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An Exploratory Analysis of Eating Disorders, Muscle Dysmorphia, and Exercise Addiction Among Men in Competitive Bodybuilding in Atlantic Canada

By

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List of Abbreviations

AN	Anorexia Nervosa
BBM	Bodybuilding men
BED	Binge Eating Disorder
BMI	Body mass index
BN	Bulimia Nervosa
CBBF	Canadian Bodybuilding Federation
CBBM	Competitive bodybuilding men
CCHS	Canadian Community Health Survey
cm	Centimetres
COVID-19	Novel Coronavirus
CVI	Content validity index
CVR	Content validity ratio
DSM	Diagnostic and Statistical Manual of Mental Disorders
EA	Exercise addiction
EAT	Eating Attitudes Test
ED	Eating disorder
FFM	Fat free mass
FFMI	Fat free mass index
GERD	Gastroesophageal reflux disease
hrs	hours
kcal	Kilocalories
kg	Kilograms
MBN	Men with bulimia nervosa
MD	Muscle Dysmorphia
NBFPA	New Brunswick Fitness and Physique Association
NLABBA	Newfoundland and Labrador Amateur Bodybuilding Association
NSABBA	Nova Scotia Amateur Bodybuilding Association
OSFED	Otherwise Specified Feeding and Eating Disorders
PEIFPA	Prince Edward Island Fitness and Physique Association
RBBM	Recreational bodybuilding men
URL	Uniform Resource Locator
WHO	World Health Organization
У	Years

Abstract

Background: Existing literature shows an overlap among the three domains of eating disorders, muscle dysmorphia, and exercise addiction, however little research to date has focused on competitive bodybuilders as a risk group for these domains. Eating disorders carry strong gender stigma, which leaves men vulnerable to lack of assessment and affiliated treatment. Bodybuilding culture seems to encourage behaviours that are characteristic not only of disordered eating, but of muscle dysmorphia and exercise addition as well, which, alone or in tandem, have potential to result in negative physiological and psychological health implications such as depression, anxiety and comorbid substance abuse. However, all of these domains have yet to be studied together, nor among competitive bodybuilders in Atlantic Canada.

Objectives: 1) To obtain content validity of a novel questionnaire tool intended to screen for risk of eating disorders and muscle dysmorphia among men in competitive bodybuilding by evaluation from experts in these fields, and 2) to determine the prevalence of, and associations between, eating disorders, muscle dysmorphia, and exercise addiction among men in competitive bodybuilding in Atlantic Canada.

Methods: We developed a novel questionnaire to screen for risk of select eating disorders (anorexia nervosa, bulimia nervosa, binge eating disorder, as assessed from the DSM-5 criteria) and muscle dysmorphia (assessed from proposed DSM-5 criteria for muscle dysmorphia). The questionnaire underwent content validity assessment by panelists in the fields of dietetics and psychology. The questionnaire also screened for exercise addiction using the Exercise Addiction Inventory. Atlantic Canadian bodybuilding men were recruited via convenience sampling. Responses were computed to place participants into dichotomous risk categories for eating disorders, muscle dysmorphia, and exercise addiction, and Spearman's correlations used to compute bivariate associations across domains.

Results: The questionnaire achieved a content validity index score of 0.83, rendering it valid for implementation. In total, 28 Atlantic Canadian bodybuilding men participated in this study, of which 21%, 21% and 100% were at risk for eating disorders, muscle dysmorphia, exercise addiction, respectively. There were significant, moderate positive correlations between muscle dysmorphia and: anorexia nervosa (*rho*=0.519, *p*=0.005), bulimia nervosa (*rho*=0.453, *p*=0.015), exercise addiction (*rho*=0.444, *p*=0.018). No other significant correlations existed.

Conclusion: Muscle dysmorphia was correlated with both disordered eating and exercise addiction in this group, however there were no significant correlations between eating disorder behaviours and exercise addiction. Given the small sample size, these results are not generalizable, however do warrant continued exploration and comparison of competitors' behaviours during competition preparation and non-preparation periods.

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1.0 Introduction

Eating disorders are considered a continuous disruption of eating behaviour altering intake and absorption of food, negatively affecting physical and mental health (1). An increased prevalence of preoccupation with physical appearance, especially leanness and muscularity, and an obsessive drive to exercise, have been reported among competitive bodybuilders. Together, these habits describe a condition known as muscle dysmorphia (2). Extreme exercise and dietary practices are often employed in competitive bodybuilding contest preparation (e.g. recurring cycles of extreme weight loss and regain) and have been linked to disordered eating behaviours (3). Existing literature shows a strong overlap among the three domains of eating disorders, muscle dysmorphia, and exercise addiction (3–5), however little research to date has focused on competitive bodybuilders as a risk group for these domains. Eating disorders carry strong gender stigma (6,7), which leaves men vulnerable to inadequate assessment and treatment options (25). Competitive bodybuilding culture seems to encourage behaviours that are characteristic of muscle dysmorphia and excessive exercise. The limited body of research in this area suggests links between bodybuilding, muscle dysmorphia, exercise addiction, and disordered eating among men, which, alone or in tandem, are associated with unfavourable physiological and psychological health implications such as depression, anxiety and comorbid substance abuse (1,25). There is limited peer-reviewed literature on this intersection, and lack of research among competitive bodybuilders, a group known for nutritional risk.

The aim of this research was to obtain content validity of, and implement, an online tool intended to screen for risk of eating disorders and muscle dysmorphia among male bodybuilders. The objectives of the current study were:

1) to obtain content validity of a questionnaire tool intended to screen for risk of eating disorders and muscle dysmorphia among men in competitive bodybuilding by evaluation from experts in the fields of dietetics and psychology, and

2) to explore the prevalence of, and associations between, eating disorders, muscle dysmorphia, and exercise addiction among men in competitive bodybuilding in Atlantic Canada, by implementing the aforementioned questionnaire alongside the Exercise Addiction Inventory (8), a previously validated tool to screen for exercise addiction, among a sample of the population.

2.0 Literature Review

2.1 Eating disorders

The Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5; 2013) defines an eating disorder as "a persistent disturbance of eating or eating-related behaviour that results in altered consumption or absorption of food and that significantly impairs physical health or psychosocial functioning" (1); **Appendix B**. Typically, eating disorders are diagnosed by a medical or mental health professional, and treated by an interdisciplinary health care team consisting of, a physician, mental health professional, and a dietitian (9). Eating disorders are characterized by chronicity, emotional disturbance, and morbidity (3). Many different types of eating disorders exist, the most widely known of which are anorexia nervosa, bulimia nervosa, and binge eating disorder (10,11).

Several changes have been made to eating disorder criteria in the most recent edition of the DSM. The DSM-5 no longer requires amenorrhea as a criterion for diagnosing anorexia nervosa as it does not apply to boys, men, pre-menarchal girls, women using hormonal contraceptives and post-menopausal women (12). Additionally, one may meet the diagnostic criteria for anorexia nervosa and still experience menstruation (12). For bulimia nervosa, the frequency requirement for episodes of bingeing and purging was reduced from two episodes per week to a minimum of one episode per week (12). Finally, binge eating disorder was included in the DSM-5 as its own category of eating disorder (12). These changes were made to improve accuracy of diagnoses and reduce the frequency of catch-all diagnoses being made (12).

Anorexia nervosa and bulimia nervosa are diagnoses typically marked by a common pathology – a preoccupation with weight and body shape (1,2,4). Anorexia nervosa can be described as severe restriction of food intake in order to lose weight, failure to gain weight, and/or having a body weight that is less than 85% of what would be considered healthy for a given height (1,10). Bulimia nervosa is characterized by recurrent episodes of binge eating followed by one or more compensatory behaviours, known as purging, such as self-induced vomiting or laxative use, excessive exercise, or restricting food intake for one or more days following a binge (1,7,10). The clinical diagnosis of bulimia nervosa requires that episodes of binging and compensatory behaviours occur at least once per week for three months (1). Another common eating disorder,

binge eating disorder, involves recurrent episodes of binge eating (at least once per week for three months), but lacks the compensatory behaviours indicative of bulimia nervosa (1,10,11,14). Eating disorder diagnoses can also be made when individuals do not meet all of the specific diagnostic criteria for anorexia nervosa, bulimia nervosa, or binge eating disorder, or if they present with symptoms of more than one eating disorder. These diagnoses fall under Atypical Eating Disorders, or Otherwise Specified Feeding and Eating Disorders (1,10). Otherwise Specified Feeding and Eating Disorders (1,10). Otherwise Specified Feeding and purging less than once per week or for less than three months), or atypical anorexia nervosa, in which a person displays significant weight loss, but bodyweight is still within or above the normal range (1,10). According to the DSM-5, diagnoses typically occur during adolescence, with 90% of diagnoses among girls and women (1). For instance, girls made up 85% of eating disorder diagnoses in a recent Dutch cohort study on mental health and social development through adolescence (N=1,597; n=58 cases) (15).

Individuals diagnosed with eating disorders have a range of treatment options, from intensive treatment programs and partial hospitalization in in-patient care facilities, to nutritional counselling, and group and/or family psychotherapy as outpatients (9). A wide range of medical complications have been associated with eating disorders (16), and are described in section 2.2.1. Therefore, medical nutrition therapy for eating disorders varies depending on the diagnosis and severity of illness, however, there are some similarities in the assessment and management of eating disorders (17). If disordered eating behaviours are present, but not a clinical eating disorder, the individual is considered to be experiencing a nutritional problem, thus a medical diagnosis is not made. If an eating disorder is present, prior to commencing the nutrition care process, patients with eating disorders are screened for malnutrition using a standardized tool (17). If malnutrition is present, degree of malnutrition is determined using a nutrition assessment tool (17). Nutrition and eating behaviour assessment can identify possible irrational beliefs and/or behaviours related to food (16,17). Biochemical assessment may also be necessary, especially for patients with anorexia nervosa, as prolonged restriction of food intake may lead to altered biochemical and hematological indices, as well as severe vitamin and mineral deficiencies (18). Among individuals with eating disorders, metabolic rate may be unpredictable given dietary restriction and/or chaotic dietary patterns, and purging behaviour, therefore, options for nutritional rehabilitation are considered on an individual basis (16). Additionally, risk of refeeding syndrome is a concern during initial stages of nutrition rehabilitation of malnourished individuals (19). Refeeding syndrome occurs when carbohydrates are introduced too quickly in a malnourished patient, causing a rapid increase in insulin production, which can reduce water and sodium excretion (19). Low serum levels of potassium (hypokalemia), phosphorus (hypophosphatemia), and magnesium (hypomagnesemia) are characteristic of refeeding syndrome (19). Refeeding syndrome confers risks such as cardiac, pulmonary, neurologic, and hematologic complications, as well as sudden death (19,20). Typical protocol for nutritional rehabilitation in severely malnourished eating disorder patients is to "start low and advance slow," meaning to begin with a low caloric intake and slowly increase intake to avoid refeeding syndrome (19).

2.2 Eating disorders: a gender gap

Eating disorders tend to be stigmatized as being a women's health issue (6,7), likely because women currently make up a higher proportion of eating disorder diagnoses in North America (10,11). A review of adolescent eating disorders estimated the gender ratios (boy:girl) for 15-19 year old patients between 2000 and 2011 to be between 1:10 - 1:15 for anorexia nervosa and 1:15 - 1:20 for bulimia nervosa (21). Similarly, the DSM-5 reports a 1:10 ratio for both anorexia and bulimia nervosa (1). Despite the large proportion of girls and women with eating disorders, men also present with these disorders (5-7), but there is currently a lack of research in this population. According to the most recent data available from the Mental Health Profile of the Canadian Community Health Survey (CCHS), the rates of diagnosed eating disorders among boys and men aged ≥ 15 years from 2002 to 2012 rose from 20,316 to 27,335 diagnoses nationwide (22). However, Statistics Canada warns that these data should be interpreted cautiously due to high sampling variability in the dataset (22,23). The only province with a specific number of diagnoses listed is Ontario, with 7,520 cases in 2002, but no reliable data available for 2012 (22). The CCHS indicates that rates of diagnosed eating disorders among girls and women aged \geq 15 years decreased from 102,761 in 2002 to 85,773 in 2012, although with a similar disclaimer to use 2012 data with caution due to high sampling variability (22,23). There are no similar data available in the 2019 CCHS. These statistics, and the degree of uncertainty in the most recent survey, highlight the need for further eating disorder research in Canada, particularly among Canadian men.

Typically, certain subgroups of men present with eating disorders more often, including competitive male athletes, queer-identifying men, and men with a history of being of higher weight in childhood (24,25). However, it is likely that underreporting occurs given that men with eating disorders have been reported to feel ashamed or embarrassed about a diagnosis that carries gendered stigma, and/or because some men may conceal the disorder due to a societal expectation to be "manly" (25,26). Compared to women, men tend to seek out healthcare less often, and later over the course of their illness (26). Finally, societal norms in high-income countries normalize the consumption of large quantities of food among men, therefore men are less likely to report binge eating than women (7).

Recently, a 2014 qualitative study of n=10 men across the United Kingdom diagnosed with eating disorders found that many were unaware of their illness given the gendered stigma associated with eating disorders, and that their physicians failed to take them seriously when they presented symptoms of disordered eating (26). A participant of this study explains his experience seeking treatment from his physician:

"... at eighteen I went to the doctor...and I spoke to her quite confidently about...what I was going through...and the doctor said to me, 'You haven't got bulimia, you're just depressed'...I'm probably quite confident in saying that that was probably because...I was male...I didn't live up to the stereotype of being young and female" (15, p5).

Another participant explained being told by a gastroenterologist that his perpetual vomiting and extreme weight loss were not physical problems, but instead of being referred to a psychologist, he was told to "be strong" and "deal with" the issue (15, p5). Thus, healthcare professionals may impede health-seeking behaviours among men with disordered eating. This is supported by a 2015 survey designed to examine the extent to which healthcare professionals (n=148) displayed stigma towards hypothetical patients who were described as men with various health concerns (27). Participants included primary care and specialized physicians, nurses, and psychologists. The healthcare professionals were randomly assigned to read one of four vignettes describing a man, either with bulimia nervosa, using steroids, using cocaine, or a healthy control (27). Using a single-factor Semantic Differential Scale (SDS), healthcare professionals were asked to rate word pairs presented to them (e.g. friendly/unfriendly, anxiety provoking/comfortable to work

with) on a scale from -3 to +3, to describe how they felt toward the hypothetical patient; stigma was calculated as a latent construct derived from responses to vignettes by calculating the general difference score between each vignette (stigma score as root-mean square error of approximation) (27). It was found that healthcare professionals exhibited significantly more stigma towards the patient with bulimia nervosa and the patient using steroids, even more so than the patient who used cocaine (27).

Although men and women can both present with eating disorders, differences tend to occur in the signs and symptoms of eating disorders among these groups. Often instead of the desire for thinness, which is typically seen among women, men tend towards an "obsessive desire for muscularity," as well as excessive exercise, focusing on muscle building (6,28,29). Men may also be less likely to present with typical compensatory tendencies in bulimia nervosa such as self-induced vomiting or laxative use, but rather use excessive exercise as a means to control body weight and shape (25). Others argue that eating disorders present similarly in men and women, while men typically present with Atypical Eating Disorders or Otherwise Specified Feeding and Eating Disorders rather than classically defined eating disorders (30). Common eating disorders seen among men are binge eating disorder and Otherwise Specified Feeding and Eating Disorders, rather than anorexia nervosa and bulimia nervosa (6).

The average age of onset for eating disorders in men is between 18-20 years, which is typical college/university age (3). It has been suggested that transitionary periods in life – such as from high school to university, or university to working professional – pose a risk for the development of behavioural symptoms of eating disorders (31,32). Authors of a 2009 survey of men attending university in the northeastern United States (N=404; 18-26 years) reported that approximately 25% of participants had binge eaten, 3% had used some form of compensatory behaviour following a binge, and 4-6% of the participants have concerns surrounding their bulimic-like tendencies (33). A 2014 survey of 780 American university students (n=339 men, 441 women) examined the relationship between eating disorder risk and body dissatisfaction with respect to body fat and muscularity and found similar results: 28% of the men were found to be at risk for an eating disorder (34). These data suggest that there is an increased risk for eating disorders with respect to negative body image among men in university and college. However, given the gendered stigma associated with eating disorders, and that men tend to underreport symptoms to

healthcare providers (6,25,26), there is a lack of formal eating disorder diagnosis, and thus skewed prevalence data among this group.

2.2.1 Adverse health outcomes associated with eating disorders

Frequently, men with eating disorders engage in excessive exercise, which current literature has shown to carry the potential for addiction (5,25). Men who are athletes also risk increased body dissatisfaction and muscle dysmorphia (preoccupation with leanness and muscularity (35)) compared to non-athletes (25,30,36). Other research reveals that men with eating disorders and bodybuilders are both at an increased risk of comorbid psychiatric disorders such as muscle dysmorphia and substance abuse (3,28,37,38). The presence of eating disorders, muscle dysmorphia, exercise addiction, or any combination of these disorders can lead to serious adverse physical and psychological health implications. Eating disorders are characterized by chronicity, psychological distress, functional impairment, morbidity (3), and often occur with a comorbid psychological disorder such as substance abuse, muscle dysmorphia, or exercise addiction (5,25). Muscle dysmorphia involves a risk for preoccupation with muscle development, causing social avoidance, job dysfunction, and risk of injury due to excessive exercise (4,39). Exercise addiction imposes similar adverse health outcomes as muscle dysmorphia, such as risk of injury due to excessive exercise, as well as a preoccupation with exercise leading to psychological distress (5).

Although eating disorders are considered psychiatric illnesses (1), they are associated with several nutritional and medical complications, morbidity, and mortality (16,17). These complications may vary depending on the type and severity of eating disorder.

Gastrointestinal complications are common with many eating disorders, including anorexia nervosa (16,40), bulimia nervosa (16,40,41), and binge eating disorder (42). During periods of severely restricted food intake, as in anorexia nervosa, gastrointestinal complications include delayed gastric emptying, decreased motility of the small bowel, and constipation, leading to increased abdominal bloating and prolonged fullness (16,40). Among individuals with bulimia nervosa who engage in self-induced vomiting, dysphagia (difficulty swallowing) (40), gastrointestinal reflux disease (GERD) (41,43), and hematemesis (vomiting blood) (41) are common. Rare, yet, serious complications of self-induced vomiting include esophageal tearing or rupture (41). With self-induced vomiting, erosion of dental enamel and increased risk of dental

caries are common as a result of gastric juice being regularly present in the oral cavity (44). Laxative misuse may also result in abdominal cramping (16), diarrhea (40), rectal bleeding and prolapse (40), and increased dependency on laxatives (40). Among individuals with binge eating disorder, repeated ingestion of large quantities of food may cause gastrointestinal distress including nausea, vomiting, abdominal pain and bloating, heartburn, diarrhea, and constipation (42).

Cardiovascular complications may also occur in the presence of eating disorders (16,40). Among individuals with anorexia nervosa, bradycardia, hypotension, cardiac arrhythmias, and pericardial effusion are common as a result of severe weight loss and malnutrition (16,20). During nutritional rehabilitation, patients must be closely monitored for refeeding syndrome to reduce risk of associated cardiovascular, pulmonary, hepatic, renal, neuromuscular, metabolic, and hematological complications, which could occur following inappropriate nutritional rehabilitation (19,45). Among individuals with bulimia nervosa, self-induced vomiting, laxative, and diuretic misuse are associated with fluid and acid-base imbalances, such as hypokalemic, hypochloremic metabolic alkalosis (16), which has been associated with risk of heart arrhythmias (16), cardiomyopathy (16,43), congestive heart failure (43), and sudden death (43).

Several other health risks have been associated with anorexia nervosa including, hematologic, endocrine, musculoskeletal, and neurological complications (40). These include, but are not limited to, anemia, leukopenia, and thrombocytopenia; hypogonadism; osteoporosis; and brain atrophy, respectively (40).

2.2.2 Eating disorders among athletes

Among athletes with eating disorders, a pattern seems to have arisen wherein disordered eating begins with a short-term diet to control weight for a competition that progresses to more restrictive eating patterns, and eventually to a clinical eating disorder due to pressure (perceived or intentional) from peers and coaches (46). It is well established that athletes, especially men, underreport symptoms of disordered eating (25,26). It has been suggested that this may be in part due to denial or shame, but also to protect the athletic organization that could be perceived as unethical for allowing athletes with eating disorders to participate (30). Alternatively, athletes may attempt to hide disordered eating from the athletic organization for fear that they will no longer be permitted to participate in the sport or event if they report their symptoms (30). There

is a higher susceptibility to developing eating disorders in sports in which athletes are classified by weight, such as gymnastics, wrestling, weight lifting, and bodybuilding (30). In bodybuilding, as is the case for many of the above-mentioned sports, there is a competitive advantage for athletes to compete in the lowest possible weight class for size. Since men typically have lower levels of body fat than women (30), and can sustain lower levels of body fat without health consequences, eating disorders reliant on this measure (e.g. anorexia nervosa) become more difficult to diagnose (25,26). Conversely, a recent meta-analysis that examined 31 studies on disordered eating among men who were athletes or healthy controls (non-athletes) found no significant correlation between disordered eating among these two groups (r=0.07, p=0.19; mean total sample size of studies of 345.45) (47). However, a weak positive correlation is seen in some specific sports: for example, the correlation between disordered eating among wrestlers was significant, albeit weak in comparison to non-athletes (r=0.14, p=0.03; mean total sample size of studies of 252) (47).

2.3 Muscle dysmorphia

In the DSM-5, muscle dysmorphia is currently classified as a sub-category of body dysmorphic disorder (35,36,39), a mental disorder characterized by the perception that part of one's own body is seriously flawed and must be fixed (35). Typical behaviours of body dysmorphic disorder include excessive body 'checking', seeking reassurance, and comparing one's own body to others (2,6,35). Muscle dysmorphia more specifically, is an obsessive preoccupation with increasing muscle mass, even if one is significantly muscular (4,30,35,36). Characteristic symptoms of muscle dysmorphia include obsession or preoccupation with body composition, with a focus on muscularity and leanness (35,36). These symptoms of muscle dysmorphia have all been shown to be strong predictors of eating disorders (3).

Older cross-sectional research examining body satisfaction with respect to muscle mass among n=43 college-aged men and n=59 adult men reported that men were dissatisfied with their current physiques and had a strong desire to be larger (48). Body satisfaction was assessed by having participants choose figure drawings which best represented their current and ideal physiques; if the chosen ideal physique differed from his current physique by at least 5 points (larger or smaller), he was categorized as dissatisfied (48). Authors found that 84% of the college-aged men and 44% of adult men were categorized as dissatisfied with their bodies and

desired to be larger (48). There was a significant difference in body satisfaction between adult men and college-aged men ($X^2 = 19$, p < 0.005) (48). Both men and women have been shown to be concerned about their appearance, but men have a primary focus on muscularity and increased muscle mass rather than thinness, which is more common among women (6,28,37). The current "ideal aesthetic" for men in Western culture is a mesomorphic somatotype, which is characterized by an athletic, muscular, strong, and very lean physique (11,16). This body type is portrayed heavily in media today, from advertisements on television, the internet and in magazines (49). Not only are these images widely available, but these body ideals may not be attainable by most individuals. As such, media exposure to idealistic body images can perpetuate negative body image attitudes (28,37). A 2012 survey of 421 women (university students) designed to examine the relationship between image-focused media, body dissatisfaction, and eating pathology (eating disorder symptoms) found statistically significant, albeit weak, positive correlations between time spent viewing image-focused internet media and body dissatisfaction (r=0.12, p<0.01), and viewing time and eating pathology (r=0.15, p<0.01) (50). It has been reported that both men and women feel "fatter", less "toned", less "attractive", and less "sexy" after viewing stereotypical images of idealistic body images (37). The effect of such self-objectification may be cumulative, and may also accelerate negative body image and anxiety, potentially increasing the risk of eating disorder onset (3). A 2016 longitudinal survey following 2,507 Italian men from their first-year of undergraduate study to graduation found that body dissatisfaction, self-objectification, body-ideal internalization and dieting were predictors of the onset and maintenance of eating disorders (3).

Among men, body dissatisfaction often results in the pursuit of an idealized mesomorphic somatotype (52). Some research suggests that some men may tend to engage in more impulsive behaviours than women (53). Given this, when dissatisfied with their bodies, this impulsivity may lead to "risky" behaviours that have a negative impact on health, such as excessive exercise and dieting, and even unsafe dietary supplementation in order to enhance muscular appearance (36,54). A recent study found that, when asked to select an ideal body type from a collection of images, over half of the men (n=33/65) chose a body type with a fat free mass index greater than 25 kg FFM/m² (34,55). These findings are alarming because it is unlikely to achieve a fat free mass index greater than 25 without the use of anabolic steroids (34). These findings also suggest that a large proportion of adult men may have a distorted perception of the ideal body image.

Boys are also at risk: the anthropometric measures of children's characters and action figures have substantially increased between 1973 and 1998 (56). An analysis of the anthropometric measurements (height, waist, chest, biceps) of several action figures, including G.I. Joe, Luke Skywalker and Han Solo (Star Wars), Batman, and Iron Man, from 1973 and 1998 was completed and extrapolated to human size based on a height of 70" (approximately 5'10"). Between 1973 and 1998, the G.I. Joe action figure's extrapolated measurements increased as follows: waist increased by 4.8" (31.7" to 36.5"), chest increased by 10.4" (44.4" to 54.8"), and biceps increased by 14.6" (12.2" to 26.8") (56). The waist and biceps measurements of the 1998 action figure are larger than that of 2017 Mr. Olympia winner, Phil Heath, whose waist measures 30", and biceps measure 23" at 5'9" tall (57). A 2018 study which examined internalization of the muscular male body ideal among boys and girls found that both boys and girls preferred hyper-muscular action figures over normally-muscular figures (58). Here, n=176 boys and 171 girls with a mean age of 10 years from the Southwestern United States were asked to observe pairings of action figures (normally- and hyper-muscular figures) and reported which they preferred (58). When researchers examined muscularity preference for each sex, boys significantly preferred the hyper-muscular figures over the normally-muscular figures $X^2 = 115$, p < 0.001), and that girls also significantly preferred the hyper-muscular figures, $X^2 = 64$, p < 1000.001) (58). This indicates that both boys and girls showed a marked preference for hypermuscular action figures (58). This exposure to unrealistic body ideals could put boys and young men at risk for muscle dysmorphia later in life (8,10).

There is an implicit overlap between bodybuilding and muscle dysmorphia, given the driving factor of both is to be as lean and muscular as possible. Muscle dysmorphia was identified in a 1993 study of 160 bodybuilding men where it was termed "reverse anorexia" (59) because individuals were cognitively similar to patients with anorexia nervosa; it was defined as a fear of being too small, or inadequately muscular (4,39,59). A 2012 meta-analysis of literature on muscle dysmorphia concluded that confusion exists surrounding the type of disorder under which muscle dysmorphia should be classified, such as an eating disorder, a subtype of body dysmorphic disorder, or an obsessive-compulsive spectrum disorder (60), suggesting that the impact of muscle dysmorphia is related to disordered eating, delusions regarding one's own body shape, as well as an obsessive drive to correct a perceived flaw. Ultimately, it has since been included in the most recent edition of the DSM-5 as a subtype of body dysmorphic disorder (35).

Excessive exercise, such as compulsive weightlifting, tends to be the most common behaviour in men with muscle dysmorphia (8,16), with secondary symptoms including restricted food intake for fat loss and enhanced muscle definition (8,16). A 2012 survey of 27-year-old Hungarian men (n=60 recreational bodybuilders, n=60 undergraduate non-bodybuilders) found that muscle dysmorphia was associated with bodybuilding, higher ideal body weight, and eating disorder characteristics (61). Similarly, a recent survey of 60 natural bodybuilding men (no steroid use) of a similar age in Australia, found a significant positive correlation between muscle dysmorphia symptomology and eating disorder pathology (r=0.31, p<0.05), and rapidity of weight loss during competition preparation (r=0.297, p<0.05) (62). An inverse correlation was found between muscle dysmorphia and number of bodybuilding competitions participants had competed in (r = -0.32, p < 0.05), suggesting that inexperienced bodybuilders may display muscle dysmorphia to a greater extent than experienced bodybuilders (62). Individuals with muscle dysmorphia have reported that deviation from their diet and training regime for even one day causes them severe anxiety, and that they tend to compensate by exercising excessively (2,3,29). Many of these individuals also report refusal to alter their regimes even though they are aware of potential adverse consequences (2).

2.4 Exercise addiction

Resistance training serves as a means to improve strength and fitness and often includes activities such as weight lifting and calisthenics (63). Many individuals begin resistance training or bodybuilding to improve self-esteem (38). Resistance training has been described as a rewarding activity associated with a feeling of well-being – many individuals report feeling "better" following a session of resistance training (5), as it is associated with many physiological and psychological benefits including feelings of euphoria and relaxation (5,63). However, rewarding activities pose a risk of potential addiction (38). It has been suggested that even exercise has a potential to become addictive (5,38,64). In the 1970s, exercise addiction was referred to as a "positive" addiction, due to its ability to promote a mental and physical sense of well-being (5). Women striving to pursue the ideal somatotype are often recognized and receive treatment for disordered eating, however paralleled behaviours in men are typically embraced in the sport of bodybuilding (37). Similar to anorexia nervosa, bulimia nervosa, and binge eating disorder, many men turn to the use of potentially dangerous dietary and exercise practices in

order to achieve the mesomorphic somatotype (4,5,38,65,66), which may lead to exercise addiction (38).

Exercise addiction is distinct from simply having a passion for physical activity, although it is not currently included as a diagnosable disorder in the DSM-5. It is characterized by symptoms including several exercise sessions per day or exercise sessions lasting for longer than recommended, obsession with exercise, foregoing responsibilities in order to exercise, and scheduling daily activities around exercise (38,64). Exercise addiction can occur as a primary addiction, or as a secondary addiction to an eating disorder (67). Other literature states that it is unclear whether the condition even exists when unaccompanied by an eating disorder (5). A 2012 cross-cultural study among adults from Mexico (n=35) and the United States (n=43) found that muscle dysmorphia symptoms were positively correlated with exercise addiction and eating pathology among men in both regions (54). Among Mexican men, muscle dysmorphia symptoms were correlated with exercise dependence (r=0.62, p<0.001), and eating pathology (r=0.44, p=0.009) (54). Among American men, muscle dysmorphia symptoms were correlated with exercise addiction (r=0.74, p<0.001), and eating pathology (r=0.50, p=0.001) (54). It has been shown that individuals who are exercise addicted are more likely to turn to resistance training as a result of, and a way to manage, stress presenting as aggression (38). Exercise addiction has been studied among bodybuilders, and aside from its correlation with eating disorders, it has also been associated with muscle dysmorphia (54). Hurst et al reported that among 35 experienced bodybuilding men (>2 years experience), 31 novice bodybuilding men, and 23 weight lifters, novice bodybuilders showed more symptoms of muscle dysmorphia than experienced bodybuilders, but that experienced bodybuilders displayed more exercise addiction than novice bodybuilders and weight lifters (68).

Exercise identity may also play a role in the development of exercise addiction (69,70). Exercise identity has previously been defined as an individual's desire to maintain a concept of oneself, or identity, where exercise plays a large role in said identity (69,70). It has been suggested that past exercise behaviour motivates future exercise behaviour in order to maintain this identity (69,70). High exercise identity has been associated with exercise addiction among men (70). In addition to bodybuilders reporting a high prevalence of exercise addiction, Hurst *et al* found that experienced bodybuilders displayed higher bodybuilding exercise identity than inexperienced

bodybuilders and weightlifters (68), suggesting that high bodybuilding exercise identity may potentially increase risk for exercise addiction.

2.5 Bodybuilding

Bodybuilders are perceived as the epitome of men's health and fitness, and their physiques are praised in the media, as they represent the mesomorphic somatotype idealized in Western culture (37). However, the mesomorphic somatotype was not always considered the ideal body type in the West. In the early nineteenth century, a thin physique for men was ideal, as muscularity was then associated with manual labour and low socioeconomic status (71). The first known bodybuilder, Eugene Sandow (1867-1925), was a European strongman who began exhibiting his strong physique as a work of art (4,71). Sandow was the first athlete to make a living by virtue of his physique alone (71). Despite a dramatic change in perspective at the time, the sport did not gain popularity in North America until the late 1970s, when the iconic bodybuilder Arnold Schwarzenegger starred in the popular documentary 'Pumping Iron,' and ultimately became a Hollywood star (4,54,72). Bodybuilding can be defined as progressive resistance training and strict dieting in pursuit of a muscular, symmetrical, and proportionate physique (4). In bodybuilding competitions, contestants present their extremely muscular bodies to judges who give scores based on size, symmetry, and muscle definition (4). Additionally, in bodybuilding competitions, the primary goal is to simply appear strong and muscular, and there is typically no physical performance of strength involved (73).

Given the modern men's ideal mesomorphic somatotype, many men engage in bodybuilding in an attempt to achieve this ideal physique (28). While women also participate in bodybuilding, men comprise the majority of bodybuilders today (4): approximately 90% of Canadian bodybuilders are men (*personal communication, Canadian Bodybuilding Federation, November 13th, 2017*). The goal of competitive bodybuilding is to increase muscle mass in the off-season and dramatically reduce body fat during the pre-contest period, all while maintaining high levels of muscle mass (74). Competitive bodybuilders adhere to meticulous resistance training and dietary practices in order to achieve this ideal physique (75). Literature suggests that as bodybuilding becomes more popular, more everyday men are becoming unhappy with their physiques (4), causing an increased risk for conditions such as muscle dysmorphia and exercise addiction (4,38). Food intake is often restricted among competitive bodybuilders to improve body shape (76,77). In dietary preparation for a bodybuilding competition, individuals engage in extreme levels of dieting and weight loss in order to enhance muscularity following a period of caloric surplus designed to gain as much muscle mass as possible (77,78). Research investigating the effects of recurring cycles of weight loss and regain has indicated that individuals who engage in these dietary patterns have an increased risk for serious medical and psychological consequences including eating disorders, anxiety, depression, and potential cardiovascular risk factors such as hypertension, dyslipidemia and insulin resistance (79). Additionally, Montani *et al* describe the "repeated overshoot theory", in which weight cycling causes continuous fluctuations in energy balance that may increase cardiac work load and glomerular pressure, potentially leading to vascular injury and/or glomerular damage (79,80).

Typically, bodybuilders undergo a period of "bulking" followed by several weeks of "cutting" (74,77). Bulking is characterized by a positive energy balance, or increased caloric intake and resistance training during the off-season in order increase muscle mass (74). In the bulking phase, individuals may consume extra calories, weight gain supplements, and alter resistance training practices in order to increase muscle mass (81). An estimated 90% of athletes globally use dietary supplements as a way to enhance performance (66). Bodybuilders typically use products such as protein powders, specific amino acids, caffeine, and creatine monohydrate, all of which are known effective performance-enhancing supplements (82). A 2018 retrospective study investigating the nutritional strategies of high-level competitive bodybuilding men and women (n=51) found that participants used protein powders, multivitamin supplements, branched-chain and individual amino acids, creatine, pre-workout supplements, omega-3 fatty acids, carbohydrate supplements, mineral supplements, vitamin C, vitamin D, and other miscellaneous supplements (77). However, in the pursuit of the ideal physique, some bodybuilders may turn to questionable substances purchased online, the potential side-effects of which are unknown (83). In a previous pilot study relating to this research, when asked what types of supplements bodybuilders normally used, one participant commented, "Everything you could ever think of and then twice as many that you would never of [sic] heard of' (68, p.25). He then elaborated,

"...supplements listed as being natural vs. gray area vs. anything goes. Now a days you can not take steroids at all and still make the same growth and

development using things you can buy on the internet that are not really legal to use but [companies] still get away with selling." (68, p.25)

In the weeks prior to competition, bodybuilders follow rigorous dieting regimes to reduce body fat to extremely low levels in order to enhance muscular appearance and vascularity (75,77). Some high-level bodybuilders have reported dieting for 23 to 25 weeks leading up to a competition (77). This is called the 'cutting' period or 'prep' period and is characterized by a caloric deficit in order to maximize fat loss while maintaining muscle mass gained in the bulking phase (74,81). Many bodybuilders have been reported to employ techniques such as steam baths, saunas, small meals, 'calorie counting', and fasting in order to reduce body fat (78). The week prior to competition, often referred to as 'peak week', involves attempts to reduce extracellular water by manipulation of fluid, electrolyte and carbohydrate intake, to enhance muscle definition and vascularity (81,82). These practices may be dangerous as they include procedures such as dehydration and consuming large quantities of sodium to achieve the desired appearance (81). In sum, the goal of bulking and cutting is to gain as much muscle mass as possible, and reduce body fat to levels as low as 2-6% according to popular fitness forums and bodybuilding websites such as bodybuilding.com and livestrong.com (84,85). With the increased focus on dieting and weight loss in the pre-contest phase, bodybuilders experience many psychological effects as a result of decreased caloric intake. A 1995 study by Andersen et al found that 85% of the 45 bodybuilding men interviewed reported binge eating post-competition, while 82% reported being preoccupied with food 'sometimes, often, or always', and between 30-50% reported anxiety, short temper, and anger while preparing for competition (78). Supporting these findings, a participant of the aforementioned pilot study for this research described his experience with psychological distress during competition preparation:

"The last week or two of prep is incredibly difficult, therefore, certainly has a negative effect on health, both physical and mental, and does not come without an extreme amount of suffering. But this suffering is necessary in the competition field" (68, p25).

A report from 2006 found that nearly 30% of men in competitive bodybuilding met the diagnostic criteria for bulimia nervosa at some point in their lives (28). Competitive bodybuilders show increased rates of body preoccupation, binge eating, and bulimia nervosa, but to a lesser extent compared with men previously diagnosed with bulimia nervosa (81). A 2018 qualitative

study of n=16 French bodybuilders of different skill levels (future competitors, competitors, noncompetitors) highlighted disordered eating in the forms of food control, food restriction and objective binge eating (86). Differences were noted between future competitors and competitors. Weighing food and excessive use of food scales seemed to be a popular form of food control among the group, but more so among future competitors (86). For example, one future competitor commented, "I began to weigh everything when I decided to get involved in competition (73, p7)." whereas a competitor noted, "I only weigh food during competitive periods...When I'm off, I do it randomly; I know approximately the quantities I need now" (73, p7). This may indicate this competitor was so accustomed to weighing his food that he was able to visually determine the mass of any given food. Food restriction was also prevalent among future and current competitors (86). A future competitor noted "I hold myself back because I know that I do not have to eat that [...]. Sometimes it's a bit complicated, but I can resist in general" (73, p7). Competitors seemed to remove pleasurable foods from their diets, "I do not eat for pleasure, in fact; I eat because I have to. So I do not care if it is good or not. I swallow, and it is settled" (73, p7). Finally, future competitors seemed more inclined to binge eat than competitors (86). One future competitor commented, "I went to the self-service buffet and ate four entrance dishes, five main courses and three dessert dishes. I took in four kilos during one meal" (73, p8). Similarly, another future competitor commented, "I suffer too much from this strict diet, so each food deviation is a big fiasco because I cannot help myself [...]. The next day, I have a major stomach ache" (73, p8). Competitors reported having binge eating sessions only after competitions, "We have been so deprived that after we let go, we eat junk without stopping" (73, p8). Although these comments provide only some insight into the issue of dietary habits among bodybuilders, it is clear that the topic warrants further investigation. A 2017 case report from Lithuania describes a 28-year-old man (professional bodybuilder) who presented to the emergency department with sudden bilateral lower limb paralysis and muscle weakness, with no history of injury, trauma, or other illness or disability (87). It was determined that the patient was experiencing an atypical manifestation of refeeding syndrome following an extreme diet, which involved 5 months of undernourishment pre-competition, and 6 days of carbohydrate overload post-competition (87). Laboratory tests demonstrated severe hypokalemia, hypophosphatemia, hypomagnesemia, and hyperglycemia, which are indicative of refeeding syndrome (87). While

this paper represents only a single case of refeeding syndrome with a bodybuilder, it further supports the need for additional research.

2.6 Summary of rationale

Existing literature shows a strong theoretical overlap among the three domains of eating disorders, muscle dysmorphia, and exercise addiction, however little research to date has focused on competitive bodybuilders as a risk group for these domains. Table 1 (Appendix A) highlights the small body of research pertaining to eating disorders, muscle dysmorphia, exercise addiction among bodybuilders. As detailed above, there is currently a lack of knowledge surrounding the prevalence of muscle dysmorphia and exercise addiction as well as the potential of underlying eating disorders, among bodybuilding men in Atlantic Canada. While some research in this area has been conducted in the United States, Europe, Australia, and Ontario, Canada, to date no research of this nature has been conducted in Atlantic Canada. Given the popularity of bodybuilding competitions in the region, as well as the fact that eating disorders often go undiagnosed among men (25), this subject merits further investigation. Assessing these associations and their potential influence on eating disorders is vital as these conditions can lead to various adverse psychological health implications such as depression, anxiety, functional impairment, increased risk of substance abuse (1,25), as well as physiological complications of the gastrointestinal, cardiovascular, and other organ systems (16). Therefore, the aim of this research was to conduct an exploratory online study to determine the prevalence of, and associations between, eating disorders, muscle dysmorphia, and exercise addiction among men in competitive bodybuilding in Atlantic Canada.

3.0 Methods

3.1 Research objectives and hypotheses

The objectives of this exploratory study were twofold:

1) to obtain content validity of a questionnaire tool intended to screen for risk of eating disorders and muscle dysmorphia among men in competitive bodybuilding by evaluation from experts in the fields of dietetics and psychology, and

2) to determine the prevalence of, and associations between, eating disorders, muscle dysmorphia, and exercise addiction among men in competitive bodybuilding in Atlantic Canada, by implementing the aforementioned questionnaire alongside the Exercise Addiction Inventory (8), a previously validated tool to screen for exercise addiction, among a sample of the population.

The hypotheses for objective 2 are:

Null hypothesis (H₀): Among men in competitive bodybuilding in Atlantic Canada, there will be no correlations between eating disorders, muscle dysmorphia, and exercise addiction.

Research hypothesis (H_A): Among men in competitive bodybuilding in Atlantic Canada, there will be positive correlations between eating disorders, muscle dysmorphia, and exercise addiction.

3.2 Research design

This cross-sectional study was exploratory in nature, given the limited body of research currently available in this area. We developed an online participant administered questionnaire and employed it with the Exercise Addiction Inventory to collect data through both open- and closed-ended questions.

3.3 Research tools

A participant-administered online questionnaire with both closed- and open-ended questions was completed by a sample of N=28 eligible participants to collect data in the domains of select eating disorders (anorexia nervosa, bulimia nervosa, and binge eating disorder), muscle dysmorphia, and exercise addiction. A read-only version of the questionnaire with questions and response options can be found in **Appendix B.** The questionnaire collected self-reported

demographic data (including age, location, ethnicity, income, and level of education), as well as height, weight, and estimated body fat percentage. Information regarding bodybuilding history, body image, exercise habits, and dietary patterns both while preparing to compete vs. not competing, was also self-reported. We collected information pertaining to the three eating disorders noted above, muscle dysmorphia, and exercise addiction using a five-point Likert scale with response options on horizontal scales of always/never (*always, usually, sometimes, rarely, never*) or agree/disagree (*strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*); discussed in depth in *Section 3.9*. These questions were formulated using existing criteria for select eating disorders (**Appendix C**) (1) and muscle dysmorphia questions were formulated based on the proposed (2) and current (35) DSM-5 criteria for muscle dysmorphia (**Appendices D & E**). Exercise addiction risk was screened for using the previously validated Exercise Addiction Inventory (**Appendix F**) (8).

3.4 Content validity

The research tool was evaluated for content validity. The questionnaire previously underwent face validity assessment (83) and was amended accordingly. In this study, the tool was evaluated for content validity by experts (88) in the fields of dietetics and psychology. Eight panelists were recruited to review the questionnaire (89). The recruitment letter and consent form can be found in **Appendices G** and **H**, respectively. The panel included dietitians and psychologists from across Canada. Each panelist evaluated the questionnaire items related to eating disorders and muscle dysmorphia and scored each item using the following scale: 4=highly relevant, 3=quite relevant, 2=somewhat relevant or 1=not relevant (89). Sample forms for validity assessment can be found in **Appendix I.** Using this scale, the more panelists who consider an item as highly or quite relevant, the higher its degree of content validity (88,89). Following evaluation from field experts, the content validity ratio (CVR) was calculated using the following formula:

$$CVR = \underline{ne - (N/2)}$$
 (88,89),
(N/2)

where n_e is the number of panelists who considered an item highly relevant or quite relevant, and N is the total number of panelists (88,89). The CVR was generated for each questionnaire item and only those that meet the minimum value were retained (88,89). In **Appendix J**, Lawshe (88) demonstrates the minimum values required for the retention of a particular questionnaire item based on the number of panelists evaluating the questionnaire. The mean of the CVR values of

retained items is then calculated to determine the content validity index (CVI), which represents the proportion of total items that have been considered valid (89). Participants of the implementation part of this study were given the opportunity to provide feedback for further face validity. This method provides an initial step in determining validity of this questionnaire. A limitation of this method is that it only assesses the quantitative aspect of the questionnaire and not the free-form aspect.

3.5 Participants and sampling

We anticipated recruiting a sample of approximately 50-100 men involved competitive bodybuilding living in Atlantic Canada to participate in this study. This number was chosen to reflect the approximate number of bodybuilding men participating in competitions in Atlantic Canada at any given time (*personal communication, Nova Scotia Amateur Bodybuilding Association, December 27th, 2017*). A sample size calculation was not conducted given the exploratory nature of this research, the lack of peer-reviewed literature on which to base a calculation, and an unknown population size.

Despite this, we looked to the literature to determine an appropriate sample size. A large number of studies reviewed from the current body of literature on the topic have recruited between 50-200 participants. For example, similar cross-sectional designs investigating eating disorders and muscle dysmorphia among bodybuilding men recruited 60 (50), 74 (28), and 120 (61) participants. Older cross-sectional studies investigating solely eating disorders among bodybuilding men recruited 45 (24) and 68 participants (37). Considering the recent literature on exercise addiction using the Exercise Addiction Inventory, sample sizes are much larger. For example, cross sectional designs examining exercise addiction among CrossFit athletes (n=603) (90), German gym-goers (n=1,008) (91), and finally football players and gym-goers (n=274) (92) had much larger samples. However, this tool alone may be less cumbersome for participants to complete, given that it is only a 6-item questionnaire, therefore allowing for larger sample sizes to participate more easily.

Personal communication with the Canadian Bodybuilding Federation in November 2017 revealed that there are approximately 5,000 bodybuilding athletes nationwide. If we assume equal participation across Canada, and take into consideration the proportion of the Canadian population living in Atlantic Canada (approximately 6.5% (93)) and extrapolating it to the

estimated 5,000 bodybuilding athletes nationwide, an approximate figure for the Atlantic Canadian competitive bodybuilding population is 325 people. Given that approximately 90% of Canadian bodybuilders are men (*personal communication, Canadian Bodybuilding Federation, November 13th, 2017*), the population of competitive bodybuilding men could be estimated at approximately 293. With such estimates, we aimed to recruit approximately one third of the Atlantic Canadian male bodybuilding population for this study.

Individuals interested in participating were directed to visit the website URL listed on the recruitment poster. The URL directed participants to a set of pre-questionnaire screening questions to determine if they were eligible to participate. If the participant answered any screening question in a way that did not align with the inclusion criteria, he was not granted access to the questionnaire, and was redirected to a page explaining that he was ineligible to participate. If a participant answered all screening questions in alignment with the inclusion criteria, he was automatically directed to the consent form, and if he provided consent, he was granted access and could subsequently complete the questionnaire.

3.6 Eligibility criteria

In order to participate in this study, participants must have been: men aged ≥ 19 years (age of majority), currently living in Atlantic Canada (Nova Scotia, New Brunswick, Prince Edward Island, or Newfoundland and Labrador), a competitive bodybuilder (defined as having competed in at least one bodybuilding competition in the past three years), and confident reading and writing/responding in English.

3.7 Ethical considerations

Given the personal and potentially uncomfortable nature of the questions, all aspects of the study remain confidential, including recruitment, data collection, analysis, results, remuneration and dissemination of information. Records are kept on the secure Mount Saint Vincent University server. Participants of the study were informed that they could withdraw from the study at any time during data collection (advised to not submit their questionnaire). Participants were also informed of appropriate contacts for mental health support, such as the National Eating Disorders Information Centre Helpline at 1-866-633-4220, and the Mental Health 24/7 Mobile Crisis Team at 1-888-429-8167, should they have felt any challenges or discomfort during the study period.

3.8 Outcomes

Three primary outcomes were selected for investigation among this sample of competitive bodybuilding men, 1) eating disorders, 2) muscle dysmorphia, and 3) exercise addiction. These outcomes were selected based on the theoretical overlap that appears to exist across these three domains in the body of currently available research. We sought to explore the prevalence of risk for these three outcomes among the sample population of competitive bodybuilding men. They are quantified by questionnaire scores on a 5-point Likert scale: eating disorder risk is quantified by scores on an agree/disagree scale for general questions, whereas for questions that involve severity of behaviour, an always/never scale was used (Appendix B). These scores reflect the current diagnostic criteria for feeding and eating disorders in the DSM-5 (1). Similarly, muscle dysmorphia risk was quantified by scores on an always/never scale, but there is no association to behaviour severity in terms of frequency. For example, it is difficult to quantify (in frequency per week) how often one may be preoccupied with their body composition. Therefore, an always/never scale is appropriate for this set of questions. Muscle dysmorphia questions were created based upon, and using similar language to, the proposed DSM-5 criteria (Appendix D). The 5-point Likert scale was chosen to reflect available responses to the previously established Exercise Addiction Inventory (8). Finally, exercise addiction risk is quantified by scores on an agree/disagree scale as per the six-item Exercise Addition Inventory by Terry et al (Appendix F) (8). Note that other data was collected from participants to be able to describe the sample (i.e. demographic characteristics: age, ethnicity, location, education, and income), and to better contextualize the responses (e.g. free-form question answers).

3.9 Statistical analysis

All quantitative analysis was completed using SPSS v.26 (IBM Corp, Armonk, NY, USA). P values <0.05 were considered significant for all statistical tests.

Descriptive statistics were computed to describe the quantitative data collected. Demographic data including location, ethnicity, education, and income are expressed as n (%), and age is represented as mean \pm SD. Self-reported anthropometric characteristics such as height, weight, body fat percentage, and indexes computed based on these self-reported anthropometric information, including body mass index (BMI) and fat free mass index (FFMI), are expressed as mean \pm SD. Bodybuilding history data including when the individual started bodybuilding

(years) and number of competitions they have completed in are expressed as mean \pm SD, while top bodybuilding information resources used are expressed as *n* (%).

Risk of select eating disorders (anorexia nervosa, bulimia nervosa, and binge eating disorder) were calculated based on responses to Likert-scale questions and some self-reported anthropometric and intake data. Each criterion is associated with one or more questions in the associated section of the questionnaire. For example, anorexia nervosa 'criterion A' is "restriction of energy intake relative to requirements, leading to a significantly low body weight in the context of age, sex, developmental trajectory, and physical health", and is associated with participants self-reported weight compared to their calculated BMI, self-reported calorie intake compared to estimated energy requirements to assess energy restriction, and the Likert-scale question, "I modify my energy intake in order to achieve or maintain a body weight that is much lower than my friends, family, or health practitioners express as healthy." Data collected from these responses were compared to the criteria upon which the questions are based (see Appendix C), the DSM-5 criteria for feeding and eating disorders (1). Responses to Likert-scale questions of "1=strongly disagree," "2=disagree," and "3=neither agree nor disagree" were collapsed to "0=not at risk," and responses of "4=agree," and "5=strongly agree" were indicative of risk for a given criterion. Responses of "2=rarely, 1-3 times per week" to "5=all the time/14+ times per week" were considered to demonstrate risk for frequency-based questions such as "I experience episodes of binge eating," given the diagnostic criteria for bulimia nervosa and binge eating disorder involving at least 1 episode of binge eating and/or purging per week for 3 months (1). Aspects such as "low bodyweight" for anorexia nervosa were scored as "0=no" and "1=yes" based on body mass index, as per current diagnostic criteria (1). For criteria such as binge eating disorder criterion B (Appendix C) where a participant must agree to three of five sub-criteria to be considered at risk, less than three responses of "4=agree" were not considered indicative of risk and three responses of "4=agree" and/or "5=strongly agree" were indicative of risk for this criterion. After accounting for responses that did not indicate risk and were collapsed to "0=not at risk," a risk score was calculated by summing risk-indicating question responses for each criterion, and subsequently each eating disorder. For anorexia nervosa, participants must have scored at least 5, 11, and 5 points for criterion A, B, and C respectively to indicate risk. For bulimia nervosa criteria, participants must have scored 2, 2, 4, 8, and 1 point for criterion A, B, C, D, and E respectively. Finally, for binge eating disorder, participants must have scored 2, 12,

4, 2, and 1 point for criterion A, B, C, D, and E respectively. These responses were kept as is in order to mimic the scoring system of the previously validated Exercise Addiction Inventory (8) as best as possible, as well as to preserve the nuance in data collected as tallied scores versus a binary system of classifying participants as simply not at risk/risk.

Similarly, risk of muscle dysmorphia was calculated based on responses of "4=agree," and "5=strongly agree" to Likert-scale questions based on proposed (2) and current (35) DSM-5 diagnostic criteria for muscle dysmorphia. The same method of comparing questions to criteria to determine an overall risk score for this domain was used. Participants must have scored at least 12, 8, and 4 points for criterion 1, 2, and 3 respectively to indicate muscle dysmorphia risk.

Exercise addiction risk was calculated using the method described in the Exercise Addiction Inventory, which was originally developed using DSM-4 criteria for substance addiction (8). The Exercise Addiction Inventory was chosen based on its length of only six items and its ability to capture exercise addiction risk with similar accuracy and reliability as two longer screening tools, the Obligatory Exercise Questionnaire and the Exercise Dependence Scale (8). In this tool, each question is assigned a factor loading based on importance according to the authors, and the overall score is determined by the sum of each question response multiplied the factor loading (8). Per instructions, total risk score was calculated by adding the number of responses of "3=neither agree nor disagree," "4=agree," and "5=strongly agree" and multiplying by the respective factor loading for each item as described in **Table 3-1** (8) before summing a total score. The maximum possible score for individuals at risk of exercise addiction was 24 (8). A participant would be considered at risk if he scored 13 or higher.

Data was tested for normality using a Shapiro-Wilks test. Since overall risk score data were not normally distributed for any of eating disorders, muscle dysmorphia, or exercise addiction, a non-parametric Spearman's correlations test was used to assess bivariate associations between eating disorders, muscle dysmorphia, and exercise addiction. *A priori*, we decided that the correlation coefficients would be interpreted as: weak ($rho \le 0.3$), moderate (rho = 0.3-0.5), good (r = 0.5-0.7), strong (rho = 0.7-1.0) (94).

Table 3-1. Factor loadin	gs for individual	Exercise Addiction	Inventory items ^{at}
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Exercise is the most important thing in my life	
Conflicts have arisen between me and my family and/or my partner about the amount of exercise I do	
I use exercise as a way of changing my mood	0.800
Over time I have increased the amount of exercise I do	0.742
If I have to miss an exercise session, I feel moody and irritable	0.801
If I cut down the amount of exercise I do, and then start again I always end up exercising as often as I did before	

^aQuestion responses multiplied by factor loadings to determine participant score ^bTable from Terry et al. 2004 (8)

3.10 Dissemination of findings

Upon completion of this study, results will be shared with the scientific community in the form of a peer-reviewed manuscript to a journal such as Applied Physiology, Nutrition, and Metabolism, and/or presentation at a relevant academic conference such as Canadian Nutrition Society Annual Conference, as well as in a lay form to share with the participants and other members of the public at www.mamalab.ca. We will also create a policy brief to share with relevant stakeholders, such as the Nova Scotia Health Authority and the Canadian Bodybuilding Federation and organizations (CBBF, NSABBA, NBFPA, PEIFPA, and NLABBA).

Study results will be made available to the public following completion of the research project at <u>www.mamalab.ca</u>. Participants are encouraged to visit <u>www.mamalab.ca</u> approximately one year after completion of the questionnaire in order to retrieve final study results (overall summary results, *not* individual results). This will ensure the researcher has no contact with participants at any point in time during the study and following study completion.

4.0 Results

4.1 Content validity

The first research objective was to obtain content validity of a questionnaire tool intended to screen for risk of eating disorders and muscle dysmorphia among men in competitive bodybuilding through evaluation from experts in these fields. These individuals were recruited via purposeful selection based on their experience working with eating disorders, athletes, body image, and/or questionnaire development. The questionnaire was evaluated by eight panelists in the fields of dietetics and psychology who provided written consent to participate. Panelists reviewed the questions pertaining to eating disorders and muscle dysmorphia and rated them based on relevancy, as well as provided feedback for improvement of wording, comprehension, and flow of the questionnaire, as described in **Section 3.4**.

Questions that were evaluated by panelists are presented in **Table 4-1** with associated number of panelists who rated a given item as highly relevant=4, or relevant=3 (n_e), as well as content validity ratio (CVR) scores calculated as described in *Section 3.4*. Content validity index (CVI), the mean of all CVR scores, is also shown.
Question	n _e ^c	CVR ^d
I have an intense fear of gaining weight and/or becoming fat.	8	1.00
I modify my energy intake in order to achieve or maintain a body weight that is much lower than my friends, family, or health practitioners express as healthy.	7	0.75
My weight and/or body shape strongly influences how I feel about myself.	8	1.00
I experience episodes of binge eating ^a .	8	1.00
I feel disgusted with myself, depressed, and/or very guilty after binge eating ^a .	7	0.75
During a binge ^a , I eat large amounts of food when I am not physically hungry.	7	0.75
During a binge ^a , I eat alone because I feel embarrassed by how much I am eating.	7	0.75
After a binge ^a , I engage in risky behaviour(s) ^b to prevent weight gain.	8	0.75
I engage in risky behaviours ^b to prevent weight gain, even if I have not engaged in binge eating ^a .	6	0.50
I am preoccupied with the idea that my body is not sufficiently lean and muscular.	7	0.75
<i>My preoccupation about the inadequacy of my body size or musculature causes me significant distress.</i>	7	0.75
I spend long hours in the gym lifting weights.	7	0.75
I pay a lot of attention to my diet.	8	1.00
I give up important social, occupational, or recreational activities to maintain my workout and diet schedule.	8	0.75
I avoid situations where my body is exposed to others, or I endure such situations only with significant distress or intense anxiety.	7	0.75
I continue to work out, diet, or use performance-enhancing substances despite knowledge of negative physical or psychological consequences.	8	1.00
	CVIe	0.83

Table 4-1. Questions evaluated by panelists, content validity ratios and content validity index of the research tool.

^a Eating an amount of food in a discrete period of time (e.g. 2 hours) that is definitely larger than what most people would consume in a

similar period of time, and/or feeling a sense of lack of control while eating.

^b Self-induced vomiting, use of laxatives, water pills (diuretics), fasting, excessive exercise.

^c n_eNumber of panelists who rated item 4 or higher.

^d Content validity ratios (CVR) calculated as: $CVR = [n_e - (N/2)]/(N/2)$ (88,89)

^e Content validity index (CVI) is the mean of all CVR scores.

The question, "*I eat alone because I feel embarrassed by what I am eating*," was removed due to low ratings and panelist feedback suggesting it be removed. It was also not related to any particular eating disorder criterion. Based on feedback, the wording of certain questions was modified, and some questions were moved to improve the overall flow and comprehensibility of the questionnaire. Two new questions were added based on feedback to split up the description of what binge eating entails. Binge eating was previously described as, "*eating an amount of food that is definitely larger than what most people would consume in a similar period of time*,

feeling a lack of control while eating, eating until uncomfortably full. "This description was changed to, "eating an amount of food in a discrete period of time (e.g. 2 hours) that is definitely larger than what most people would consume in a similar period of time, and/or feeling a sense of lack of control while eating." Feedback from panelists recommended that the item, "...I eat until I am uncomfortably full" be used as a follow up question for participants who answered "yes" to "I experience episodes of binge eating." Additionally, "...I eat much more quickly than normal," was added as a follow up question to the same in order to reflect Binge Eating Disorder criteria B1 and B2 respectively (See Appendices B, C).

As described in *Section 3.4*, with a total of 8 panelists, the minimum value for questionnaire item retention was CVR=0.75. Content validity ratio scores for each item can be found in Table 4-1. All final items met this requirement except for one question, "*I engage in purging behaviour even when I have not engaged in binge eating*," the score of which was calculated to be CVR=0.50, with two panelists deeming the question either somewhat relevant or not relevant. Despite this low score, this question was retained because disordered eating can exist on a continuum and knowing whether purging behaviour was occurring in the absence of a binge eating episode may provide insight into the level of risk present in the population. It was also acceptable to maintain this question because overall questionnaire content validity was maintained at an appropriate level. The mean overall CVR score—the CVI, was computed as 0.83, which according to the pre-designated cut-off of 0.75, means the questionnaire as a whole was valid for implementation in research. The final questionnaire can be found in **Appendix B**.

4.2 Participant characteristics

The questionnaire was clicked 47 times. One participant formally withdrew from the study by clicking "clear and exit survey" in the browser window, 2 participants viewed the screening questionnaire but did not respond, and 18 participants abandoned their questionnaires without submitting. A sample of 28 participants was recruited via convenience sampling through advertisements on social media pages, Atlantic Canadian universities, and through recognized associations of the Canadian Bodybuilding Federation (CBBF) in Atlantic Canada: The Nova Scotia Amateur Bodybuilding Association (NSABBA), New Brunswick Physique and Fitness Association (PEIFPA), and Newfoundland Amateur Bodybuilding Association (NLABBA).

Participants' sociodemographic characteristics are presented in **Table 4-2**. Participants ranged in age from 19 to 67 years, with a mean age of 34 ± 11 years. The majority of participants were located in Newfoundland and Labrador (*n*=12) and Nova Scotia (*n*=10). Most participants were of Western European descent (*n*=20; English, French, Portuguese, etc.), had completed college or university (*n*=16), and the most frequently reported total annual household income was between \$50,000-\$99,999 (*n*=12).

Characteristic	<i>n</i> (%), or mean ± SD		
Age, years	34.0 ± 11.4		
Location			
Newfoundland & Labrador	12 (43%)		
Nova Scotia	10 (36%)		
New Brunswick	5 (18%)		
Prince Edward Island	1 (4%)		
Ethnicity			
Western European	20 (74%)		
Northern African	2 (7%)		
<i>Other</i> ^a	5 (19%)		
Education			
Completed high school or equivalent	3 (11%)		
Some college/university	4 (14%)		
Completed college/university	16 (57%)		
Completed graduate/ professional degree	5 (18%)		
Annual household income (CAD\$)			
<\$50,000	8 (30%)		
\$50,000-\$99,999	12 (44%)		
>\$100,000	7 (26%)		

 Table 4- 2. Sociodemographic characteristics of 28 Atlantic Canadian bodybuilding men who participated in the study

^aLatin American (n=1), North American Aboriginal (n=1), Mixed ethnicity (n=3).

Table 4-3 shows self-reported anthropometric characteristics of study participants. The height and weight of participants was 178 ± 17 cm, and 92 ± 13 kg, respectively. Average self-reported body fat percentage was approximated at 14 ± 4 % (*n*=25). Body mass index (BMI) was determined to be 29 ± 3 kg/m². Upon calculating participants' fat free mass, the mean Fat Free Mass Index (FFMI) was computed as 25 ± 3 kg FFM/m², with a range of 19–35 kg FFM/m².

Characteristic	n	Mean ± SD	Range
Height (cm)	28	178 ± 17	165–188
Body Mass (kg)	28	92 ± 13	71–136
Approximate body fat (%)	25	14 ± 4	9–25
Fat free mass (kg) ^b	25	79 ± 13	57–123
Body mass index (BMI; kg/m ²) ^b	28	28.9 ± 3.3	24.0-39.0
Fat free mass index (FFMI; FFM/m ²) ^c	25	24.7 ± 3.2	19.0–34.7

Table 4- 3. Self-reported anthropometric characteristics of Atlantic Canadian bodybuilding men

 who participated in the study

^b Calculated using self-reported data: $BMI = mass [kg] / (height [m])^2$

^c Calculated using self-reported data: FFMI = fat free mass $[kg] / (height [m])^2$

Table 4-4 presents information regarding participants' involvement in competitive bodybuilding, as well as what resources they typically use to find information regarding nutrition and exercise specific to bodybuilding. Participants had a wide range of involvement in bodybuilding, with a range between 1 to 30 years, and the number of competitions ranging from 1 to 11. Participants accessed a variety of different resources for nutrition and exercise information, the most common being interpersonal communication between friends and other bodybuilders (79%) and searching online (75%) for information. Online sources reported include social media (YouTube, Facebook, Reddit) and websites such as bodybuilding.com and rxmuscle.com. Some participants reported accessing books (32%), and peer reviewed journals (29%), however, specific titles were not provided. Some participants also sought other means of learning (n=9, 32%): via personal trainers (n=2), bodybuilding coaches (n=4), and their own prior education (n=3).

bodybunding men who participated in the study	
Characteristic	<i>n</i> (%), or mean ± SD
Years involved in bodybuilding	9.0 ± 6.4
Number of competitions	4.4 ± 3.1
Sources used for nutrition/exercise information ^a	
Friends and Other Bodybuilders	22 (79%)
Internet	21 (75%)
Books	9 (32%)
Peer Reviewed Journals	8 (29%)
Other	9 (32%)

Table 4- 4. Bodybuilding history data of Atlantic Canadian bodybuilding men who participated in the study

 $^{a}Categories$ not mutually exclusive, so percentages in this category do not sum to 100% .

Table 4-5 shows participants' diet- and exercise-related behaviours and body fat percentage ideals. Participants reported a range of caloric intakes. Mean approximate calorie intakes while not preparing for a competition and near peak competition preparation period were 3670 ± 1037 kcal/day and 1739 ± 360 kcal/day, respectively (p < 0.001). Participants reported spending less time, an average of 2.6 ± 1.7 hours per week, on cardiovascular exercise when not competing, compared to 7.2 ± 4.1 hours per week near competition time (p < 0.001). Hours per week spent on resistance training during both periods did not differ: 7.6 ± 3.5 when not competing, and 8.4 ± 4.0 near competition time (p = 0.104). Participants' ideal body fat percentage when not competing was an average of 13.2 ± 2.8 %. For competition, average ideal body fat percentage lowered significantly to 5.5 ± 2.6 % (p < 0.001).

Table 4- 5. Self-reported diet- and exercise-related behaviours and ideals of Atlantic Canadian bodybuilding men who participated in the study

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Chavastavistia		Competi	ng		n nalu a		
Characteristic	п	$Mean \pm SD$	Range	п	$Mean \pm SD$	Range	p value
Daily energy intake (kcal/day)	28	1739 ± 360	1200–2800	28	3670 ± 1037	1850–6000	< 0.001
Cardiovascular exercise (hrs/wk)	28	7.2 ± 4.1	1–21	27	2.6 ± 1.7	0–7	< 0.001
Resistance training (hrs/wk)	27	8.4 ± 4.0	2–14	28	7.6 ± 3.5	0–14	0.104
Ideal body fat percentage (%)	28	5.5 ± 2.6	2–15	28	13.2 ± 2.8	7–20	< 0.001

^aP values from paired t-test assessing differences within each row by competition preparation status.

The most frequently expressed ideal body fat percentage during competition period was 5%, with n=13 of the 28 participants reporting this value as their ideal competition body fat percentage. Responses ranged from values as low as 2% and up to 15%. This was significantly different than the participants' current self-reported approximate body fat percentage (p<0.001). During non-competition period, the most frequently expressed ideal was 12%, with n=11 participants reporting this value as their ideal non-competition body fat percentage. Responses ranged from 7% up to 20%. No significant differences were found between current self-reported approximate body fat percentage (p=0.158). 4.3 Risk of eating disorders, muscle dysmorphia, and exercise addiction Risk for select eating disorders, muscle dysmorphia, and exercise addiction are shown in **Table 4-6**, as calculated per *Section 3.9*. Six participants demonstrated risk for eating disorders: 1 for bulimia nervosa, 2 for binge eating disorder, and 3 participants were found to be at risk for both bulimia nervosa and binge eating disorder. No participants demonstrated risk for anorexia nervosa. Six participants were found to be at risk for muscle dysmorphia, and all 28 participants showed risk for exercise addiction according to the Exercise Addiction Inventory (8).

exercise addiction.		
	At Risk <i>n</i> (%)	Not at Risk n (%)
Anorexia nervosa	0 (%)	28 (100%)
Bulimia nervosa	4 (14%)	24 (86%)
Binge eating disorder	5 (18%)	23 (82%)
Muscle dysmorphia	6 (21%)	22 (79%)
Exercise addiction	28 (100%)	0 (0%)

Table 4- 6. Participants' risk for anorexia nervosa, bulimia nervosa, binge eating disorder, muscle dysmorphia, and exercise addiction.

4.4 Correlations between eating disorders, muscle dysmorphia, and exercise addiction A Shapiro-Wilks test determined the overall scores for eating disorders (anorexia nervosa, p=0.036; bulimia nervosa, p=0.001; binge eating disorder, p=0.001), and exercise addiction (p=0.034) were all normally distributed, except for muscle dysmorphia (p=0.739), which was not normally distributed. Given the presence of non-normal data, and a small sample size, a nonparametric Spearman's correlation test was employed. Pairwise correlations were computed between select eating disorders, muscle dysmorphia, and exercise addition. There was a significant, positive moderate correlation found between anorexia nervosa and muscle dysmorphia (rho=0.519, p=0.005) despite no participants being at risk of anorexia nervosa; as well as bulimia nervosa and muscle dysmorphia (rho=0.453, p=0.015). There was a significant positive, moderate correlation between exercise addiction and muscle dysmorphia (rho=0.205, p=0.295), nor between exercise addiction and muscle dysmorphia (rho=0.205, p=0.295), nor between exercise addiction any of anorexia nervosa (rho=0.296, p=0.127) and bulimia nervosa (rho=0.368, p=0.054) or binge eating disorder (r=0.046, p=0.817). **Figures 4-1** to **4-4** display scatterplots of bivariate associations between anorexia nervosa, bulimia nervosa, binge eating disorder, muscle dysmorphia, and exercise addiction, showing the associations between these domains.



Anorexia Nervosa Risk **Figure 4- 1.** Pairwise correlations between anorexia nervosa, muscle dysmorphia, and exercise addiction



Figure 4-3. Pairwise correlations between binge eating disorder, muscle dysmorphia, and exercise addiction







Exercise Addiction Risk **Figure 4- 2.** Pairwise correlations between muscle dysmorphia and exercise addiction

4.5 Impact of COVID-19 on participant responses

Although n=11 participants completed data collection before the COVID-19 State of Emergency in Canada, data was collected from n=17 participants during the pandemic. For those who completed data collection during the pandemic, following each set of questions pertaining to eating disorders, muscle dysmorphia, and exercise addiction, participants were given an opportunity to describe whether they felt the COVID-19 state of emergency had influenced their behaviours and/or question responses. Many participants reported eating more and exercising less, some reporting weight gain and decreased body image. Responses below are quoted identically as participants had written them. One participant commented,

"yes COVID has factored in immensely. In the past 3 months I have gained 20lbs mostly due to increased food/alcohol consumption and lack of physical activity. Now that the gyms are opened I am actively trying to reduce weight via healthy diet and added cardio[.]"

He then elaborated,

"Workouts have only been able to resume in the last 2 weeks here. So now I am working out 6 days a week instead of the normal 4 days a week pre-COVID...because I put on weight during the pandemic, I would be very hesitant to show off my upper body."

Another wrote that despite not being able to access fitness facilities, the time has been helpful to focus on healing injuries,

"The lack of access to proper training facilities, due to COVID, has greatly effected my mood and my perception of my physique. I do understand that it has been positive, in that my injuries seem to have healed greatly."

Other participants commented that their eating habits remained normal during the pandemic, having more time to spend cooking,

"...I have had more time to focus on my diet and meal prep over these past few months. I have definitely been eating more but I am comfortable and happy with that as I am eating whole healthy foods."

Some participants commented that while they have not been experiencing symptoms currently, when they are preparing for a competition, they would have an increase in certain symptoms, "over these past three months I have not been taking my training as seriously as I was before. But when I do train, I train hard and I do feel like...I'm more irritable when I miss my training sessions."

Another wrote, "during my non-competitive season I don't feel guilty about binging...but during contest prep, if I did end up binging I would feel guilty."

5.0 Discussion

We found, in this small study, that 21% of participants were at risk of an eating disorder, 21% were at risk for muscle dysmorphia, and 100% were at risk for exercise addiction. Muscle dysmorphia was found to be positively correlated with anorexia nervosa (rho=0.519, p=0.005), bulimia nervosa (rho=0.453, p=0.015), and exercise addiction (rho=0.444, p=0.018), which aligns with the study hypothesis. These results suggest that bodybuilding men exhibit symptomatology of certain eating disorders, muscle dysmorphia, and exercise addiction, with some overlap or connection between these various disorders. However, given the small sample size and homogenous nature of the sample, findings are not necessarily generalizable.

5.1 Content validity

Content validity of the research tool used in the present study was established for questions surrounding eating disorders and muscle dysmorphia. The research tool is intended to screen for risk of eating disorders, muscle dysmorphia, and exercise addiction, and not to provide a diagnosis of any mental health condition. Content validity and face validity are good initial measures to determine whether implementation of a research tool is justified, however, further assessment is needed to determine whether the tool is reliable (95). As such, future work is required to establish construct validity, which provides insight into whether the research tool measures what it claims to measure, and reliability of the research tool, by producing similar results with repeated implementation among different samples (95).

5.2 Participant characteristics

This study had quite a small sample of N=28 participants. As a whole, the participants had high socioeconomic status. Much of the research on bodybuilders to date has recruited participants from universities and fitness clubs, which could indicate a higher average socioeconomic status given the associated costs with these institutions (34,37). Participants had spent an average of 9 ± 6 years involved in bodybuilding and had competed in 4.4 ± 3.1 competitions, similar to a 2017 study examining the correlations of muscle dysmorphia symptomology among a sample of n=99 participants where participants had competed in an average of 4.0 ± 3.9 competitions, but had only been participating for 3.7 ± 3.2 years (62).

The average BMI for participants was 29 kg/m², however, BMI does not take into account an individual's total body composition, so it would be unwise to classify this as "overweight" as per traditional BMI cut-offs (96). As such, fat free mass index may be a more useful tool in this case as it eliminates differences in fat free mass and body fat associated with height (55). Normal FFMI of (non-bodybuilding) men in a 2003 study (n=2,982 men aged 18-98 years) reported an average FFMI of $19 \pm 1 \text{ kg FFM/m}^2$ (55). Participants of this study had an average FFMI of $25 \pm 3 \text{ kg FFM/m}^2$. A 2014 study (n=339 men) found that when asked to identify their current body type from a range of illustrations, 40% of men chose an illustration with a FFMI of ~22 kg FFM/m², which aligns with the FFMI found in our study.

Given the small sample size, these participants may not be representative of the entire population of bodybuilding men in Atlantic Canada. There was some participation from individuals of Indigenous Canadian, Latin American, and African descent, however, given the small number of participants, no comparisons could be made by sociodemographic characteristics like ethnicity, educational attainment, or household income. Similar research in this area has recruited between 50-200 participants, so a larger, more heterogeneous sample would have provided more generalizability to the results of the present study. Although our sample was insufficient to compare between groups, a previous study by Giardino and Procidano among a sample of 113 men in New York City and Mexico City reported little difference between the two groups (54), however, it was noted that the sample of men from Mexico may not have been representative of the entire population.

5.3 Risk of eating disorders, muscle dysmorphia, and exercise addiction

5.3.1 Eating disorders

There is currently limited research on eating disorders among men, and athletes who are men, as eating disorders have long been considered a women's health issue (6,7). Previous research has estimated that women make up approximately 68% of eating disorder diagnoses (anorexia nervosa, bulimia nervosa, and binge eating disorder) (97). In Canada, the CCHS, a nationwide survey conducted every 2 years, is designed to provide reliable estimates of various health parameters at the health region level (98). However, the most recent CCHS data on eating disorders among men is from 2012: the rates of diagnosed eating disorders among boys and men

aged ≥ 15 years from 2002 to 2012 rose from 20,316 to 27,335 diagnoses nationwide (22). However, Statistics Canada warns that these data should be interpreted cautiously due to high sampling variability in the dataset (22,23). In addition to the lack of recent data available on eating disorders among boys and men, we know even less about how eating disorders affect different communities such as boys and men from various socioeconomic groups, ethnic groups, religions, etc. The present study aimed to screen for risk of three different eating disorders, anorexia nervosa, bulimia nervosa, and binge eating disorder, among a sample of Atlantic-Canadian bodybuilding men. We found that 6 participants were at risk for an eating disorder: 1 participant was at risk for bulimia nervosa, 2 at risk for binge eating disorder, and 3 participants at risk for both bulimia nervosa and binge eating disorder. Despite the small sample size in our current study, this finding is supported by a 2014 survey (n=339 men) examining the relationship between eating disorder risk and dissatisfaction with body fat and muscularity, which found that 28% of the men were considered to be at risk for an eating disorder (34). A similar, but larger 2018 cross sectional study of bodybuilding men in Turkey examining the relationship between eating disorders and muscle dysmorphia found that 68% of participants had eating disorder scores above the test's cut-off point, indicating potentially pathological eating disturbance (99). An older report from 2006 found that nearly 30% of men in competitive bodybuilding met the diagnostic criteria for bulimia nervosa at some point in their lives (28), which is a much higher prevalence than was found in this study.

Participants' self-reported daily energy intake during non-competition and competition preparation periods was compared to estimated energy requirements based on calculations from the WHO for physically active adult men 18-30y, 31-60y, and >60y (100). On average, participants in this study required between 3102 to 3522 kcal/day (100). Participants' mean calorie intake during non-competition periods was 3670 ± 1037 kcal/day, which is appropriate according to the WHO calculation (100). During competition preparation, however, average daily calorie intake was quite low at 1739 ± 360 kcal/day. Given participants' combined level of cardiovascular and resistance training of between 10.2 and 15.6 hours per week during noncompetition and competition preparation periods, respectively, this is a significant energy restriction. This intake is approximately 49-56% of the estimated energy requirements for the average participant. A 92 kg 34-year-old man (the average participant in this study) who is moderately active would require approximately 3547 kcal/day (100). In contrast, the average 30 kg 10-year-old boy who engages in moderate physical activity would require approximately 1959 kcal/day (101), which is 220 calories more than the average competition period intake of the participants of this study (1739 \pm 360 kcal/day). Energy intake of \leq 50% for >1 week or any energy intake reduction for >2 weeks is an etiological criterion for diagnosing malnutrition (102). Bodybuilders typically diet for 6-12 weeks or more (74,77) to prepare for competition, therefore may be at increased risk for malnutrition as per the aforementioned guidelines.

It is worth noting that if an individual's BMI/body mass is within or above normal range, he would not qualify for a diagnosis of anorexia nervosa despite severe caloric restriction, body image disturbance, and weight loss (1). All participants would have screened out of the anorexia nervosa risk category due to their normal or high bodyweight and BMI, as the necessity of a low bodyweight for diagnosis is repeated in each of the three diagnostic criteria for anorexia nervosa (1). Current malnutrition risk screening tools state that a weight loss of <5% in the past 6 months is indicative of moderate malnutrition (102). While the current study did not examine how much weight competitors typically lose in preparation for a bodybuilding competition, it is worth questioning whether they may be at increased risk for moderate to severe malnutrition, alongside the aforementioned criterion of energy intake $\leq 50\%$ for >1 week (102). It may be important to reconsider BMI and low bodyweight as part of the diagnostic criteria for anorexia nervosa in favour of a model which focuses on rate of weight loss such as in malnutrition risk screening guidelines. While individuals who meet all other diagnostic criteria for anorexia nervosa may be diagnosed with atypical anorexia nervosa, the potential for a diagnosis of moderate malnutrition with $\leq 5\%$ bodyweight loss over 6 months may indicate that atypical anorexia is a redundant diagnosis, and the diagnostic criteria should be updated.

Risk may also be dependent on a competitor's current phase of competition preparation, which was not examined in the current study. Some participants did highlight that their feelings of guilt associated with binge eating, hesitation towards exposing parts of their bodies, and abstaining from social activities due to their diet and exercise regimens would change based on how close they were to the date of a competition. For example, the participant who commented, "during my non-competitive season I don't feel guilty about binging...but during contest prep, if I did end up bingeing, I would feel guilty." This highlights a need for future research in comparing the attitudes of bodybuilding competitors during periods when they are not preparing to compete versus when they are preparing to compete.

5.3.2 Muscle dysmorphia

Muscle dysmorphia is currently classified as a subtype of body dysmorphic disorder in the DSM-5 (35), and can be defined as an obsessive preoccupation with increasing muscle mass, even if one is significantly muscular (4). Prior to its inclusion in the DSM-5, there was confusion surrounding the type of disorder under which muscle dysmorphia should be classified, such as an eating disorder, a subtype of body dysmorphic disorder, or an obsessive-compulsive spectrum disorder (60), suggesting that muscle dysmorphia is related to disordered eating, body image disturbance, as well as an obsessions regarding perceived flaws about oneself. Some researchers argue that muscle dysmorphia should be re-classified as an addiction due to individuals continuing to engage in behaviours that enhance muscularity despite knowledge that they may be harmful to physical and/or psychological health (103).

In this study, 6 of the participants were found to be at risk for muscle dysmorphia, and it was found to be positively correlated to overall risk for anorexia nervosa (rho=0.519, p=0.005), bulimia nervosa (rho=0.453, p=0.015), as well as exercise addiction (rho=0.444, p=0.018). Due to the small sample size of this study, these findings are not definitive. However, this finding is supported by a 2017 survey of 60 bodybuilding men in Australia, which reported a significant positive correlation between muscle dysmorphia and eating pathology (r=0.31, p<0.05) (62). A 2012 cross-cultural study among men Mexico and the United States also found significant positive correlations between muscle dysmorphia and eating pathology for both Mexican (r=0.44, p=0.009; n=35) and American men (r=0.50, p=0.001; n=43) (54).

Regarding body fat percentage, the most frequently expressed ideal body fat percentage during competition period was 5%, with n=13 of the 28 participants reporting this value as their ideal competition body fat percentage. On average, participants' ideal body fat percentage when competing was 5.5 ± 2.6 %. This finding is supported by anecdotes on popular fitness forums and bodybuilding websites such as bodybuilding.com and livestrong.com (84,85) which suggest it is ideal to reduce body fat to as low as 2-6% for competition. During non-competition period, the ideal body fat percentage increased significantly to 13.2 ± 2.8 % (p<0.001).

A 2014 study of university students (n=339 men) in Florida found that half of the men desired a body with a FFMI greater than 25 kg FFM/m² (34). These findings are worth further investigation as it has been reported that it is unlikely to achieve a fat free mass index greater

than 25 without the use of anabolic steroids (34). It has also been suggested that some men may tend to engage in more impulsive behaviours than women (53). Given this, when dissatisfied with their bodies, men may be more likely to engage in "risky" behaviours that have a negative impact on health, such as excessive exercise and dieting, and even unsafe dietary supplementation or steroid use in order to enhance muscular appearance (36,54). The FFMI calculated in the current study according to participants' height and approximate body fat percentage ranged between 19-34.7 FFM/m², and some participants commented that they use steroids to enhance their physique, despite being aware of the dangers associated with steroid use.

The results of this study show that muscle dysmorphia is positively correlated with both eating disorder risk and exercise addiction risk. These results are supported by research which showed that muscle dysmorphia has been associated with behaviours such as dieting and excessive exercise (36). Symptoms of muscle dysmorphia include preoccupation with body composition with respect to perceived insufficient muscularity and leanness, dieting, and excessive exercise (35,36). These symptoms of muscle dysmorphia have all been shown to be predictors of eating disorders (3). This overlap as well as the findings in this study may suggest that muscle dysmorphia is a key factor in predicting eating disorder and/or exercise addiction risk.

5.3.3 Exercise addiction

Exercise addiction is not currently classified in the DSM-5. In the present study, all 28 participants were found to be at risk for exercise addiction per the Exercise Addiction Inventory. This finding is alarming, suggesting an expectation in bodybuilding culture to adhere to an intense exercise regimen, which seems to encourage excessive exercise. Alternatively, it may also suggest that this is not a sensitive tool, at least not among bodybuilding men.

Some participants in the current study reported being moody if they had to miss out on an exercise session during their contest preparation period: "...when I do train, I train hard and I do feel like...I'm more irritable when I miss my training sessions." Exercise addiction was also found to be moderately correlated to muscle dysmorphia (rho=0.402, p=0.034) in the present study. This finding is supported by a 2012 cross-cultural study among adults from Mexico and the United States found that for both groups of men (n=35 Mexican, n=43 American), muscle dysmorphia symptoms were positively correlated with exercise addiction, using the Exercise

Dependence Scale, among both Mexican men (r=0.62, p<0.001), and American men (r=0.74, p<0.001) (54).

We cannot conclude that spending a combined average of 15.6 hours per week, or 2.2 hours per day doing cardiovascular and resistance exercise is indicative of exercise addiction on its own. Many individuals participate in a variety of sports that require long hours spent exercising, such as long-distance running, cycling, and rock climbing. However, when this amount of exercise is compared to responses to the Exercise Addiction Inventory, we can question whether perhaps there is an element of control behind the drive to exercise for over 2 hours a day on average. An older study comparing correlations between exercise addiction, social physique anxiety, and social support among experienced and inexperienced bodybuilders and weightlifters found that experienced participants exhibited greater exercise addiction than inexperienced participants (p<0.001), suggesting an increased need to control their training schedules.

Additionally, the primary requirement to excel in bodybuilding is to appear muscular, defined, and aesthetically pleasing to judges (73). This focus on exercise for appearances sake is a form of self-objectification which has been linked to psychological distress, including the onset and maintenance of eating disorders (3), although the latter finding was not replicated in this study.

5.3.4 Adverse health outcomes

As described in the literature review, assessing disordered eating and exercise behaviours is important as a means of highlighting questions surrounding the potential risk of comorbid conditions. Our findings have indicated that bulimia nervosa and binge eating disorder are of greater concern in this population than anorexia nervosa. While comorbid conditions associated with eating disorders, muscle dysmorphia and exercise addiction were not examined in this study, with increased risk of one or more of these disorders poses increased risk of other conditions (16,17). A 2018 study (N=3,319) conducted in the United States examining hospitalization outcomes and comorbidities associated with bulimia nervosa between 2010 and 2014 found that the most common psychiatric comorbidities to bulimia nervosa were psychosis (52.4%), and depression (23.5%), followed by drug abuse (21.5%) and alcohol abuse (17.1%) (104). Medical comorbidities found included fluid and electrolyte disorders (36.6%), weight loss, (22.3%), deficiency anemias (10.4%), hypothyroidism (7.5%), obesity (5.3%), hypertension (5.7%), uncomplicated diabetes (3%), renal failure (1%), and congestive heart failure (0.3%)

(104). Women in this study were more likely to present with psychiatric and medical comorbidities (104). We know that muscle dysmorphia, a sub-type of body dysmorphic disorder (35), has previously been associated with excessive exercise and eating pathology (54), however, older study of N=63 American men with body dysmorphic disorder has suggested an increased risk of suicide (p=0.02), substance use disorders (*p*=0.03), steroid use (*p*=0.009), associated with muscle dysmorphia when compared to those with non-muscle body dysmorphic disorder (105). Exercise addiction has commonly occurred as secondary to eating disorders (67), however we found no such correlation in the present study. Despite not finding similar results, exercise addiction carries risk for physical injury associated with excessive exercise and psychological distress if one's training regime is altered (5). In light of the various comorbid conditions associated with the domains examined in this research, it would be worthwhile to examine the domains of eating disorders, exercise addiction, and muscle dysmorphia as well as comorbid risk in this population.

5.3.5 Impact of COVID-19 on participant responses

Given that the COVID-19 state of emergency disrupted the normal routine and lifestyle of many individuals due to stay-at-home orders and the closure of many businesses such as fitness facilities, participants were not engaging in their typical diet- and exercise- regimens and may have been in lockdown for several months at the time of responding to the questionnaire. This would have impacted responses to questions pertaining to eating disorders, muscle dysmorphia, and exercise addiction as it was instructed to answer the questions "thinking back over the past 3 months." The findings of this study are therefore not generalizable to conditions of ordinary life, such as when a global pandemic is not taking place. The COVID-19 state of emergency may have also impacted the sample size of the study as many individuals were experiencing increased stress and anxiety related to the pandemic, which may have negatively impacted participant interest. Additionally, due to the stay-at-home orders, all recruitment was done online, mostly via social media, where information regarding COVID-19 was prominent. As such, potential participants may not have seen recruitment posters on their news feeds as much as they may have without the influx of pandemic-related news.

5.4 Strengths and limitations

This study had several strengths, namely that it was the first study to screen for risk of eating disorders, muscle dysmorphia, and exercise addiction among Atlantic-Canadian men involved in competitive bodybuilding. Another strength is that the novel research tool developed for this study achieved appropriate content validity before being implemented in the current study. This study also adds to a limited body of literature: a large proportion of eating disorder diagnoses are among girls and women (1), and given the gendered stigma associated with eating disorders, and that men tend to underreport symptoms to healthcare providers (26), there are fewer formal diagnoses, and thus skewed prevalence data among this group. This study provided an opportunity for men to share their experiences surrounding diet, exercise, and body image. The online nature of the questionnaire provided a safe space for participants to share about their experiences. The study also sheds light on questions surrounding the attainability and sustainability of the current body shape ideal for men in Western culture (11,16), and provides an opportunity to ask questions about our level of concern about physical appearance, at times, in spite of our physical and mental well-being.

The current study was not without its limitations. The sample size was small, which may have impacted study results. Consequently, we cannot gauge whether the sample is representative of the entire population of Atlantic-Canadian bodybuilding men. The timing of recruitment took place partially during the COVID-19 state of emergency, which also may have had an impact on participants' questionnaire responses. Finally, although this study was completed confidentially, we cannot discount the possibility of social desirability bias, with participants potentially overstating time spent on exercise or other activities knowing that researchers were interested in this topic.

5.5 Recommendations for future research

Future research in this area should include a larger and more heterogeneous sample size in order to improve the generalizability of results. A larger sample size would allow for the comparison between more experienced bodybuilders and inexperienced bodybuilders, as well as a number of other comparisons by sociodemographic groups (e.g. ethnicity, age). Given the small population of bodybuilders, it may be suitable to include participants from across Canada as opposed to simply sampling from Atlantic Canada. Additionally, establishing construct validity and reliability in addition to the content validity established here would improve the research tool. It may be worth examining participants' attitudes during contest preparation and non-preparation periods (via a repeated measures study) to determine if there are significant differences in risk for eating disorders, muscle dysmorphia, and exercise addiction. Additionally, given the risk criteria for malnutrition, future studies should include this in their methodology, perhaps performing malnutrition risk screening as part of the study protocol. Asking questions regarding how much weight participants lose over a set period of time, the duration of their dieting period, alongside questions regarding calorie restriction may provide useful insight into potential risk of malnutrition among competitors during their competition preparation period.

6.0 Conclusions

In this study we established the content validity of, and implemented, an online research tool intended to screen for risk of eating disorders, muscle dysmorphia, and exercise addition among a sample of Atlantic Canadian bodybuilding men. After review by field experts, the research tool was established as valid with a CVI of 0.83. We found that 21% of participants were at risk of an eating disorder, 21% were at risk for muscle dysmorphia, and 100% were at risk for exercise addiction. Eating disorder behaviour (anorexia nervosa: rho=0.519, p=0.005; bulimia nervosa: rho=0.453, p=0.015), and exercise addiction (rho=0.444, p=0.018) were found to be positively correlated to muscle dysmorphia, indicating a positive linear relationship between these domains. No significant correlations were established between eating disorder behaviour and exercise addiction, despite previous research finding this relationship.

7.0 References

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8.0 Appendices

Appendix A – Evidence table summarizing available research Table 1: Summary of research on bodybuilding men (BBM), eating disorders (ED), muscle dysmorphia (MD), and exercise addiction (EA).

Logation Author Voor	Design	Sampla Siza	Dantiainanta	1 00	Results				sults
Location, Author, rear	Design	Sample Size	1 articipants	Age	BBM	ED	MD	EA	
Philadelphia, PA, Andersen, Bartlett, Morgan <i>et al</i> , 1994 (78)	Cross- sectional study	N=45	Drug-free BBM	16-42 y	x	x			85% of subjects reported gaining weight, 46% reported binge eating after competitions. 81.5% reported being preoccupied with food sometimes, often, or always. Between 30-50% reported psychological distress when preparing for competition.
Toronto, ON, Davis, Scott- Robertson, 2000 (37)	Cross- sectional study	N=68	22 BBM, 46 women with AN	28.4 ± 4.3 y	X	X			Psychological profile of bodybuilders is very similar that of women with AN. Bodybuilders reported positive self-worth while AN patients had very negative self-worth.
Staten Island, NY Leit, Gray, Pope 2002 (29)	Cross- sectional study	N=82	Undergraduate male students Control group n=40 Experimental group $n=42$	19.8 ± 2.8 y			x		Students exposed to images of muscular men experienced ↑ rates of body dissatisfaction compared with control group. These results suggest that advertisements portraying muscular male figures produces body dissatisfaction in men.
Ottawa, ON, Godfield, Blouin, Woodside, 2006 (28)	Cross- sectional study	N=74	25 RBBM, 27 CBBM, 22 MBN	20-43 y	X	x	X		BBM and MBN share many similar eating behaviours but fewer psychological ones. It is unclear whether bodybuilding fosters disordered eating or whether MBN gravitate to bodybuilding. CBBM report ↑ rates of binge eating and BN than RBBM.

Location Author Vear	Design	Sampla Siza	Participants	1 90	Results			ults	
Location, Author, Tear	Design	Sample Size	1 al ticipants	Age	BBM	ED	MD	EA	
Tampa, FL, Cafri, Oliviardia, Thompson 2008 (36)	Cross- sectional study	N=51	Weight lifting men 15 MD, 8 past MD, 28 no MD	18-40 y			x		Compared with men with no history of MD, men with MD experienced frequent thoughts about their muscularity, body dissatisfaction, appearance checking and bodybuilding dependence. Men with a history of MD experience ↑ rates of mood and anxiety disorders.
Adelaide, AU Emini, Bond 2012 (38)	Cross- sectional study	N=101	Male weight trainers/bodybuilde rs	18-67 y	X			Х	Motives for bodybuilding include mood control, physique anxiety and personal challenge. Bodybuilding dependence may be a result of and method for coping with feelings of stress, anger, hostility and aggression.
Budapest, HG Babusa, Túry 2012 (61)	Cross- sectional study	N=120	Non-bodybuilders n=60 non-competitive BBM $n=60$	27.8 +/- 7.45 y 27.7 +/- 7.53 y	Х	Х	Х		Positive relationship exists between MD, ED characteristics and steroid use.
Mecico City, MX New York City, NY Giardino, Procidano 2012 (54)	Cross- sectional study	N=113	Mexican men n=39 American men n=43		x	x	x	x	MD occurrence similar in both groups. MD symptoms correlated with bodybuilding, exercise dependence and eating pathology in both groups. Among American men, bodybuilding behaviors were more related to MD.

Location Author Vear	Design	Sample Size	Particinants	Аде	Results				sults
Location, Author, Tear	Design	Sample Size	1 ai ticipants	Age	BBM	ED	MD	EA	
Denmark Beck, Christiansen, Elklit <i>et al</i> 2013 (5)	Case- control study	N=121	79 men, 42 women control group $n=80$ EA group $n=41$	19-56 y		x		X	EA is separate to an eating disorder but shares some similar symptoms such as perfectionism. EA is driven by a desire to achieve goals which results in overuse injuries.
Edinburgh, UK Murray, MacKenzie, Newman, Brown 2013 (69)	Cross- sectional study	<i>N</i> =101	N=39 men N=62 women	32 +/- 12.1y				X	Strong exercise beliefs, but not exercise role identity, associated with a higher risk of exercise dependence symptoms.
Boston, MA Field, Sonneville, Crosby, Swanson, <i>et al</i> 2014 (106)	Prospective co <i>rho</i> rt study 1999-2010	N=5527	Men who responded to the 1996 "Growing up Today Study"	14.9 +/- 1.6		x	x*		(*↑ concerns about muscularity) *Common among boys and young men and increased with age. As many as 31% engaged in infrequent disordered eating behaviours. Most eating disorder assessments fail to assess for muscularity concerns which overlooks many men with a potential ED.
Miami, FL, Mayo, George, 2014 (34)	Cohort study	N=780	339 male, 441 female college students	22 ± 4 y		x	X		28% of the men had an Eating Attitudes Test (EAT) score indicating that they were at risk for an eating disorder. Men chose a significantly leaner and more muscular body type than what women chose as attractive.

Lombardy, PV Dakanalis, Pla-Sanjuelo, Caslini <i>et al</i> , 2016 (3)	Longitudin al study	N=2,507	Undergraduate male students	18.5 ± 1.41 y		X		Body dissatisfaction, self- objectification, appearance-ideal internalization, dieting, and negative affectivity are all predictors of ED onset and maintenance. Self-objectification was the largest contributor of ED onset and maintenance.
Sydney, AU Mitchell, Murray, Hoon, Hackett, Prvan, O'Connor 2017 (62)	Cross- sectional study	<i>N</i> =60	Natural BBM	29.6 +/- 7.1 y	x	x	x	Significant positive association of ED pathology (B=.298) with MD symptomatology. Rapidity of weight loss during competition preparation associated with MD (B=.307) symptoms. Number of competitions also predicted MD symptoms (B=257) No association found between training volume and MD.

Search Terms: bodybuilding men (BBM), recreational bodybuilding men (RBBM), competitive bodybuilding men (CBBM), men with bulimia nervosa (MBN) eating disorders (ED), Databases: Academic search premier (EBSCO), Directory of open access journals, Google Scholar, Medline, Medline Plus, PsychInfo (EBSCO), PubMed, SAGE Journals Online, Science Direct (Elsevier), Springer Link (CRKN), Wiley Online Library, WorldCat. Appendix B - Read-only copy of research tool

Bodybuilding Study

* Are	vou	confident	in	reading	and	writina	in	English?
740	,00	connacin		reading	ana	minung		English.

Yes

No

*	Are	you	aged	19	years	or	older?
---	-----	-----	------	----	-------	----	--------

Yes

🗌 No

*	In	terms	of	aender.	do	vou	identify	as	а	man?
		CIIII3	o,	gender,	uu	you	racinary	as	а	man

Yes

🗌 No

* Are you currently living in Atlantic Canada?

(Nova Scotia, New Brunswick, Prince Edward Island, or Newfoundland and Labrador)

Yes

🗌 No

* Do you participate in bodybuilding, physique, or other aesthetic fitness competitions*?

*Competitions in which you are scored based on the size, symmetry, and/or definition of your muscularity.

Yes

No

* Have you competed at least once in the past 3 (three) years?

Yes

⊖No

* Have you ever been diagnosed with an eating disorder, muscle dysmorphia, or exercise addiction?

🗌 Yes

🗌 No

Objective of research

Current research shows that some bodybuilders take part in extreme diet and exercise activities both before and after competitions that may be damaging to their physical and mental health. However, no researchers to date have looked at the prevalence of these activities among bodybuilders in Atlantic Canada, nor have they explored the whole spectrum of behaviours. Here, we will ask you about your exercise and diet activities, and about how you feel about the way you look and feel, in order to better understand bodybuilders here in Atlantic Canada, and to see if there are patterns of behaviours among bodybuilders that may be risky to long-term health.

This study is being conducted through the Department of Applied Human Nutrition at Mount Saint Vincent University and the School of Nutrition and Dietetics at Acadia University. You will be asked to complete an online questionnaire which will take approximately 10-15 minutes to complete. Participation in this study is entirely voluntary and will not cost you anything.

Procedure

Screening

Through the pre-questionnaire screening you have just completed, we have determined that you are eligible to participate in this study. If you consent to participate in this study, you will be directed to complete an online questionnaire (it will take approximately 10-15 minutes). Participation in this survey is voluntary. You are free to skip any question(s) you prefer not to answer. If at any point you wish to withdraw from participation, simply close the survey window in your browser. If you choose to withdraw, you will still have the opportunity to be entered into the draw for a gift card. Simply click "Next page" at the bottom of your screen until you withdraw will be saved for analysis.

<u>Confidentiality</u>

Your confidentiality will be respected; your records will be kept on a secure server housed at Mount Saint Vincent University. You will be assigned a unique study number as a participant in this study. Only this number will be used on any research-related information collected about you during the course of this study, so that your identity as a participant in this study will be kept confidential. The results of the study may be presented at scientific meetings and published in a scientific journal.

Risks

There is a minor psychological risk to participating in this study due to the personal nature of the content of the questionnaire (e.g. we will ask you about personal eating and exercise habits). Remember, you don't need to answer any questions you don't feel comfortable answering, and you can withdraw from the study at any time by simply exiting out of your web browser.

You may want to reach out to speak with a professional if you feel upset during or after completing the questionnaire. Some resources you may be interested in could include:

The National Eating Disorders Information Centre Helpline toll-free at 1-866-633-4220, Eating Disorders Nova Scotia at 1-902-229-8436, or the Mental Health 24/7 Mobile Crisis Team at 1-888-429-8167.

Benefits

You will receive no direct benefits from participating in the study. However, we hope that the information learned from this study can be used in the future to benefit bodybuilding men in Atlantic Canada, and potentially across Canada.

As a thank you for participating, you will be entered into a draw for a chance to win 1 of 10 \$100 gift cards to Amazon.ca. We'll provide instructions on how to enter this draw at the end of the survey. Importantly, the draw process is separate from the survey, so the e-mail address you provide for the draw will not be connected to the study data in any way, will be stored separately, and will be destroyed after gift cards have been awarded.

Questions and further information

If you have questions about how this study is being conducted and wish to speak with someone who is not directly involved in the study, you may contact the Chair of the University Research Ethics Board (UREB) c/o MSVU Research Office, at 1-902-457-6350 or via e-mail at <u>research@msvu.ca</u>

Research Results

If you wish, you can choose to view a summary of the study results, which will be available around one year after the end of the study, by visiting <u>www.mamalab.ca</u>.

Participant Authorization

I have read the information in this consent form. I understand the nature of the study and I understand the potential risks. I understand that I have the right to withdraw from the study at any time without any problems.

I freely agree to participate in this research study.

(Please only select "Yes" if you are sure you wish to continue.)

O Yes

*

O No, I do not wish to participate in this survey

PLEASE NOTE THAT YOU MAY ONLY PARTICIPATE IN THIS STUDY ONCE.

Part 1

Where are you located?

- O Nova Scotia
- New Brunswick
- Prince Edward Island
- Newfoundland and Labrador

What is your ethnicity? You may choose more than one.

- Eastern European (Polish, Russian, Croatian, etc.)
- Western European (English, French, Portuguese, etc.)
- East Asian (Chinese)
- East Asian (Korean)
- East Asian (Japanese)
- South Asian (East Indian, Pakistani, Sri Lankan, etc.)
- Southeast Asian (Vietnamese, Malaysian, Filipino, etc.)
- WestAsian (Iranian, Afghan, Palestinian, etc.)
- East African (Ethiopian, Kenyan, Somali, etc.)

- Middle African (Cameroonian, Chadian, Congolese, etc.)
- Northern African (Moroccan, Algerian, Egyptian, Sudanese, etc.)
- Western African (Ghanaian, Nigerian, Guiniean, etc.)
- Latin American (Argentinean, Costa Rican, Mexican, etc.)
- Caribbean Region (Jamaican, Trinidadian/Tobagonian, etc.)
- Indian-Caribbean (Guyana with origins in India)
- North American Aboriginal (Inuit, Métis, First Nations, etc.)
- Australia or New Zealander
- Other

What is your total household income before tax?

(We classify a household as anyone you live with who shares expenses, for example, the total income of you and your partner or you and your parents, but not of you and your roommates)

Prefer not to say

Less than \$10,000

Between \$10,000 and \$14,999

Between \$15,000 and \$24,999

Between \$25,000 and \$34,999

Between \$35,000 and \$49,999

Between \$50,000 and \$75,999

Between \$75,000 and \$99,999

Between \$100,000 and \$149,999

Between \$150,000 and \$199,999

\$200,000 or more

What is your highest level of education?

Did not complete high school

Completed high school or equivalent (high school diploma, GED) Some

college/university without obtaining a degree, diploma, certificate

Completed college/university (Bachelor's degree, diploma, or certificate)

Completed graduate degree (Master's, PhD)

Completed a professional Degree (e.g., MD, DDS, DVM, LLB, JD) Other

How old are you in years?

Example: 30

How tall are you in feet and inches?

Example: 6 feet 2 inches = 6'2"

How much do you weigh in pounds?

Example: 190

What is your approximate body fat percentage (%)?

My approximate body fat percentage is...

I'm not sure

Part

How long have you been involved in bodybuilding (in years)?

How many competitions have you participated in?

Where do you access information regarding nutrition and exercise for bodybuilding preparation?

Select all that apply and include titles where applicable.

Friends or other bodybuilders

Internet (blogs, forums, videos, etc.)

Self-help or bodybuilding books

Textbooks

Peer reviewed journal articles (e.g. Journal of Applied Physiology, Nutrition and Nutrition)

Other

Are there certain foods or nutrients that you usually limit or exclude from your diet while you are preparing for a competition?

🗌 Yes

No

What types of foods or nutrients do you limit or exclude from your diet during preparation for competition?

How many calories (kcal) do you typically consume per day...

When you are NOT competing?

At/near the end of your competition preparation period?

Have you used any of the following techniques to enhance the muscular appearance of your physique for competition?

Fluid and electrolyte manipulation

Diuretics (water pills)

Saunas

Other (Please specify)

How many hours per week do you usually spend exercising?

	Cardiovascular Exercise	Resistance Training			
While you are preparing for a competition?					
While you are NOT preparing for a competition?					

What is your ideal body fat percentage (%) ...

When you are competing?	
When you are NOT competing?	

Please answer the following questions (parts 3-5) thinking back over the past 3 months.
Part 3

Please answer the following questions thinking back over the past 3 months...

I have an intense fear of gaining weight and/or becoming fat.

Strongly agree	Agree	Neither agree	Disagree	Strongly
0	0	nor disagree	0	disagree
		0		0

I modify my energy intake in order to achieve or maintain a body weight that is much lower than my friends, family, or health practitioners express as healthy.

Strongly agree	Agree	Neither agree	Disagree	Strongly
		nor disagree		disagree

My weight and/or body shape strongly influences how I feel about myself.

Strongly agree	Agree	Neither agree	Disagree	Strongly
		nor disagree		disagree

I experience episodes of binge eating*.

*Eating an amount of food in a discrete period of time (e.g. 2 hours) that is definitely larger than what most people would consume in a similar period of time, and/or feeling a sense of lack of control while eating.

Never	Rarely	Sometimes	Usually	Always
(0 times per	(1-3 times per	(4-7 times per	(8-13 times per	(14+ times per
week)	week)	week)	week)	week)

Juring an episode of binge eating, I eat much more quickly than normal.

Strongly agree	Agree	Neither agree	Disagree	Strongly
		nor disagree		disagree

During an episode of binge eating, I eat until I am uncomfortably full.

Strongly agree	Agree	Neither agree	Disagree	Strongly
		nor disagree		disagree

I feel disgusted with myself, depressed, and/or very guilty after binge eating.

Strongly agree	Agree	Neither agree	Disagree	Strongly
		nor disagree		disagree

During a binge, I eat large amounts of food when I am not physically hungry.

Strongly agree	Agree	Neither agree	Disagree	Strongly
		nor disagree		disagree

During a binge, I eat alone because I feel embarrassed by how much I am eating.

Strongly agree	Agree	Neither agree	Disagree	Strongly
		nor disagree		disagree

After a binge, I engage in risky behaviour(s)* to prevent weight gain.

*Self-induced vomiting, use of laxatives, water pills (diuretics), fasting, excessive exercise.

Never Rarely		Sometimes	Usually	Always	
(0 times per	(1-3 times per	(4-7 times per	(8-13 times per	(14+ times per	
week)	week)	week)	week)	week)	

l engage in risky behaviours*	to prevent	weight	gain,	even if	l have
not engaged in binge eating**					

*Self-induced vomiting, use of laxatives, water pills (diuretics), fasting, excessive exercise. **Eating an amount of food in a discrete period of time (e.g. 2 hours) that is definitely larger than what most people would consume in a similar period of time, and/or feeling a sense of lack of control while eating.

Never	Rarely	Sometimes	Usually	Always
(0 times per	(1-3 times per	(4-7 times per	(8-13 times per	(14+ times per
week)	week)	week)	week)	week)

Please comment on whether you think your answers for this set of questions may have been affected by the COVID-19 state of emergency.



Part 4

h

Please answer the following questions thinking back over the past 3 months...

I am preoccupied with the idea that my body is not sufficiently lean and muscular.

Strongly agree	Agree	Neither agree	Disagree	Strongly
		nor disagree		disagree

My preoccupation about the inadequacy of my body size or musculature causes me significant distress.

Strongly agree	Agree	Neither agree	Disagree	Strongly
		nor disagree		🗌 disagree

I spend long hours in the gym lifting weights.

Strongly agree	Agree	Neither agree	Disagree	Strongly
		nor disagree		🗌 disagree

I pay a lot of attention to my diet.

Strongly agree	Agree	Neither agree	Disagree	Strongly
		nor disagree		disagree

I give up important social, occupational, or recreational activities to maintain my workout and diet schedule.

Strongly agree	Agree	Neither agree	Disagree	Strongly
		nor disagree		disagree

I avoid situations where my body is exposed to others, or I endure such situations only with significant distress or intense anxiety.

Strongly agree	Agree	Neither agree	Disagree	Strongly
0	0	nor disagree		disagree
		0		0

I continue to work out, diet, or use performance-enhancing substances despite knowledge of negative physical or psychological consequences.

Strongly agree	Agree	Neither agree	Disagree	Strongly
0	0	nor disagree		disagree
		0		0

Please comment on whether you think your answers for this set of questions may have been affected by the COVID-19 state of emergency.

Part 5

Please answer the following questions thinking back over the past 3 months...

Exercise is the most important thing in my life.

Strongly agree	Agree	Neither agree	Disagree	Strongly
0	0	nor disagree	0	disagree
		0		0

Conflicts have arisen between me and my family and/or my partner about the amount of exercise I do.

Strongly agree	Agree	Neither agree	Disagree	Strongly
0	0	nor disagree	0	disagree
		0		

I use exercise as a way of changing my mood.

(e.g. to get a buzz, to escape etc.)

Strongly agree	Agree	Neither agree	Disagree	Strongly
0	0	nor disagree	0	disagree
		0		0

Over time I have increased the amount of exercise I do in a day.

Strongly agree	Agree	Neither agree	Disagree	Strongly
0	0	nor disagree	0	disagree
		0		0

If I have to miss an exercise session I feel moody and irritable.

Strongly agree	Agree	Neither agree	Disagree	Strongly
0	0	nor disagree	0	disagree
		0		0

If I cut down the amount of exercise I do, and then start again, I always end up exercising as often as I did before.

Strongly agree	Agree	Neither agree	Disagree	Strongly
0	0	nor disagree	0	disagree
		0		0

Please comment on whether you think your answers for this set of questions may have been affected by the COVID-19 state of emergency.

We appreciate your participation.

We would like to enter you into a draw for a chance to win one of ten \$100 gift cards to Amazon.ca as thanks for participating in this study. The draw will take place by July 31, 2020.

Please enter an email address below so that we can send you the gift card. The email address you provide will not be traceable to your questionnaire responses.

You may want to reach out to speak with a professional if you felt upset during or after completing the questionnaire.

Some resources you may be interested in could include:

- National Eating Disorders Information Centre Helpline 1-866-633-4220
- Mental Health 24/7 Mobile Crisis Team 1-888-429-8167
- Eating Disorders Nova Scotia 1-902-229-8436

Appendix C – DSM-5 Diagnostic criteria for select eating disorders

Diagnostic criteria - Anorexia Nervosa

- A. Restriction of energy intake relative to requirements, leading to a significantly low body weight in the context of age, sex, developmental trajectory, and physical health. *Significantly low weight* is defined as a weight that is less than minimally normal or, for children and adolescents, less than that minimally expected.
- B. Intense fear of gaining weight or of becoming fat, or persistent behavior that interferes with weight gain, even though at a significantly low weight.
- C. Disturbance in the way in which one's body weight or shape is experienced, undue influence of body weight or shape on self-evaluation, or persistent lack of recognition of the seriousness of the current low body weight.
- Coding note: The ICD-9-CM code for anorexia nervosa is 307.1, which is assigned regardless of the subtype. The ICD-10-CM code depends on the subtype (see below).

Specify whether:

- (F50.01) Restricting type: During the last 3 months, the individual has not engaged in recurrent episodes of binge eating or purging behavior (i.e., self-induced vomiting or the misuse of laxatives, diuretics, or enemas). This subtype describes presentations in which weight loss is accomplished primarily through dieting, fasting, and/or excessive exercise.
- (F50.02) Binge-eating/purging type: During the last 3 months, the individual has engaged in recurrent episodes of binge eating or purging behavior (i.e., self-induced vomiting or the misuse of laxatives, diuretics, or enemas).

Specify if:

- In partial remission: After full criteria for anorexia nervosa were previously met, Criterion A (low body weight) has not been met for a sustained period, but either Criterion B (intense fear of gaining weight or becoming fat or behavior that interferes with weight gain) or Criterion C (disturbances in self-perception of weight and shape) is still met.
- In full remission: After full criteria for anorexia nervosa were previously met, none of the criteria have been met for a sustained period of time.

Specify current severity:

• The minimum level of severity is based, for adults, on current body mass index (BMI) (see below) or, for children and adolescents, on BMI percentile. The ranges below are derived from World Health Organization categories for thinness in adults; for children and adolescents, corresponding BMI

percentiles should be used. The level of severity may be increased to reflect clinical symptoms, the degree of functional disability, and the need for supervision.

- o Mild: BMI $\ge 17 \text{ kg/m}^2$
- Moderate: BMI 16–16.99 kg/m²
- \circ Severe: BMI 15–15.99 kg/m²
- \circ Extreme: BMI < 15 kg/m²

Diagnostic criteria - Bulimia Nervosa

- A. Recurrent episodes of binge eating. An episode of binge eating is characterized by both of the following:
 - Eating, in a discrete period of time (e.g., within any 2-hour period), an amount of food that is definitely larger than what most individuals would eat in a similar period of time under similar circumstances.
 - 2) A sense of lack of control overeating during the episode (e.g., a feeling that one cannot stop eating or control what or how much one is eating).
- B. Recurrent inappropriate compensatory behaviors in order to prevent weight gain, such as self-induced vomiting; misuse of laxatives, diuretics, or other medications; fasting; or excessive exercise.
- C. The binge eating and inappropriate compensatory behaviors both occur, on average, at least once a week for 3 months.
- D. Self-evaluation is unduly influenced by body shape and weight.
- E. The disturbance does not occur exclusively during episodes of anorexia nervosa.
- Specify if:
- In partial remission: After full criteria for bulimia nervosa were previously met, some, but not all, of the criteria have been met for a sustained period of time.
- In full remission: After full criteria for bulimia nervosa were previously met, none of the criteria have been met for a sustained period of time.

Specify current severity:

- The minimum level of severity is based on the frequency of inappropriate compensatory behaviors (see below). The level of severity may be increased to reflect other symptoms and the degree of functional disability.
 - Mild: An average of 1–3 episodes of inappropriate compensatory behaviors per week.
 - Moderate: An average of 4–7 episodes of inappropriate compensatory behaviors per week.
 - Severe: An average of 8–13 episodes of inappropriate compensatory behaviors per week.
 - Extreme: An average of 14 or more episodes of inappropriate compensatory behaviors per week.

Diagnostic criteria – Binge Eating Disorder

- A. Recurrent episodes of binge eating. An episode of binge eating is characterized by both of the following:
 - Eating, in a discrete period of time (e.g., within any 2-hour period), an amount of food that is definitely larger than what most people would eat in a similar period of time under similar circumstances.
 - 2) A sense of lack of control over eating during the episode (e.g., a feeling that one cannot stop eating or control what or how much one is eating).
- B. The binge-eating episodes are associated with three (or more) of the following:
 - 1) Eating much more rapidly than normal.
 - 2) Eating until feeling uncomfortably full.
 - 3) Eating large amounts of food when not feeling physically hungry.
 - 4) Eating alone because of feeling embarrassed by how much one is eating.
 - 5) Feeling disgusted with oneself, depressed, or very guilty afterward.
- C. Marked distress regarding binge eating is present.
- D. The binge eating occurs, on average, at least once a week for 3 months.
- E. The binge eating is not associated with the recurrent use of inappropriate compensatory behavior as in bulimia nervosa and does not occur exclusively during the course of bulimia nervosa or anorexia nervosa.

Specify if:

- In partial remission: After full criteria for binge-eating disorder were previously met, binge eating occurs at an average frequency of less than one episode per week for a sustained period of time.
- In full remission: After full criteria for binge-eating disorder were previously met, none of the criteria have been met for a sustained period of time.

Specify current severity:

- The minimum level of severity is based on the frequency of episodes of binge eating (see below). The level of severity may be increased to reflect other symptoms and the degree of functional disability.
 - Mild: 1–3 binge-eating episodes per week.
 - Moderate: 4–7 binge-eating episodes per week.
 - Severe: 8–13 binge-eating episodes per week.
 - **Extreme:** 14 or more binge-eating episodes per week.

Other Specified Feeding or Eating Disorder

This category applies to presentations in which symptoms characteristic of a feeding and eating disorder that cause clinically significant distress or impairment in social, occupational, or other important areas of functioning predominate but do not meet the full criteria for any of the disorders in the feeding and eating disorders diagnostic class. The other specified feeding or eating disorder category is used in situations in which the clinician chooses to communicate the specific reason that the presentation does not meet the criteria for any specific feeding and eating disorder. This is done by recording "other specified feeding or eating disorder" followed by the specific reason (e.g., "bulimia nervosa of low frequency"). Examples of presentations that can be specified using the "other specified" designation include the following:

- 1) Atypical anorexia nervosa: All of the criteria for anorexia nervosa are met, except that despite significant weight loss, the individual's weight is within or above the normal range.
- 2) Bulimia nervosa (of low frequency and/or limited duration): All of the criteria for bulimia nervosa are met, except that the binge eating and inappropriate compensatory behaviors occur, on average, less than once a week and/or for less than 3 months.
- 3) **Binge-eating disorder (of low frequency and/or limited duration):** All of the criteria for bingeeating disorder are met, except that the binge eating occurs, on average, less than once a week and/or for less than 3 months.
- 4) **Purging disorder:** Recurrent purging behavior to influence weight or shape (e.g., self-induced vomiting; misuse of laxatives, diuretics, or other medications) in the absence of binge eating.
- 5) Night eating syndrome: Recurrent episodes of night eating, as manifested by eating after awakening from sleep or by excessive food consumption after the evening meal. There is awareness and recall of the eating. The night eating is not better explained by external influences such as changes in the individual's sleep-wake cycle or by local social norms. The night eating causes significant distress and/or impairment in functioning. The disordered pattern of eating is not better explained by binge-eating disorder or another mental disorder, including substance use, and is not attributable to another medical disorder or to an effect of medication.

American Psychiatric Association. (2013). Feeding and Eating Disorders. In *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* (pp. 329–354).

Appendix D – Proposed criteria for nuscle dysmorphia

Proposed DSM-5 criteria for muscle dysmorphia

1. The person has a preoccupation with the idea that one's body is not sufficiently lean and muscular. Characteristic associated behaviors include long hours of lifting weights and excessive attention to diet.

2. The preoccupation causes clinically significant distress or impairment in social, occupational, or other important areas of functioning, as demonstrated by at least two of the following four criteria:

2a) the individual frequently gives up important social, occupational, or recreational activities because of a compulsive need to maintain his or her workout and diet schedule;2b) the individual avoids situations where his or her body is exposed to others, or endures such situations only with marked dis- tress or intense anxiety;

2c) the preoccupation about the inadequacy of body size or musculature causes clinically significant distress or important areas of functioning;

2d) the individual continues to work out, diet, or use ergogenic (performance-enhancing) substances despite knowledge of adverse physical or psychological consequences.

3. 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 BDD.

Pope, H. G., Gruber, A. J., Choi, P., Olivardia, R., & Phillips, K. A. (1997). Muscle Dysmorphia: An Underrecognized Form of Body Dysmorphic Disorder. *Psychosomatics*, 38(6), 548–557. Appendix E – DSM-5 Criteria for body dysmorphic disorder

DSM-5 Criteria for body dysmorphic disorder

- A. Preoccupation with one or more perceived defects or flaws in physical appearance that are not observable or appear slight to others.
- B. At some point during the course of the disorder, the individual has performed repetitive behaviors (e.g., mirror checking, excessive grooming, skin picking, reassurance seeking) or mental acts (e.g., comparing his or her appearance with that of others) in response to the appearance concerns.
- C. The preoccupation causes clinically significant distress or impairment in social, occupational, or other important areas of functioning.
- D. The appearance preoccupation is not better explained by concerns with body fat or weight in an individual whose symptoms meet diagnostic criteria for an eating disorder.

Specify if:

• With muscle dysmorphia: The individual is preoccupied with the idea that his or her body build is too small or insufficiently muscular. This specifier is used even if the individual is preoccupied with other body areas, which is often the case.

Specify if:

- Indicate degree of insight regarding body dysmorphic disorder beliefs (e.g., "I look ugly" or "I look deformed").
- With good or fair insight: The individual recognizes that the body dysmorphic disorder beliefs are definitely or probably not true or that they may or may not be true.
- With poor insight: The individual thinks that the body dysmorphic disorder beliefs are probably true.
- With absent insight/delusional beliefs: The individual is completely convinced that the body dysmorphic disorder beliefs are true.

American Psychiatric Association. (2013). Obsessive-Compulsive and Related Disorders. In *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition*.

Appendix F - Recruitment letter for content validity panelists

Dear (Firstname Lastname),

My name is Caroline Anderson, a graduate student at Mount Saint Vincent University, completing a Master's degree in Applied Human Nutrition (Dietetics).

I am conducting a study to explore eating and exercise patterns among men in competitive bodybuilding in Atlantic Canada. I am interested in the dietary and exercise patterns of competitive bodybuilders and how they affect self-perception.

I am writing to ask for input on the questionnaire items. We are seeking to obtain content validity of the questionnaire prior to its implementation. The questionnaire contains items pertaining to eating disorders, muscle dysmorphia, and exercise addiction.

- The eating disorder questions were created based around current DSM-5 criteria [1].
- The muscle dysmorphia questions were created based around proposed DSM-5 criteria by Pope et al [2].
- The exercise addiction questions are pulled directly from a previously validated questionnaire, *The* Exercise Addiction Inventory [3], and therefore do not require additional input.

The questionnaire also contains descriptive questions and some free-form answer questions.

Involvement in this study would involve reviewing the questions and filling out a form to rate the questions which are relevant to your field on a scale from 1 - not relevant, to 4 - highly relevant and provide feedback if necessary, in order for us to determine which questionnaire items to retain.

If you are willing to participate, please review and sign the consent form on the following page and return it to me, Caroline Anderson, at <u>caroline.anderson2@msvu.ca</u>, or my thesis supervisor, Dr. Kyly Whitfield at <u>kyly.whitfield@msvu.ca</u> by (date, 2019). Upon receipt of the completed consent form, we will provide access to the evaluation forms.

If you have any questions, please feel free to contact me to schedule a call or video conference to better understand the study itself, the consent form, or both.

This study has been reviewed by the Applied Human Nutrition Departmental Research Ethics Board and the MSVU Research Ethics Board.

Kind regards,

Caroline Anderson BScAHN, MScAHN (C) Mount Saint Vincent University Kyly C Whitfield, PhD Assistant Professor, Applied Human Mount Saint Vincent University

- 1. American Psychiatric Association. DSM-5. 2013.
- 2. Pope et al. Psychosomatics. 1997;38(6):548–57.
- 3. Terry et al. Addiction Research and Theory. (2004);12(5):489–499

Appendix G - Consent form for content validity panelists

Eating Disorders, Muscle Dysmorphia and Exercise Addiction among Men in Competitive Bodybuilding in Atlantic Canada

Investigators Ms. Caroline Anderson Department of Applied Human Nutrition, Mount Saint Vincent University Phone: E-mail: caroline.anderson2@msvu.ca Dr. Kyly C Whitfield Department of Applied Human Nutrition, Mount Saint Vincent University Phone: (902) 457-5978 E-mail: kyly.whitfield@msvu.ca Dr. Shannan Grant Department of Applied Human Nutrition, Mount Saint Vincent University Phone: (902) 457-5400 E-mail: shannan.grant2@msvu.ca Dr. Mojtaba Kaviani Department of Nutrition and Dietetics, Acadia University Phone: (902) 585-1884 E-mail: mojtaba.kaviani@acadiau.ca

Introduction

You are invited to take part in the research study named above. This form provides information about the study. Before you decide if you want to participate, it is important that you understand the purpose of the study, the risks and benefits, and what you will be asked to do. We will provide you with information before asking for your authorization to participate. You may decide not to participate, or you may withdraw from the study at any time. Participation is entirely voluntary.

Consent

Objective of research

Current research shows that some bodybuilders take part in extreme diet and exercise activities both before and after competitions that may be damaging to their physical and mental health. However, no researchers to date have looked at the prevalence of these activities among bodybuilders in Atlantic Canada, nor have they explored the whole spectrum of behaviours. We have created a questionnaire that asks about exercise and diet activities, and questions about selfperception, in order to better understand bodybuilders here in Atlantic Canada, and to see if there are patterns of behaviours among bodybuilders that may be risky to long-term health.

This study is being conducted through the Department of Applied Human Nutrition at Mount Saint Vincent University and the School of Nutrition and Dietetics at Acadia University. We are asking you to evaluate the content of the questionnaire that relates to your field so we can determine whether it is valid for implementation. **Participation in this study is entirely voluntary and will not cost you anything.** We hope that the validation of the content of this questionnaire will help us to collect the information we need to encourage further research in this field.

Procedure

Screening

We have determined, through purposeful selection, that you are an ideal candidate to participate in the content validity evaluation portion of this research. If you consent to participate in this study, you will be asked to complete forms to rate the questionnaire items. You do not have to answer any questions unrelated to your field of practice or research, or that you do not wish to answer.

If you consent to participate in this study, once we receive the signed consent form from you, we will send you the forms with instructions for completion, which you would fill out and send back to us via e-mail.

Confidentiality

Your confidentiality will be respected; your digital forms will be kept on a secure server housed at Mount Saint Vincent University. None of your personal information (name, e-mail, specific job title, organization) will be included in the research dataset. Information that contains your identity will remain only with the research team.

The results of the study may be presented at scientific meetings and published in a scientific journal. If you choose to withdraw from the study, simply contact the investigator(s) via e-mail to express your desire to withdraw.

Risks

There no risk involved in your participation in the evaluation of this questionnaire. However, if for any reason you decide you no longer wish to participate, you can withdraw from the study at any time by simply contacting us via e-mail.

Benefits

You will receive no direct benefits from participating in the study. However, we hope that the information learned from this study can be used in the future to benefit bodybuilding men in Atlantic Canada, and potentially across Canada.

As a thank you for your input, we would like to offer to acknowledge you by name in the Acknowledgements section of any manuscript we publish about this research. We will ask you on the final page of this consent form whether you would like to be acknowledged by name.

Questions and further information

Participation is completely voluntary. If you decide to withdraw before completing the evaluation, we ask that you simply do not complete it. If you decide to withdraw after you have submitted the evaluation, the evaluation will be retained as it will already have been included in our calculation for content validity.

If you have questions about how this study is being conducted and wish to speak with someone who is not directly involved in the study, you may contact the Chair of the University Research Ethics Board (UREB) c/o MSVU Research and International Office, at 457-6350 or via e-mail at research@msvu.ca

Participant Rights

By accepting the terms and conditions, you indicate that you have understood the information regarding participation in the research project and agree that you will participate. You are free to withdraw from the study at any time.

By accepting the terms and conditions, you indicate that you understand that for purposes of the research project, if you choose to withdraw from the study at any time, you may do so without any problems. You also indicate that you are aware that the researchers may publish the study results in scientific journals, keeping your identity confidential.

Research Results

If you wish, you can choose to view a summary of the study results, which will be available around one year after the end of the study, by visiting <u>www.mamalab.ca.</u>

Participant Authorization

I have read the information in this consent form. I understand the nature of the study and I understand the potential risks. I understand that I have the right to withdraw from the study at any time without any problems.

I would like to be acknowledged by name in any published manuscript pertaining to this research.

\Box_{YES}		NO
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I freely agree to participate in this research study.

	YES	l		NO
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Name of Participant: _____

Signature:	
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Deter

	Part 3 – Eating Disorders							
Operational	Operational Definition: A persistent disturbance of eating or eating-related behavior that results in altered consumption or absorption of							
food and that significantly impairs physical health or psychosocial functioning (1).								
Item #	Rationale for question AN – anorexia nervosa BN – bulimia nervosa BED – binge eating disorder	1 – Not Relevant 2 – Somewhat Relevant 3 – Quite Relevant 4 – Highly relevant	If you rated this question a 1 or 2, how could it be improved? (If not applicable, leave blank)	How would you rate this question if we improved the question as per your recommendations? (If not applicable, leave blank)				
25	AN criterion B	1 2 3 4		1 2 3 4				
26	AN criterion A			1 2 3 4				
27	AN criterion C/BN criterion D	1 2 3 4		1 2 3 4				
28	BN/BED criterion A1, A2	1 2 3 4		1 2 3 4				
29	BED criterion B1	1 2 3 4		1 2 3 4				
30	BED criterion B2	1 2 3 4		1 2 3 4				
31	BED criterion B3	1 2 3 4		1 2 3 4				
32	BED criterion B5, C	1 2 3 4		1 2 3 4				
33	BED criterion B4	1 2 3 4		1 2 3 4				
34	BN criterion B	1 2 3 4		1 2 3 4				
35	BN criterion B	1 2 3 4		1 2 3 4				
What additional items would you recommend including to measure the construct? If you have no suggestions, please enter "none."								
What additional items would you recommend deleting? If you have no suggestions, please enter "none."								
Please provide any additional information you believe may be useful in assessing the identified construct with this instrument. If you have no suggestions, please enter "none."								

Appendix H – Evaluation form for content validity analysis of the questionnaire tool.

1. American Psychiatric Association. Feeding and eating disorders. In: Diagnostic and statistical manual of mental disorders. 5th ed. 2013. p. 329-54.

Part 5 – Muscle Dysmorphia Operational Definition: An obsessive preoccupation with increasing muscle mass, even if one is significantly muscular (2)						
Item # Rationale for question (based on proposed DSM-5 criteria) 1 – Not Relevant 2 – Somewhat Relevant 3 – Quite Relevant 4 – Highly relevant If you rated this question a 1 or 2, how could it be improved? How would you rate the question if we improved question as per your recommendations?						
36	Criterion 1	1 2 3 4		1 2 3 4		
37	Criterion 2c	1 2 3 4		1 2 3 4		
38	Criterion 1			1 2 3 4		
39	Criterion 1	1 2 3 4		1 2 3 4		
40	Criterion 2a	1 2 3 4		1 2 3 4		
41	Criterion 2b	1 2 3 4		1 2 3 4		
42	Criterion 2d	1 2 3 4		1 2 3 4		
What additional items would you recommend including to measure the construct? If you have no suggestions, please enter "none."						
What additional items would you recommend deleting? If you have no suggestions, please enter "none."						
Please provide any additional information you believe may be useful in assessing the identified construct with this instrument. If you have no suggestions, please enter "none."						

2. Pope HG, Gruber AJ, Choi P, Glivardia R, Katharine BA, Phillips A, et al. Muscle dysmorphia: an underrecognized form of body dysmorphic disorder. Psychosomatics. 1997;38(6):548–57. Appendix I – Minimum values for content validity ratio of questionnaire items

Number of Panelists	Minimum Value for Item Retention			
5	0.99			
6	0.99			
7	0.99			
8	0.75			
10	0.62			
11	0.59			
12	0.56			
13	0.54			
14	0.51			
15	0.56			
From: Lawshe, C. H. (1975). A quantitative approach to content validity. <i>Personnel</i> <i>Psychology</i> , 28, 563–575.				

Content Validity Ratio = $\frac{\text{ne} - (N/2)}{(N/2)}$

When all say "essential" the CVR is computed to be 1.00, but it is adjusted to 0.99 for ease of manipulation. When the number saying "essential" is more than half, but less than all the CVR is somewhere between 0 and 0.99.

Appendix J – Certificate of ethics clearance



University Research Ethics Board (UREB)

Certificate of Research Ethics Clearance

		Clearance		Secondary Data Clearance		Renewal		Modification		Change to Study Personnel
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Effective Date	<u>May 5, 2020</u>	Expiry Date	<u>May 9, 2021</u>
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File #:	2018-180
Title of project:	An Exploratory Analysis of Eating Disorders, Muscle Dysmorphia, and
	Exercise Addiction Among Men in Competitive Bodybuilding in Atlantic
	Canada
Researcher(s):	Caroline Anderson
Supervisor (if applicable):	Kyly Whitfield
Co-Investigators:	Shannan Grant; Mojtaba Kaviani
Version :	3

The University Research Ethics Board (UREB) has reviewed the above named research proposal and confirms that it respects the *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans* and Mount Saint Vincent University's policies, procedures and guidelines regarding the ethics of research involving human participants. This certificate of research ethics clearance is valid for a period of **one year** from the date of issue.

Researchers are rem	Researchers are reminded of the following requirements:						
Changes to Protocol	Any changes to approved protocol must be reviewed and approved by the UREB prior to their						
	implementation.						
	Form: REB.FORM.002	Info: REB.SOP.113	Policy: REB.POL.003				
Changes to	Any changes to approved person	s with access to research da	ta must be reported to the UREB				
Research Personnel	immediately.		-				
	Form: REB.FORM.002	Info: REB.SOP.113	Policy: REB.POL.003				
Annual Renewal	Annual renewals are contingent	upon an annual report sub	mitted to the UREB prior to the				
	expiry date as listed above. You	may renew up to four time	s, at which point the file must be				
	closed and a new application sub	mitted for review.					
	Form: REB.FORM.003	Info: REB.SOP.116	Policy: REB.POL.003				
Final Report	A final report is due on or before	the expiry date.					
	Form: REB.FORM.004	Info: REB.SOP.116	Policy: REB.POL.003				
Privacy Breach	Researchers must inform the U	REB immediately and subn	nit the Privacy Breach form. The				
	breach will be investigated by th	e REB and the FOIPOP Office	г.				
	Form: REB.FORM.015						
Unanticipated	Researchers must inform the UR	EB immediately and submit	a report to the UREB within seven				
Research Event	(7) working days of the event.						
	Form: REB.FORM.008	Info: REB.SOP.115	Policy: REB.POL.003				
Adverse Research	Researchers must inform the UR	EB immediately and submit	a report to the UREB within two				
Event	(2) working days of the event.						
	Form: REB.FORM.007	Info: REB.SOP.114	Policy: REB.POL.003				
*For more information	n: http://www.msvu.ca/ethics						

Dr. Daniel Séguin, Chair University Research Ethics Board

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