter the response to RE, and that higher intensities may be needed to elicit an improvement in body image.

Affective States
Despite significant changes in affective valence (FS scores) and perceived activation (FAS scores) during and after the session, both groups began and ended (i.e., at DELAY) the session in a low-activation pleasure state (i.e., lower left quadrant). At POST, however, men in the non-MD group shifted into a high-activation pleasure state (i.e., upper right quadrant). These findings only partially support our hypothesis. The hypothesis that men in the non-MD group would have a pleasurable experience during the session was supported. However, the hypothesis that men in the MD group would experience displeasure during this session was only partially supported. Specifically, men in the MD group remained in a low-activation pleasure state at all time points; however, the combination of FS and FAS scores from POST to DELAY showed a shift towards baseline and a low-activation displeasure state. Thus, men in the non-MD group had a pleasurable experience during and after the session, while men in the MD group started to experience displeasure after the session. There are likely a number of factors that contributed to this unpleasant experience including a structured RE routine instead of a self-selected one, lifting in front of study staff in silence (i.e., very little conversation and no music), or being aware that they were participating in a research study instead of being in their regular gym doing one of their normal routines. However, the most likely factor that may have contributed to the unpleasant experience could have been the low-intensity, and by extension, the perception that this RE session did not increase muscle size or move them closer to their ideal.

Conclusions

To our knowledge, this is the first study to examine the acute effects of RE in men with MD symptoms; an important first step in the process of developing an optimal RE routine that could be added to augment existing MD treatment methods. The results appear to support the use of the four eligibility questions to differentiate and recruit men with and without MD symptoms. For example, in addition to the group differences before and after RE, scores on all
baseline psychological assessments lend further support, as there were significant differences between the two groups on all relevant measures. Using these questions to recruit men with MD symptoms in the future could provide more valuable insight into this at-risk population compared to eligibility criteria that has previously been used for recruitment. For example, one study identified men with, or at risk for MD, based on whether they could bench press their body weight for 10 repetitions (Cafri et al., 2008). Another study identified men with, or at risk for MD, based on whether they were currently performing RE for more than three days each week for at least 45 minutes each time (Baghurst & Lirgg, 2009). This is problematic, as MD is more complex than muscular strength and RE frequency and duration and requires a more in-depth and specific set of inclusion criteria.

Despite these preliminary findings, more research is needed to further explore the acute effects of RE and potential mechanisms that can explain these effects in men with MD symptoms. For example, given the potential link between changes in body image and perceived muscle size, the dissertation will include a measure of perceived muscle size, and will explore if it is associated with changes in state body image before and after RE. Additionally, how much men with MD enjoy a RE session may be a mechanism of action supporting a change in body image and affective states (Jekauc, 2015). For example, one study found that men with MD enjoy exercising significantly more than men with anorexia nervosa (Murray et al., 2012), and another study in male weight lifters found that exercise enjoyment significantly improved from pre to post RE but not from pre to post cycling (i.e., aerobic exercise) (Waldorf et al., 2016). Thus, it is possible that there is a link between improvements in state body image, affective states, and perceived muscle size, and how much these men enjoy the session. In other words, the level of enjoyment during and after RE may be tied to how much these men perceive their muscle size to be improving, which may ultimately lead to improvements in body image and affective states.
Looking forward, the preliminary results from this pilot study support further exploration into the effects of RE in men with MD symptoms. This future work, which is the aim of my dissertation, will help further elucidate the acute effects of RE and the potential mechanisms that can explain these effects in men with MD symptoms. Ultimately, this pilot study and the dissertation study will provide current and future researchers with direction and guidance towards the development an optimal RE routine that could maximize body satisfaction in this population.
Figure 1. Hypothesized relationship between RE and MD symptoms.
Table 2. Sample characteristics divided by group.

<table>
<thead>
<tr>
<th></th>
<th>MD Group (n = 10)</th>
<th>Non-MD Group (n = 10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>$M = 26.7$</td>
<td>$M = 26.4$</td>
</tr>
<tr>
<td></td>
<td>$SD = 4.7$</td>
<td>$SD = 4.1$</td>
</tr>
<tr>
<td>Race</td>
<td>$N$ (%)</td>
<td>$N$ (%)</td>
</tr>
<tr>
<td>Asian</td>
<td>3 (30%)</td>
<td>4 (40%)</td>
</tr>
<tr>
<td>Black or African American</td>
<td>2 (20%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>White</td>
<td>5 (50%)</td>
<td>5 (50%)</td>
</tr>
<tr>
<td>Other</td>
<td>0 (0%)</td>
<td>1 (10%)</td>
</tr>
<tr>
<td>Education</td>
<td>$N$ (%)</td>
<td>$N$ (%)</td>
</tr>
<tr>
<td>High school graduate</td>
<td>0 (0%)</td>
<td>1 (10%)</td>
</tr>
<tr>
<td>Some Vocational School/College</td>
<td>2 (20%)</td>
<td>1 (10%)</td>
</tr>
<tr>
<td>Completed college</td>
<td>1 (10%)</td>
<td>3 (30%)</td>
</tr>
<tr>
<td>Some graduate school</td>
<td>4 (40%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>College graduate (masters)</td>
<td>2 (20%)</td>
<td>4 (40%)</td>
</tr>
<tr>
<td>College graduate (doctoral)</td>
<td>1 (10%)</td>
<td>1 (10%)</td>
</tr>
<tr>
<td>Employment</td>
<td>$N$ (%)</td>
<td>$N$ (%)</td>
</tr>
<tr>
<td>Full time</td>
<td>3 (30%)</td>
<td>4 (40%)</td>
</tr>
<tr>
<td>Student</td>
<td>7 (70%)</td>
<td>6 (60%)</td>
</tr>
<tr>
<td>Income</td>
<td>$N$ (%)</td>
<td>$N$ (%)</td>
</tr>
<tr>
<td>&lt; $11,500</td>
<td>3 (30%)</td>
<td>3 (30%)</td>
</tr>
<tr>
<td>$15,001-$25,000</td>
<td>0 (0%)</td>
<td>1 (10%)</td>
</tr>
<tr>
<td>$25,001-$40,000</td>
<td>3 (30%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>$40,001-$60,000</td>
<td>1 (10%)</td>
<td>2 (20%)</td>
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<td>$60,001-$80,000</td>
<td>1 (10%)</td>
<td>1 (10%)</td>
</tr>
<tr>
<td>$80,001-$100,000</td>
<td>0 (0%)</td>
<td>1 (10%)</td>
</tr>
<tr>
<td>Do not know</td>
<td>0 (0%)</td>
<td>1 (10%)</td>
</tr>
<tr>
<td>Do not want to answer</td>
<td>2 (20%)</td>
<td>1 (10%)</td>
</tr>
<tr>
<td>Sexual Orientation</td>
<td>$N$ (%)</td>
<td>$N$ (%)</td>
</tr>
<tr>
<td>Heterosexual</td>
<td>9 (90%)</td>
<td>9 (90%)</td>
</tr>
<tr>
<td>Homosexual</td>
<td>0 (0%)</td>
<td>1 (10%)</td>
</tr>
<tr>
<td>Bisexual</td>
<td>1 (10%)</td>
<td>0 (0%)</td>
</tr>
</tbody>
</table>
Table 3. Means, standard deviations, and significance tests for all psychological and physiological measures.

<table>
<thead>
<tr>
<th></th>
<th>MD Group</th>
<th>Non-MD Group</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Psychological</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BDS</td>
<td>44.40 (4.77)</td>
<td>29.90 (3.81)</td>
<td>7.51</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>MDI</td>
<td>30.80 (5.65)</td>
<td>18.50 (5.54)</td>
<td>4.91</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>RS</td>
<td>17.30 (6.41)</td>
<td>9.50 (3.69)</td>
<td>3.33</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>SPAS</td>
<td>37.90 (7.40)</td>
<td>26.00 (6.36)</td>
<td>3.86</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>CES-D 10</td>
<td>11.40 (3.17)</td>
<td>6.50 (3.69)</td>
<td>3.19</td>
<td>0.01</td>
</tr>
<tr>
<td>STAI</td>
<td>48.60 (7.17)</td>
<td>36.30 (6.22)</td>
<td>4.09</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>RPE</td>
<td>3.50 (1.43)</td>
<td>3.70 (1.42)</td>
<td>0.31</td>
<td>0.76</td>
</tr>
<tr>
<td><strong>Physiological</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height (in)</td>
<td>69.70 (3.59)</td>
<td>70.61 (1.62)</td>
<td>0.69</td>
<td>0.49</td>
</tr>
<tr>
<td>Weight (lbs)</td>
<td>163.03 (21.41)</td>
<td>169.70 (20.23)</td>
<td>0.69</td>
<td>0.49</td>
</tr>
<tr>
<td>Body fat (%)</td>
<td>15.02 (7.30)</td>
<td>17.62 (3.94)</td>
<td>0.95</td>
<td>0.36</td>
</tr>
<tr>
<td>10-RM Chest Press</td>
<td>81.50 (18.11)</td>
<td>65.00 (19.18)</td>
<td>1.98</td>
<td>0.06</td>
</tr>
<tr>
<td>10-RM Leg Extension</td>
<td>53.75 (10.02)</td>
<td>46.75 (12.91)</td>
<td>1.35</td>
<td>0.19</td>
</tr>
<tr>
<td>10-RM Shoulder Press</td>
<td>40.75 (6.46)</td>
<td>35.00 (10.62)</td>
<td>1.46</td>
<td>0.16</td>
</tr>
<tr>
<td>10-RM Biceps Curl</td>
<td>31.00 (3.94)</td>
<td>25.5 (7.05)</td>
<td>2.15</td>
<td>0.05</td>
</tr>
</tbody>
</table>

BDS = Bodybuilding Dependence Scale; MDI = Muscle Dysmorphic Inventory; RS = Restraint Scale; SPAS = Social Physique Anxiety Scale; CES-D 10 = 10-item Center for Epidemiological Studies Depression Scale; STAI = State-Trait Anxiety Inventory; RPE = Ratings of Perceived Exertion; RM = Repetition Maximum.
Table 4. ANOVA results for state body image (BISS) over Group x Time.

<table>
<thead>
<tr>
<th></th>
<th>PRE</th>
<th>POST</th>
<th>DELAY</th>
<th>F Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>MD</td>
<td>3.04 (.55)</td>
<td>3.28 (.59)</td>
<td>3.07 (.47)</td>
<td>6.57*</td>
</tr>
<tr>
<td>Non-MD</td>
<td>3.53 (.45)</td>
<td>3.94 (.37)</td>
<td>3.49 (.49)</td>
<td></td>
</tr>
</tbody>
</table>

*p < .01*.

Figure 2. Mean changes in BISS scores over Group x Time.

a. Significant difference from PRE to POST for the non-MD group.

b. Significant difference from POST to DELAY for the non-MD.
Table 5. ANOVA results for affective valence (FS) over Group x Time.

<table>
<thead>
<tr>
<th></th>
<th>PRE</th>
<th>POST</th>
<th>DELAY</th>
<th>F Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Time</td>
</tr>
<tr>
<td>MD</td>
<td>2.60 (.15)</td>
<td>3.10 (.13)</td>
<td>2.10 (.88)</td>
<td>4.61*</td>
</tr>
<tr>
<td>Non-MD</td>
<td>3.20 (.11)</td>
<td>3.60 (.11)</td>
<td>3.10 (.13)</td>
<td></td>
</tr>
</tbody>
</table>

*p < .05*.

Figure 3. Mean changes in FS scores over Group x Time.

a. Significant difference from POST to DELAY for the MD group.
Table 6. ANOVA results for perceived activation (FAS) over Group x Time.

<table>
<thead>
<tr>
<th></th>
<th>PRE</th>
<th>POST</th>
<th>DELAY</th>
<th>F Statistics</th>
<th>Time</th>
<th>Group</th>
<th>Group x Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>MD</td>
<td>2.90</td>
<td>3.60</td>
<td>1.70</td>
<td>43.80***</td>
<td>.59</td>
<td>.95</td>
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<tr>
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<td>4.30</td>
<td>2.20</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$ p < .001^*$. 

Figure 4. Mean changes in FAS scores over Group x Time.

a. Significant difference from PRE to POST for the non-MD.
b. Significant difference from POST to DELAY for the non-MD group.
c. Significant difference from PRE to DELAY for the MD group.
d. Significant difference from POST to DELAY for the MD group.
CHAPTER 3
DISSERTATION STUDY
Acute Effects of Resistance Exercise in Men with Symptoms of Muscle Dysmorphia
Introduction

The results of the pilot study suggest that low intensity RE (50% of 10-RM) is ineffective at temporarily improving state body image and exercise-related affective states in men with MD symptoms. This could be attributed to a number of different factors, but it is likely that the feedback associated with RE at higher intensities acts as important experiential evidence that one’s body is increasing in muscle size and moving closer to a muscular ideal, ultimately improving body image. Thus, the purpose of this dissertation study was to expand upon the results of the pilot study by examining the acute effects of two higher RE intensities (moderate vs. high) in men with MD symptoms.

Similar procedures and measures were used for this study (detailed below); however, two acute measures have been added to this study that were not included in the pilot study and affective states were assessed at the midpoint of each session. One of these assessments is the male-body silhouette scale, which assessed acute changes in how participants perceived their muscle size to change before and after RE. The second acute assessment added was a single-item measure of exercise enjoyment, which assessed levels of exercise enjoyment during and after RE.

Research Question 1

What are the acute effects of RE of varying intensities (70% of 10-RM vs. 100% of 10-RM) on state body image in men with MD symptoms?

Hypothesis

Both moderate and high-intensity RE will have a beneficial effect on state body image. However, high compared to moderate-intensity RE will be more effective.
Research Question 2
What are the acute effects of RE of varying intensities (70% of 10-RM vs. 100% of 10-RM) on affective states in men with MD symptoms?

Hypothesis
Both moderate and high-intensity RE will have a beneficial effect on affective states. However, high compared to moderate-intensity RE will be more effective.

Research Question 3
What are the acute effects of RE of varying intensities (70% of 10-RM vs. 100% of 10-RM) on perceived muscle size in men with MD symptoms?

Hypothesis
Both moderate and high-intensity RE will improve perceived muscle size. However, high compared to moderate-intensity RE will be more effective.

Research Question 4
What are the delayed effects (i.e., 30 minutes post RE) of moderate and high intensity RE on state body image, affective states, and perceived muscle size in men with MD symptoms?

Hypothesis
High compared to moderate intensity RE will have a longer-lasting beneficial effect on state body image, affective states, and perceived muscle size.

Research Question 5
Do men with MD symptoms enjoy participating in high intensity RE more than moderate intensity RE?

**Hypothesis**

Men will enjoy the high-intensity RE session significantly more than the moderate-intensity RE session.

**Methods**

**Participants**

Twenty-one men aged 18-35 years were recruited. Inclusion required that all men were currently performing RE for ≥ 3 days per week for > 45 minutes each time. Participants who had any medical contraindication to exercise based on the guidelines from the American College of Sports Medicine (Thompson et al., 2013), and who were currently in or seeking mental health treatment were excluded. In addition, participants must have met the same set of criteria for MD symptoms as the pilot study (i.e., “Yes” to two or more (i.e., 1 cognitive, 1 behavioral).

**Recruitment**

Participants were recruited with flyers posted in NYC fitness centers, online through free online classified listings (e.g., Craigslist), and on Facebook and Instagram. The phrase “muscle dysmorphia” was not used in the advertisements or description of the study.

**Procedure**

This study was a randomized within-subjects crossover design, such that all participants completed an acute bout of moderate (70% of 10-RM) and high (100% of 10-RM) intensity RE in a counterbalanced order. An online random number generator was used to create the session order. Consistent with the procedures from the pilot study, participants will be required to
abstain from any exercise 48-hours prior to both RE sessions. Importantly, to minimize expectancy bias, participants were blinded to the intensity of the RE sessions.

Session 1

Participants who were assessed as eligible over the phone were scheduled for their first of four onsite sessions. They were first orientated to the study’s procedures, and if still interested, signed an informed consent and HIPAA. Eligibility was then reassessed to ensure participants still met all inclusion criteria (e.g., MD symptoms, self-reported weekly exercise, physical health), and this was followed by psychological and physiological assessments. More specifically, psychological assessments included the Muscle Dysmorphic Inventory, Bodybuilding Dependence Scale, Male Body Silhouette Scale, and the Restraint (Eating) Scale. Physiological assessments included resting heart rate and blood pressure after participants had been sitting for at least five minutes, height and weight, and body composition (i.e., body fat %). Participants who remained eligible were then scheduled for Session 2.

Session 2

Upon arrival, participants completed additional psychological and physiological assessments. This included the Reasons for Exercise Inventory, Social Physique Anxiety Scale, the 10-item Center for Epidemiologic Studies Depression Scale, and the State-Trait Anxiety Inventory. Physiological assessments included resting heart rate and blood pressure after participants had been sitting for at least five minutes, and a series of 10-repetition maximum (10-RM) muscular strength tests. The National Strength and Conditioning Association’s guidelines for determining 10-repetition maximum (10-RM) were followed (Haff et al., 2015). The exercises assessed were the chest press, leg extension, shoulder press, and biceps curl. Prior to testing, participants warmed up on a stationary bicycle for 5 minutes, followed by progressively heavier warm-up sets for each exercise. During testing, if a successful RM
attempt was made, the load was increased by 5% to 10% for upper body exercises (i.e., chest press, shoulder press, and biceps curl), and 10% to 20% for the lower body (i.e., leg extension).

Session 3

Upon arrival, and after participants had been sitting for at least 5 minutes, heart rate and blood pressure were assessed, followed by a warmup of 5 minutes on a stationary bicycle. Participants then completed either a session of moderate or high intensity RE. Moderate and high intensity were operationalized as 70% and 100% of 10-RM, respectively, based on previous research examining RE intensity and affect (Arent et al., 2005). Weight was rounded to the nearest 2.5-pound increment. State body image and perceived muscle size were assessed prior to RE (PRE), immediately after RE (POST), and 30 minutes after RE (DELAY). Affective state (i.e., affective valence and perceived activation) was assessed at PRE, at the midway point of the session (i.e., after the last set of leg extensions) (MID), POST, and DELAY. Ratings of perceived exertion (RPE) and exercise enjoyment were assessed at MID and POST. Upon completion, Session 4 was scheduled at least 48-hours later.

Session 4

Session 4 followed a similar protocol to Session 3; however, participants completed the RE intensity that was not completed at Session 3. Participants were then debriefed about the true nature of the study, were provided with their scores on study measures, had time to ask any questions related to the study, and were paid $50 for completing the entire five-session protocol. This study was approved by the College’s Institutional Review Board.

Exercise Session Protocol

Sessions 3 and 4 lasted approximately 60 minutes. Heart rate and blood pressure were assessed first after participants had been sitting for at least 5-minutes. Participants then
completed their PRE-assessments, followed by their 5-minute warmup on a stationary bicycle. During the exercise sessions, participants performed 3 sets of 10 repetitions of the exercises tested at Session 2 in the following order: chest press, leg extensions, shoulder press, and biceps curls. Participants were given 90 seconds of rest between sets.

*Delay Protocol*

During the delay, participants sat quietly in the weight room out of sight of any mirrors and read a non-fitness related magazine (e.g., National Geographic) for 30-minutes. The weight room used for this study is used primarily for research, and no outside observers or exercisers were present at any point during the study, nor was there any music or access to electronic devices.

*Measures*

*Demographics*

This questionnaire assessed participant’s age, gender, race/ethnicity, living situation, education, employment, income, and sexual orientation.

*Health History*

This questionnaire assessed any history of mental health disorders, and to ensure that participants have no contraindications to RE based on the guidelines from the American College of Sports Medicine (Thompson et al., 2013).

*Self-Reported Physical Activity*

The Modifiable Activity Questionnaire (MAQ) was used to assess participation in various forms of physical activity over the past week (i.e., past 7-days). The MAQ is an interview-administered style survey that measures the amount of physical activity participation over the
past week (Gabriel, McClain, Schmid, Storti, & Ainsworth, 2011). Previous research has shown that the MAQ is a reliable and valid way to assess physical activity performed in the past week (Gabriel et al., 2011). The MAQ was administered over the phone to determine initial eligibility, and once again at Session 1 to ensure participants remained eligible.

**Screening for Muscle Dysmorphia Symptoms**

Four questions were used to screen for MD symptoms (Pope, Jr. et al., 1997). These four questions have recently been used to identify and compare those with and without MD symptoms (Schneider et al., 2017).

**Bodybuilding Dependence**

The Bodybuilding Dependence Scale (BDS) assessed exercise dependence related to bodybuilding. The BDS is a 9-item, 7-point Likert-type scale with scores ranging from 7 to 63 with higher scores indicating more bodybuilding dependence (Hurst et al., 2000). Three different factors are associated with this scale: 1) Mastery (Questions 1 and 2); 2) Social dependence (Questions 3, 4, and 5); and 3) Training dependence (Questions 5, 6, 7, 8, and 9). Previous research has shown that the BDS is a valid way to assess bodybuilding dependence in a sample of men who perform RE (Smith et al., 1998).

**Depressive Symptoms**

The 10-item Center for Epidemiological Studies Depression Scale (CES-D 10) assessed depressive symptoms (Björgvinsson et al., 2013). The CES-D 10 asks participants to rate how depressed they have been feeling over the past week (i.e., last seven days) with scores ranging from 0 to 30 with higher scores indicating more depressive symptoms.

**Symptoms of Anxiety**
The State-Trait Anxiety Inventory Trait Version (STAI-Y2) assessed levels of anxiety (Bieling et al., 1998). The STAI-Y2 trait version consists of 20 items that asks participants to rate how they generally feel on a scale with scores ranging from 20 to 80 with higher scores indicating higher levels of anxiety.

**Social Physique Anxiety**

The Social Physique Anxiety Scale (SPAS) assessed levels of physique anxiety in social environments (Hart et al., 1989). The SPAS is a 12-item, Likert-type scale with scores ranging from 12 to 60 with higher scores indicating more social physique anxiety. Questions 1, 2, 5, 8, and 11 are reversed scored. The SPAS has strong psychometric properties (Hart et al., 1989), and has been used to assess social physique anxiety in men who perform RE (Hurst et al., 2000; A. Thomas et al., 2014).

**Motivations for Exercise**

The Reasons for Exercise Inventory (REI) assessed motivation for exercise (Silberstein, Striegel-Moore, Timko, & Rodin, 1988). The REI is a 24-item measure that assesses seven different motives for exercise: 1) weight control; 2) fitness; 3) mood; 4) health; 5) attractiveness; 6) enjoyment; and 7) tone. Scores range from 1 (Not at all important) to 7 (Extremely important). Scores on each of the subscales are totaled independently with higher scores indicating participant’s motivation for exercise. For purposes of this study, the instructions will be adapted to emphasize reasons for RE as opposed to reasons for exercise in general. This method has previously been used to determine motivations for RE in men who perform RE (Williams & Cash, 2001).

**Perceived Muscularity**
Perceived muscle size was assessed using a male-body silhouette scale (Lynch & Zellner, 1999). This nine-item scale has figures of men that range from 10 (Not at all muscular) to 90 (Extremely muscular). At Session 1, participants were shown the scale and asked to choose the figure that corresponded the most similar to the following four statements:

1) Please choose the figure that you think you currently look like.
2) Please choose the figure that you would ideally want to look like.
3) Please choose the figure that you think other people would choose as ideal.
4) Please choose the figure that you think your romantic partner (or future romantic partner) would find most attractive.

During Sessions 3 and 4 (i.e., exercise sessions), participants were given the scale and asked to respond to statement one at PRE, POST, and DELAY. This scale has previously been used to assess changes in perceived muscle size in college-aged men before and after RE (Cafri & Thompson, 2004; Ginis, Eng, Arbour, Hartman, & Phillips, 2005).

Muscle Dysmorphia Symptom Severity

The Muscle Dysmorphic Inventory (MDI) assessed MD symptom severity (Wolke & Sapouna, 2008). The MDI is a 16-item, 5-point Likert-type scale with scores ranging from 0 to 64 with higher scores indicating a greater MD symptom severity. Previous research has shown that the MDI is a valid way to assess MD symptom severity in men who perform RE (Rhea et al., 2004).

Exercise Enjoyment

A single-item questionnaire was used to examine participants exercise enjoyment (Stanley & Cumming, 2010). This questionnaire prompted participants to respond to the following question: “Indicate how much you are enjoying this resistance exercise session” Scores will range from 1 (Not at all) to 7 (Extremely).
**State Body Image**

State body image was assessed using the Body Image States Scale (BISS) (Cash et al., 2002). The BISS is a 6-item, 9-point, bipolar, Likert-type scale. Half of the questions (1, 3, and 5) are presented in a negative to positive direction, and the other half (2, 4, and 6) are presented in a positive to negative direction. Scores were coded from 1 “Extremely dissatisfied” to 9 “Extremely satisfied” and ranged from 6 to 54 with higher scores indicating a more favorable state body image. The BISS is a reliable and valid way to assess state body image (Cash et al., 2002), and has been used to measure acute changes in body image in men before and after RE (Waldorf et al., 2016).

**Affective States**

A dimensional model of exercise-specific affect was used to assess changes in affective states (Ekkekakis & Petruzzello, 2002). Specifically, the Feeling Scale (FS) (Hardy & Rejeski, 1989) is a single-item measure of affective valence (pleasure/displeasure). The FS is an 11-point bi-polar measure with scores ranging from -5 “very bad” to 0 “neutral” to +5 “very good”. Perceived Activation (i.e., arousal) was measured using the Felt Arousal Scale (FAS) (Svebak & Murgatroyd, 1985). The FAS is a 6-point single-item measure with scores ranging from 1 “low arousal” to 6 “high arousal”. The FS and FAS have good reliability and have been used in similar populations to measure affect and arousal before and after RE (Arent, Landers, Matt, & Etnier, 2005; Ekkekakis, 2013; Greene & Petruzzello, 2015).

Affective valence and perceived activation were used to highlight changes in exercise-related affective states before and after RE via the circumplex model (Ekkekakis et al., 2011). In this model, the horizontal dimension is affective valence (FS) and the vertical dimension is perceived activation (FAS), and can be divided into four quadrants:

1) Upper right quadrant: high activation pleasure (e.g., energy, and vigor)
2) Lower right quadrant: low activation pleasure (e.g., calmness, relaxation)
3) Upper left quadrant: high activation displeasure (e.g., tension, distress)
4) Lower left quadrant: low activation displeasure (e.g., tiredness, boredom)

*Rating of Perceived Exertion*

The single-item Rating of Perceived Exertion (RPE) (Borg, 1982) scale assessed ratings of perceived exertion during resistance training. Participants were asked how hard they were currently working with responses ranging from 0 “Rest” to 10 “Maximal”.

*Resting Heart Rate/Blood Pressure*

Resting heart rate/blood pressure was measured prior to the 10-RM muscular strength testing and both sessions of RE for safety purposes using standardized procedures after participants have been sitting for five minutes.

*Height, Weight, Body Composition*

Standard procedures were used to measure height and weight. Participants removed their shoes and height was measured with a stadiometer. Body weight was measured using a calibrated electronic scale. Body composition was assessed using whole-body air-displacement plethysmography (BodPod, COsmed, Inc., Concord, CA, USA) with estimated thoracic gas volume according to the manufacture’s guidelines. The validity of air-displacement plethysmography for men has been established (Baracos et al., 2012).

*Muscular Strength*

The National Strength and Conditioning Association’s guidelines for determining 10-repetition maximum (10-RM) muscular strength were followed (Haff et al., 2015).
**Power Analysis**

The total sample size needed to achieve 80% power to detect differences between RE intensities for the primary outcome (i.e., state body image; BISS) was calculated in G*Power 3.1 using standard procedures (Faul, Erdfelder, Lang, & Buchner, 2007). Data from the MD group in the pilot study (n = 10) were used to calculate partial eta squared for a within factors interaction effect. To determine the sample size, the following procedures were followed: 1) F test = ANOVA (within factors); 2) alpha level (α) = .05; 3) power = 80% (i.e., 1-β = .80); 4) number of groups = 1; 5) number of measurements = 3; 6) Nonsphericity correction Epsilon (ε) = 0.728 (the assumption of equal correlation was violated; thus the correction factor “Huynh-Feldt” Epsilon was used) (Geisser & Greenhouse, 1958; Huynh & Feldt, 1976); and 7) the partial eta squared (η²) of the interaction effect = 0.12 (as calculated in SPSS version 25). The effect size f was calculated directly from the partial eta squared in G*Power 3.1 (f = .37). Based on these procedures, the estimated required sample size is n = 21.

**Data Analysis**

Descriptive statistics describing baseline demographic characteristics and scores on all psychological and physiological assessments are presented as means (standard deviations) for continuous data, and as percentages for categorical data. To answer the research questions, a series of repeated measures ANOVAs were used to assess changes in state body image, affective valence, perceived activation, and perceived muscle size. The statistical significance level was set *a priori* at p < .05 and paired-samples t-tests were used for all post-hoc tests. Effect sizes are reported as Cohen’s d and can be interpreted as .20 = small, .50 = medium, and .80 = large (Borenstein, 2009). All analyses were conducted using IBM SPSS 25.

**Results**

*Study Flow*
A total of 283 potential participants were screened on the phone and 53 were initially eligible. Among the 53 eligible participants, 17 did not attend Session 1 and 15 were ineligible or no longer interested after Session 1. Complete details of the study flow are presented in Figure 5.

Demographic and Descriptive Characteristics

The mean age of participants was 25 years ($SD = 5.1$). Participants were mostly non-white (66.7%), non-Hispanic (57.1%), living with a roommate or family member (52.4%), and heterosexual (76.2%). Participants performed RE on average 4.2 ($SD = .90$) days each week, for an average of 75 ($SD = 26.2$) minutes each session. A complete demographic description of the aggregate sample is presented in Table 7.

Muscle Dysmorphia Symptoms

Results from the eligibility questions showed that 95.2% of participants are stressed with respect to their body size in social, occupational, or other areas of their lives; 90.5% continue to work out when they are sick or injured despite the knowledge of negative consequences; 52.4% of participants frequently give up important social, occupational, or recreational activities to maintain their workout schedule; and 28.6% avoid social situations when they have to take their shirt off.

Substance Use

Participants reported using a variety of substances with varying frequencies of use. Specifically, 71.2% have used marijuana in their lives and 19% have used marijuana in the last seven days. In addition, 42.9% of participants have used stimulants (e.g., crack, cocaine, MDMA) in their lives, and 9.5% have used stimulants in the last 30 days. Alcohol use was also prevalent among the sample. For example, 85.7% of participants have had a drink containing
alcohol in their lives and 33.3% drink alcohol 2 to 3 times per week, 4.8% consume 7 to 9 drinks containing alcohol during a typical day of drinking, and 14.3% report that they consume six of more drinks at one time on a weekly basis. Of note, only 4.8% of participants smoke cigarettes daily and only 9.5% have smoked a cigarette in the last seven days. Of particular interest, zero participants reported ever using any form of anabolic steroids.

**Supplement Use**

Participants also reported using a variety of different nutritional supplements with varying frequencies of use. Specifically, 100% of participants have used a protein supplement (e.g., powder or bar) in their lives and 47.6% use a protein supplement daily. In addition, 52.4% of participants have used a creatine supplement (e.g., pill or powder) in their lives and 28.6% use a creatine supplement daily. Of note, 95.2% of participants have never used ephedra, and 90.5% of participants have never used diuretics.

**Reasons for Exercise**

Results from the reasons for exercise inventory showed that improving strength was the most important reason to exercise ($M = 6.43$, $SD = .68$; Range = 5-7). Other notable reasons to exercise included: to improve overall health ($M = 6.29$, $SD = .85$; Range = 5-7); to maintain physical well-being ($M = 6.24$, $SD = .83$; Range = 5-7); to improve appearance ($M = 6.19$, $SD = .87$; Range = 4-7); to improve body shape ($M = 6.19$, $SD = .98$; Range = 4-7); and to improve muscle tone ($M = 5.95$, $SD = 1.25$; Range = 3-7). A complete description of participant’s reasons for exercise is presented in Figure 6.

**Baseline Perceptions of Muscle Size**

Results from the male-body silhouette scale (i.e., perceived muscle size) at Session 1 showed that participants perceived their current physique ($M = 55.70$, $SD = 7.46$; Range = 40-
to be significantly less muscular than what they would ideally want to look like ($M = 73.80$, $SD = 5.90$; Range = 70-90); $t(20) = 11.06$, $p < .001$; what other people would choose as ideal ($M = 68.80$, $SD = 10.62$; Range = 40-80); $t(20) = 4.95$, $p < .001$; and what their current or future romantic partner would find most attractive ($M = 70.00$, $SD = 6.32$; Range = 60-80); $t(20) = 6.09$, $p < .001$.

Trait Psychological Assessments

A detailed description of scores on all trait psychological assessments are presented in Table 8; however, presented here are the mean scores and standard deviations on the assessments with established cutoffs, and the percentage of participants who scored above these cutoffs. First, the average score on the Muscle Dysmorphic Inventory was 33.4 ($SD = 10.3$) with scores ranging from 15-53. One of the 21 participants (4.8%) scored above the average for men with clinical levels of MD (i.e., $> 52$) (Cunningham et al., 2017). Second, the average score on CES-D 10 was 9.5 ($SD = 6.2$) with scores ranging from 1-22. Nine of the 21 participants (42.8%) scored above the clinical cutoff of $> 10$ (Björgvinsson et al., 2013). Third, the average score on the STAI was 47.6 ($SD = 12.5$) with scores ranging from 29-74. Thirteen of 21 participants (61.9%) scored $\geq 45$ which has been shown to indicate a possible anxiety disorder (Bunevicius et al., 2013).

Physiological Assessments

The average height, weight, and bodyfat % of the aggregate sample was 69.9 ($SD = 2.3$) inches, 176.6 ($SD = 29.1$) lbs, and 16.7% ($SD = 6.8$), respectively. The average 10-RM muscular strength for chest press was 90 ($SD = 28.9$) lbs, leg extension was 59 ($SD = 17.4$) lbs, shoulder press was 45 ($SD = 10.7$) lbs, and biceps curl was 32.7 ($SD = 8.1$) lbs. A more complete description of the scores on all physiological assessments is presented in Table 8.
**State Body Image**

A 2 x 3 (condition x time) repeated measures ANOVA for state body image (i.e., BISS scores) showed a significant effect of time ($F = 8.05, p < .01, \eta^2 = .17$), but not condition ($F = 3.27, p = .08, \eta^2 = .08$) or condition x time ($F = .86, p = .43, \eta^2 = .02$). During the high intensity session, post hoc analyses revealed that state body image significantly increased from PRE ($M = 3.19, SD = .73$) to POST ($M = 3.60, SD = .73$); $t(20) = 3.23, p < .01, d = .57$ but not from PRE to DELAY ($p = .26$). There were also no significant changes from POST to DELAY ($p = .06$). During the moderate intensity session, post hoc analyses revealed that state body image significantly increased from PRE ($M = 2.99, SD = .57$) to POST ($M = 3.21, SD = .54$); $t(20) = 2.28, p = .03, d = .39$ but not from PRE to DELAY ($p = .83$). Of note, state body image significantly decreased during the moderate intensity session from POST ($M = 3.21, SD = .54$) to DELAY ($M = 3.01, SD = .49$); $t(20) = 2.19, p = .04, d = .38$. Lastly, BISS scores were not significantly different at any time point between the sessions ($p < .05$). Mean changes in state body image between RE intensities are presented in Table 9 and Figure 7.

**Affective Valence**

A 2 x 4 (condition x time) repeated measures ANOVA for affective valence (i.e., FS scores) showed a significant effect of time ($F = 5.12, p = .01, \eta^2 = .28$). However, there were no significant effects of condition ($F = 3.21, p = .08, \eta^2 = .07$), or condition x time ($F = .46, p = .68, \eta^2 = .01$). During the moderate intensity session, post hoc analysis revealed a significant decrease in affective valence from MID ($M = 2.14, SD = 1.53$) to DELAY ($M = .81, SD = 1.97$); $t(20) = 2.97, p < .01, d = .75$, and from POST ($M = 2.29, SD = 1.49$) to DELAY ($M = .81, SD = 1.97$); $t(20) = 3.32, p < .01, d = .85$. There were no significant changes in affective valence at any other time point during the moderate intensity session ($p < .05$). During the high intensity session, post hoc analysis revealed there were no significant changes in affective valence at any time point ($p < .05$). Lastly, FS scores were not significantly different at any time point.
between the sessions ($ps > .05$). Mean changes in affective valence between RE intensities are presented in Table 10 and Figure 8.

**Perceived Activation**

A 2 x 4 (condition x time) repeated measures ANOVA for perceived activation (i.e., FAS scores) showed a significant effect of time ($F = 48.47, p < .001, \eta^2 = .79$), condition ($F = 9.13, p < .01, \eta^2 = .19$), and condition x time ($F = 3.49, p = .03, \eta^2 = .22$). During the moderate intensity session, post hoc analysis revealed a significant increase in perceived activation from PRE ($M = 3.24, SD = 1.26$) to MID ($M = 4.19, SD = .75$); $t(20) = 4.48, p < .001, d = .92$, and from PRE ($M = 3.24, SD = 1.26$) to POST ($M = 4.00, SD = 1.23$); $t(20) = 2.77, p = .01, d = .61$, but significantly decreased from PRE ($M = 3.24, SD = 1.26$) to DELAY ($M = 1.95, SD = 1.28$); $t(20) = 4.64, p < .001, d = 1.02$, MID ($M = 4.19, SD = .75$) to DELAY ($M = 1.95, SD = 1.28$); $t(20) = 7.46, p < .001, d = 2.13$, and from POST ($M = 4.00, SD = 1.23$) to DELAY ($M = 1.95, SD = 1.28$); $t(20) = 6.26, p < .001, d = 1.63$. There were no significant changes from MID to POST ($p = .41$). During the high intensity session, post hoc analysis revealed a significant increase in perceived activation from PRE ($M = 3.67, SD = 1.28$) to MID ($M = 4.81, SD = 1.03$); $t(20) = 4.93, p < .001, d = .98$, PRE ($M = 3.67, SD = 1.28$) to POST ($M = 5.43, SD = .75$); $t(20) = 7.73, p < .01, d = 1.68$, and from MID ($M = 4.81, SD = 1.03$) to POST ($M = 5.43, SD = .75$); $t(20) = 3.83, p < .01, d = .69$. Additionally, there was a significantly decrease in perceived activation from PRE ($M = 3.67, SD = 1.28$) to DELAY ($M = 2.38, SD = 1.47$); $t(20) = 4.05, p < .01, d = .94$, from MID ($M = 4.81, SD = 1.03$) to DELAY ($M = 2.38, SD = 1.47$); $t(20) = 6.70, p < .001$, and from POST ($M = 5.43, SD = .75$) to DELAY ($M = 2.38, SD = 1.47$); $t(20) = 10.01, p < .001, d = 2.61$. Lastly, FAS scores were significantly different between the moderate ($M = 4.19, SD = .75$) and high ($M = 4.81, SD = 1.03$); $t(20) = 2.23, p = .03$, intensity sessions at MID, and at POST (moderate; $M = 4.00, SD = 1.23$) vs. (high; $M = 5.43, SD = .75$); $t(20) = 4.56, p < .01$. Mean changes in perceived activation between RE intensities are presented in Table 11 and Figure 9.
Exercise-Related Affective Stress

The circumplex model was also used to further highlight changes in exercise-related affective states (Ekkekakis et al., 2011). Specifically, both conditions began and ended (i.e., at DELAY) the session in a low-activated pleasure state. However, participants shifted to a more highly-activated pleasure state at MID and POST during the moderate intensity session. Participants stay in a low-activated pleasure state during the entire session despite shifting towards a more highly-activated pleasure state at POST. The circumplex model is presented in Figure 10.

Perceived Muscle Size

A 2 x 3 (condition x time) repeated measures ANOVA for perceived muscle size showed a significant effect of time ($F = 8.79, p < .01, \eta^2 = .31$), but not condition ($F = 1.54, p = .22, \eta^2 = .04$) or condition x time ($F = 2.70, p = .08, \eta^2 = .12$). During the high intensity session, post hoc analyses revealed that perceived muscle size significantly increased from PRE ($M = 5.76, SD = .83$) to POST ($M = 6.29, SD = .78$); $t(20) = 4.69, p < .001, d = .66$ but not from PRE to DELAY ($p = .19$). Notably, perceived muscle size significantly decreased from POST ($M = 6.29, SD = .78$) to DELAY ($M = 5.90, SD = .70$); $t(20) = 3.51, p < .01, d = .53$. There were no significant changes in perceived muscle size at any time point during the moderate intensity session ($ps > .05$). Lastly, perceived muscle size scores were not significantly different at any time point between the sessions ($ps > .05$). Mean changes in perceived muscle size between RE intensities are presented in Table 12 and Figure 11.

Exercise Enjoyment

Mean exercise enjoyment (i.e., EE scores) during the moderate intensity at MID was 4.67 ($SD = 1.24$) and at POST was 4.33 ($SD = 1.45$). These scores were not significantly
different. During the high intensity session, exercise enjoyment at MID was 5.05 ($SD = 1.36$) and at POST was 5.52 ($SD = 1.29$), and significantly increased between these two time points $t(20) = 3.21, p < .01$. Lastly, exercise enjoyment scores were significantly different between the sessions at POST (moderate; $M = 4.33, SD = 1.46$) vs. (high; $M = 5.52, SD = 1.28$); $t(20) = 2.80, p = .01$. Mean changes in exercise enjoyment between RE intensities are presented in Figure 12.

*Ratings of Perceived Exertion*

Mean ratings of perceived exertion (i.e., RPE scores) during the moderate intensity session at MID were 4.48 ($SD = 1.69$) and at POST was 3.24 ($SD = 1.61$), and significantly decreased between these two time points $t(20) = 3.83, p < .01, d = .72$. During the high intensity session, mean RPE scores at MID were 7.00 ($SD = 1.61$) and at POST were 7.43 ($SD = 1.99$). There were no significant differences in RPE from MID to POST during the high intensity session ($p = .12$). Mean changes in RPE between RE intensities are presented in Figure 13.

**Discussion**

This study explored and compared the acute psychological effects of moderate and high-intensity RE in men with MD symptoms. The results suggest that after high compared to moderate intensity RE, men with MD symptoms feel better about their bodies both overall (i.e., BISS scores) and in regard to perceived muscle size after high compared to moderate intensity RE. Additionally, participants enjoyed the high-intensity sessions significantly more than the moderate intensity session. These findings expand on the results of my pilot study, provide further support for the conceptual model discussed above, and provides further information that can be used to design future studies in men with MD.

*State Body Image*
The hypothesis for the first research question was supported. Specifically, it was hypothesized that both sessions would improve state body image, but that the magnitude of change would be greater immediately after the high compared to moderate-intensity session. The results showed that state body image significantly increased from PRE to POST during both RE sessions, but that the magnitude of change was greater during the high ($d = .57$) compared to the moderate ($d = .39$) intensity session. Thus, it appears that both sessions provided the physiological feedback (i.e., muscle pump, muscle pain) to improve how these participants felt about their bodies unrelated to muscle size. However, the difference in effect size could be attributed to how much participants felt like they had to exert themselves during the session. For example, the participants' rating of perceived exertion scores (i.e., RPE scores) at both assessment points (MID and POST) during the moderate intensity session were significantly lower than at the same time points during the high intensity session, and significantly decreased from MID to POST during the moderate intensity session. The lower perceived exertion scores during the moderate intensity session may have tempered how much these participants perceived their bodies to move closer to their ideal body image. These findings support previous research which suggests that intensity is likely an important factor in the relationship between RE and state body image in men with MD symptoms (Waldorf et al., 2016), and is important for future researchers to consider when developing RE interventions aimed at maximizing body satisfaction in this population.

**Affective States**

The hypothesis for the second research question was not supported. Specifically, it was hypothesized that both RE sessions would improve affective states, but that participants would have a greater affective response to the high compared to moderate intensity RE session. Specifically, there were no changes in affective valence (i.e., FS scores) during either session from PRE to MID or from PRE to POST. There were, however, significant increases in
perceived activation (i.e., FAS scores) from PRE to MID and from PRE to POST during both sessions, and a significant increase from MID to POST during the high intensity session only. According to the circumplex model (Ekkekakis et al., 2011), participants initiated both sessions in an low-activation pleasure state, and remained in this affective state at MID and POST during the high intensity session. This differed from the results found during the moderate intensity session, which showed a shift to a high-activation pleasure state at MID and POST. This is somewhat surprising seeing that participants were about to engage in RE after 48-hours of no exercise. Instead, it would have been reasonable to assume that given their high levels of RE dependence based on their bodybuilding dependence scores, the participants would have initiated both sessions in a high activated displeasure state (i.e., tension, anxiety). Also, given the previous research which suggests that a deviation from the daily RE routine would result in marked distress for men with MD (Murray et al., 2010), it was expected that participants would begin the session in a high activated displeasure state. However, the participants in this study performed RE approximately 4 days each week, which indicates that 48-hours of no exercise may have been typical, and unlike the RE routine of men with a clinical diagnosis of MD.

These results, however, support a multitude of studies with apparently healthy adults, which have found that moderate intensity RE results in pleasure, but conflicts with studies that show that high intensity RE results in displeasure (Arent et al., 2005; Ekkekakis, 2009; Ekkekakis et al., 2011; Greene & Petruzzello, 2015). The conflict in the results may be due to the fact that the participants in this study may be more accustomed to the temporary muscular discomfort that accompanies high-intensity RE. In fact, as depicted by the conceptual model, the muscular pain associated with high-intensity RE may be reframed as evidence that the body is becoming more muscular. Thus, the drive to increase muscle size may be a moderating factor in the RE-affect relationship.

*Perceived Muscle Size*
The hypothesis for the third research question was partially supported. Specifically, it was hypothesized that both RE sessions would improve perceptions of muscle size, but that participants would perceive a greater improvement in muscle size immediately after the high compared to moderate intensity RE session. The results showed that perceived muscle size significantly increased from PRE to POST during the high intensity session but not from PRE to POST during the moderate intensity session. The improvements during the high intensity session corresponded to the improvements in state body image during the same time period, which indicates that improvements in muscle size may be closely tied to how one feels about their body overall. However, significant improvements in state body image during the moderate intensity session did not correspond to significant improvements in perceived muscle size. One explanation for this could be how participants perceived themselves to look in the mirror during the final sets of biceps curl. More specifically, biceps curls were the final exercise of the four exercises and were performed immediately after shoulder press with dumbbells standing up in front of the mirror. As a result, participants may have experienced a more intense state of local muscle swelling (i.e., fluid retention; muscle pump) in the upper arms, resulting in the perception that their bodies had increased in muscle size (Waldorf et al., 2016; Thomas et al., 2011). In contrast, the less intense state of local muscle swelling during the moderate intensity session may have been the factor that led to no improvements in muscle size. The improvements in perceived muscle size and state body image at POST during the high intensity session also corresponded with a shift towards a more highly-activated and pleasant affective state (although not significant). These findings provide further support for high-intensity as a key factor for maximizing body and muscle satisfaction in this population.

*Delayed Effects of Moderate and High Intensity Resistance Exercise*

The hypothesis for the fourth research question was not supported. Specifically, it was hypothesized that high compared to moderate intensity RE sessions would result in longer-
lasting improvements in state body image, affective states, and perceived muscle size. The results were similar between sessions, such that all variables showed a decrease towards baseline at DELAY. First, state body image decreased (although not significant) from POST to DELAY to just above baseline levels during the high intensity session, and significantly decreased during the same period during the moderate intensity session. While the magazine reading during the DELAY period could have affected this result by being different from the normal post-workout routine (i.e., socializing, eating, drinking a protein shake), it is still important to note that these results lend new information for the conceptual model discussed above, such that state body image may decline after any intensity but at a slower rate after high-intensity RE compared to moderate intensity.

Second, affective state shifted from a high-activation pleasure state at POST to a low-activation and pleasant state at DELAY during the moderate intensity session. Comparatively, participants remained in a low-activation pleasure state at all time points during the high intensity session. Although the affective state at DELAY during both sessions could be classified as pleasant, Figure 10 clearly shows a trend at DELAY towards a low-activation displeasure state. According to the circumplex model this would indicate feelings of tiredness and/or boredom (Ekkekakis et al., 2011). It is difficult to separate whether the decrease in affective state was a result of the RE sessions or the magazine reading, but what is clear is that the combination of the two should be further explored to see if a longer duration RE session with more volume could positively affect affective states in the long-term.

Third, perceived muscle size decreased to approximately baseline levels from POST to DELAY during the high intensity session, and significantly decreased from POST to DELAY during the moderate intensity session. Thus, although the high-intensity was effective at temporarily improving perceived muscle size, these effects were not long-lasting. Overall, the decreases in perceived muscle size during both sessions could, like the decrease in state body image, be attributed to the magazine reading, such that the participants’ focus shifted from their
muscle size to the contents of the magazine. Another possibility includes the factors within the RE sessions, such as volume and duration. Each session included three sets of 10 repetitions for each exercise with 90 seconds of rest between sets and exercises. This may have been less volume (i.e., weight x repetitions x sets) than what is customary, and although effective enough to temporarily improve perceived muscle size (and state body image), was ineffective at having a long-lasting effect. Further, the RE portion of Sessions 3 and 4 were approximately 30 minutes, which is 45 minutes shorter than the average amount of time (75 minutes) these participants reported performing RE each time that they do. This shorter than normal RE session could have impacted their perception of muscle size during the delay period.

*Exercise Enjoyment*

The hypothesis for the fifth research question was supported. Specifically, it was hypothesized that participants would enjoy the high intensity RE significantly more than the moderate intensity session. The results for exercise enjoyment showed that participants reported a significant increase in enjoyment from MID to POST during the high intensity session and showed a slight decrease (although not significant) in exercise enjoyment during the moderate intensity session. When considering the significant findings during and after the high intensity session for state body image, perceived muscle size, and exercise enjoyment, it’s possible that the level of enjoyment during RE is contingent on how much these men perceive it to increase their muscle size and improve their body image. In support of this, state body image and perceived muscle size both increased along with exercise enjoyment during the high intensity session. Interestingly, however, improvements in these variables did not coincide with changes in affective states. Thus, enjoyment may not imply enjoyment in the conventional sense and instead be directly linked to how they perceive their body and muscle size to change during RE.
Limitations and Strengths

This dissertation study had limitations worth mentioning. First, similar to the pilot study, we did not seek out or require participants to have a formal diagnosis of MD, and while we did screen for MD symptoms based on empirically-supported criteria, the results may not be generalizable to men with a clinical MD diagnosis. Second, although intensity seems to be a likely factor that moderates the effects of RE on the acute psychological variables tested in this study, other RE factors such as exercise selection, session duration, frequency (i.e., sessions per week), or volume may also play an important role. Second, the sample size was small (n = 21); however, the result of the power analysis indicated that the power to detect moderate effects for the main outcome (i.e., state body image) was 80%. Third, in addition to the differences in intensity, participants lifted a lower amount of volume (i.e., reps x sets x weight) during the moderate intensity session. Thus, future studies that test the acute psychological response to these intensities while equating for volume may provide a more accurate interpretation of the acute response to these intensities. Fourth, although the pilot study included a non-symptomatic control group, this study did not. However, the primary purpose of this dissertation study was to explore and compare the acute psychological effects of two different RE intensities, precluding the need to include a non-symptomatic control group. Lastly, the difference between the number of participants who inquired about the study and the number of participants who completed the study is potentially problematic. First, the difficulty in recruitment could present a challenge during future studies that attempt to recruit larger samples, or, in studies that require participants to attend more than four sessions over a longer period of time.

Despite these limitations this study has several strengths. First, this study included young men who, although did not have clinical diagnosis of MD, met MD criteria that is empirically supported to help identify individuals with symptoms of the disorder. Second, the majority of the exercise and body image literature has focused predominantly on the effects of
aerobic exercise on body image in females (Campbell & Hausenblas, 2009; Hausenblas & Fallon, 2006; Reel et al., 2007). As such, this study adds to the literature by focusing the effects of RE on body image in men. Third, the existing literature on the affective response to varying exercise intensities is very limited and is even more scarce when it relates to testing the acute effects of varying RE intensities (Ekkekakis, 2009; Ekkekakis et al., 2011). Thus, the results push the field forward as it relates to the affective response to varying RE intensities in men. Lastly, this study incorporated measures to capture acute changes in perceived muscle size and exercise enjoyment; two measures that were not used in the pilot study or in any other study focusing on the acute effects of RE in men with MD symptoms.

Conclusions

Overall, it appears that men with MD symptoms have a more favorable response to high compared to moderate intensity RE, but that these positive effects are not long lasting. These findings provide preliminary guidance and direction toward the development of a RE routine that could potentially be added to augment treatment methods to help treat MD. Specifically, it seems that high-intensity is one piece of the larger puzzle of determining what exercise variables elicit the greatest positive effect. A next step in this line of work could be testing the effects of frequency (i.e., sessions per week), duration (i.e., session length), free weights compared to weight machines, and different exercises using varying set and repetition schemes. Eventually, longitudinal research could test the effects of a multi-modal intervention of CBT, family-based treatment, or pharmacotherapy, and RE, compared to an existing program alone, in men with a clinical MD diagnosis.
Figure 5. Study flow.

Assessed for potential eligibility over the phone (n = 283)

Eligible after phone screener (n = 53)

Not eligible after phone screening (n = 230)
  • Not meeting MD criteria (n = 158)
  • Not interested after being screened (n = 46)
  • Out of age range (n = 13)
  • Does not RE (n = 6)
  • Frequency of RT (n = 3)
  • Length of RE sessions (n = 3)
  • Seeking mental health care (n = 1)

Participants lost prior to Session 1 (n = 17)
  • Unreachable after phone screener (n = 15)

Rescreened for eligibility at Session 1 (n = 36)

Not eligible after Session 1 (n = 15)
  • Not meeting MD criteria (n = 8)
  • Duration of RE (n = 1)
  • Frequency of RE (n = 1)
  • Unreachable (n = 4)
  • No longer interested (n = 1)

Attended Sessions 2-4, and completed Study (n = 21)
Table 7. Sample characteristics (n = 21).

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>M (SD)</th>
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</thead>
<tbody>
<tr>
<td>Age</td>
<td>25.0 (5.1)</td>
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<tr>
<td>Race n (%)</td>
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<tr>
<td>White</td>
<td>7 (33.3%)</td>
</tr>
<tr>
<td>Black or African American</td>
<td>3 (14.3%)</td>
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<tr>
<td>Asian</td>
<td>4 (19.0%)</td>
</tr>
<tr>
<td>Other</td>
<td>5 (23.8%)</td>
</tr>
<tr>
<td>Do not know/want to answer</td>
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</tr>
<tr>
<td>Ethnicity n (%)</td>
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<td>Hispanic</td>
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<td>Education n (%)</td>
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<tr>
<td>Completed college</td>
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<tr>
<td>Some graduate school</td>
<td>3 (14.3%)</td>
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<tr>
<td>Completed graduate degree</td>
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<tr>
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<td>Unemployed</td>
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<td>Other</td>
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<td>Living situation n (%)</td>
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<td>Living alone</td>
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<td>Living with romantic partner</td>
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<td>Living with roommate/family member</td>
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<tr>
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<tr>
<td>&gt;$75,001</td>
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<td>Do not want to answer</td>
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<td>Sexual orientation n (%)</td>
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<td>Heterosexual</td>
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<td>Homosexual</td>
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<tr>
<td>Bisexual</td>
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<tr>
<td>Frequency of RE (days/week)</td>
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<td>Duration of RE sessions (minutes/session)</td>
<td>75 (26.2)</td>
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RM=Repetition Maximum; Lbs.=pounds; RE = Resistance Exercise
Figure 6. Mean-item scores for the Reasons for Exercise Inventory.
Table 8. Mean, standard deviation, and range for all psychological and physiological measures.

<table>
<thead>
<tr>
<th>Psychological</th>
<th>M (SD)</th>
<th>Range</th>
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<tbody>
<tr>
<td>BDS</td>
<td>41.4 (8.3)</td>
<td>28 – 54</td>
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<tr>
<td>MDI</td>
<td>33.4 (10.3)</td>
<td>15 – 53</td>
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<tr>
<td>RS</td>
<td>15.0 (5.4)</td>
<td>4 – 24</td>
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<tr>
<td>SPAS</td>
<td>38.9 (8.5)</td>
<td>26 – 54</td>
</tr>
<tr>
<td>CES-D 10</td>
<td>9.5 (6.2)</td>
<td>1 – 22</td>
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<tr>
<td>STAI</td>
<td>47.6 (12.5)</td>
<td>29 – 74</td>
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<table>
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<tr>
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<td>Height (in)</td>
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<td>68 – 76</td>
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<tr>
<td>Weight (lbs)</td>
<td>176.6 (29.1)</td>
<td>131.4 – 223.7</td>
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<tr>
<td>Body fat (%)</td>
<td>16.7 (6.8)</td>
<td>5.9 – 32.8</td>
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<tr>
<td>10-RM Chest Press</td>
<td>90.0 (28.9)</td>
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<td>10-RM Leg Extension</td>
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<td>10-RM Shoulder Press</td>
<td>45.0 (10.7)</td>
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<tr>
<td>10-RM Biceps Curl</td>
<td>32.7 (8.1)</td>
<td>20 – 50</td>
</tr>
</tbody>
</table>

BDS = Bodybuilding Dependence Scale; MDI = Muscle Dysmorphia Inventory; RS = Restraint Scale; SPAS = Social Physique Anxiety Scale; CES-D 10 = Center for Epidemiologic Studies Depression Scale; STAI = State-Trait Anxiety Inventory (Trait); In = Inches; Lbs = Pounds; RM = Repetition Maximum
Table 9. ANOVA results for State Body Image (BISS) over Condition x Time.

<table>
<thead>
<tr>
<th></th>
<th>PRE</th>
<th>POST</th>
<th>DELAY</th>
<th>F Statistics</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td></td>
<td></td>
<td>Time</td>
</tr>
<tr>
<td>High Intensity</td>
<td>3.19 (.73)</td>
<td>3.60 (.73)</td>
<td>3.36 (.49)</td>
<td>8.05**</td>
</tr>
<tr>
<td>Moderate Intensity</td>
<td>2.99 (.57)</td>
<td>3.21 (.54)</td>
<td>3.14 (.49)</td>
<td></td>
</tr>
</tbody>
</table>

p < .01*.

Figure 7. Mean changes in BISS scores over Condition x Time.

a. Significant difference from PRE to POST during the high intensity session.
b. Significant difference from PRE to POST during the moderate intensity session.
c. Significant difference from POST to DELAY during the moderate intensity session.
Table 10. ANOVA results for affective valence (FS) over Condition x Time.

<table>
<thead>
<tr>
<th></th>
<th>Mean (SD)</th>
<th>F Statistics</th>
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<tbody>
<tr>
<td></td>
<td>PRE</td>
<td>MID</td>
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<tr>
<td>High Intensity</td>
<td>2.43 (1.83)</td>
<td>2.71(1.93)</td>
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<tr>
<td>Moderate Intensity</td>
<td>1.38 (1.96)</td>
<td>2.14(1.53)</td>
</tr>
</tbody>
</table>

*p < .01*.

Figure 8. Mean changes in FS scores over Condition x Time.

a. Significant difference from MID to DELAY during the moderate intensity session.
b. Significant difference from POST to DELAY during the moderate intensity session.
Table 11. ANOVA results for perceived activation (FAS) over Condition x Time.

<table>
<thead>
<tr>
<th></th>
<th>PRE</th>
<th>MID</th>
<th>POST</th>
<th>DELAY</th>
<th>Time</th>
<th>Condition</th>
<th>Condition x Time</th>
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</thead>
<tbody>
<tr>
<td>High intensity</td>
<td>3.67</td>
<td>4.81</td>
<td>5.43</td>
<td>2.38</td>
<td>48.47***</td>
<td>9.13**</td>
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<td>Moderate intensity</td>
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<td>4.19</td>
<td>4.00</td>
<td>1.95</td>
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</tr>
</tbody>
</table>

Mean (SD)

$\*p < .05$, $\**p < .01$, $\***p < .001$

Figure 9. Mean changes in FAS scores over Condition x Time.

- a. Significant difference from PRE to MID during the high intensity session.
- b. Significant difference from PRE to POST during the high intensity session.
- c. Significant difference from MID to POST during the high intensity session.
- d. Significant difference from PRE to DELAY during the high intensity session.
- e. Significant difference from MID to DELAY during the high intensity session.
- f. Significant difference from POST to DELAY during the high intensity session.
- g. Significant difference from PRE to MID during the moderate intensity session.
- h. Significant difference from PRE to POST during the moderate intensity session.
- i. Significant difference from PRE to DELAY during the moderate intensity session.
- j. Significant difference from MID to DELAY during the moderate intensity session.
- k. Significant difference from POST to DELAY during the moderate intensity session.
Figure 10. Changes in exercise-related affective states over Condition x Time.

Horizontal axis represents affect (FS) and the vertical axis represents perceived activation (FAS).
Table 12. ANOVA results for perceived muscle size over condition x time.

<table>
<thead>
<tr>
<th></th>
<th>PRE</th>
<th>POST</th>
<th>DELAY</th>
<th>F Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Time</td>
<td>Condition</td>
<td>Condition x time</td>
<td></td>
</tr>
<tr>
<td>High intensity</td>
<td></td>
<td></td>
<td></td>
<td>8.79*</td>
</tr>
<tr>
<td></td>
<td>2.3 (1.4)</td>
<td>3.3 (1.3)</td>
<td>3.5 (1.6)</td>
<td>1.54</td>
</tr>
<tr>
<td>Moderate intensity</td>
<td>2.2 (1.4)</td>
<td>2.1 (1.7)</td>
<td>2.8 (1.5)</td>
<td>2.7</td>
</tr>
</tbody>
</table>

$p < .01^*$. 

Figure 11. Mean Changes in perceived muscle size over Condition x Time.

a. Significant difference from PRE to POST during the high intensity session.
Figure 12. Mean Changes in exercise enjoyment over Condition x Time.

![Graph showing mean exercise enjoyment over time for HIGH and MOD conditions.]

- Significant difference from MID to POST during the high intensity session.
Figure 13. Mean Changes in Ratings of Perceived Exertion (RPE) by Condition x Time.

a. Significant difference from MID to POST during the moderate intensity session.
References


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