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Development of the Muscle Dysmorphia Inventory (MDI)

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Aim. **The development of the 6-factor, 27-item Muscle Dysmorphia Inventory (MDI) was based on Lantz *et al.* proposed model of characteristics associated with Muscle Dysmorphia.**
Methods. **Experimental design: quantitative procedures including item-to-total correlations, exploratory and confirmatory factor analyses, and structure equation modeling confirmed the construct validity of the scale. Convergent validity was also tested. Setting: bodybuilding and powerlifting competition venues, weight training facilities, and university athletic venues. Participants: the 1st study consisted of 77 experienced male free weight lifters. The 2nd study consisted of 156 male non-competitive bodybuilders and weight lifters and 168 elite level powerlifters and bodybuilders. The 3rd study consisted of 151 male and female bodybuilders and weight lifters. Measures: each participant completed demographic information, the MDI, Drive for Thinness subscale of the Eating Disorder Inventory, and the Training Dependency subscale of the Bodybuilding Dependence Scale.**
Results. **Reliability estimates (Cronbach's α) ranged from 0.72 to 0.94. Factor loadings in all 3 studies supported the 6-factor structure (size/symmetry, supplement use, exercise dependence, pharmacological use, dietary behavior, and physique protection). Much of the scale validation was focused on construct validity, however, correlations with the MDI's subscales and the Training Dependency subscale of the Bodybuilding Dependence Scale and the Drive for Thinness subscale of the Eating Disorder Inventory provided evidence of convergent validity also.**
Conclusion. **From these preliminary results, the MDI appears to contribute to the identification of a newly formed disorder by offering a multi-dimensional measure of factors related to Muscle Dysmorphia.**

KEY WORDS: Muscle dysmorphia - Exercise psychology - Exercise.

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Muscle Dysmorphia (MD) has recently been proposed as a new disorder addressing the pathological pursuit of a hyper-mesomorphic physique. Originally, Pope and Katz [1] termed MD as a reverse anorexia, but more recently researchers [2, 3] have considered it as a subtype of Body Dysmorphic Disorder (BDD). BDD has always been defined as an intense preoccupation with an imagined physical defect or an overemphasis regarding a slight defect commonly involving specific body parts such as hair, nose, or irregularities in skin pigmentation. However, the DSM-IV-TR [4] additionally links global bodily concerns such as body shape and size as associated BDD characteristics with the addition of the phrase, "an obsession with muscle and bodybuilding". According to many researchers, muscle dysmorphics are obsessed with muscle viewing themselves as thin and weak, and feeling pressure to gain muscle size and/or strength even though they are quite large and muscular.[2, 3, 5]

Although MD has gained increasing attention in the research literature, there are limitations involving the identification of specific characteristics associated with MD and to what degree a person must possess these characteristics to be "diagnosed" as muscle dysmorphic.[6] Pope *et al.*[3,7], Olivardia *et al.*[5] recently diagnosed persons as dysmorphic based on clinical interviews involving three specific criteria. These criteria include: a) a preoccupation with thoughts of being insufficiently muscular, b) impaired social functioning, and c) relinquishing other enjoyable activities due to preoccupation with body concerns. Unfortunately, the clinical nature of their assessment and the use of vague and subjective criteria provide limited conceptual understanding of this disorder for individuals working in non-clinical settings. Lantz *et al.*[2] suggested a need for the "development of a quantifiable assessment device that would allow for the standardized identification of people with MD". Currently, one questionnaire (Body Dysmorphic Disorder Modification of the Yale-Brown Obsessive Compulsive Scale) exists that some have used to measure muscle dysmorphia.[5,8,9] This scale assesses a cognitive preoccupation with muscularity from the global identification of BDD, but does not take into consideration a conceptual model of psychobehavioral factors associated specifically with MD as Lantz *et al.*[2] have proposed. While the clinical samples identified as muscle dysmorphic introduced by Pope *et al.* was a good first step, the literature is void of a measure that encompasses the clinical criteria and non-clinical empirical reports as proposed by Lantz *et al.*[2]

The purpose of the 3 studies presented in this article was to develop a psychometrically sound scale to measure the factors of muscle dysmorphia identified by Lantz *et al.*[2] The following sections describe the 3 studies used to develop the Muscle Dysmorphia Inventory (MDI): 1) construction of the initial questionnaire, 2) scale refinement using confirmatory factor analysis, and 3) final estimation of validity and reliability of the MDI.

Materials and methods

Study 1: Construction of initial questionnaire

Item generation

The 1st stage in the development of the MDI involved the generation of items to reflect the factors identified in Lantz *et al.*'s [2] conceptual model.

Items were generated based on an extensive review of the muscle dysmorphia literature and Klein's [10] ethnographic work.

The initial version of the scale contained 46 items designed to measure the following 6 areas: a) drive for size (8 items) – preoccupation with the development of a hyper-mesomorphic body; b) body dissatisfaction (10 items) – a disturbance of the feeling that one has about one's body; c) pathogenic weight control (8 items) – use of steroids and other illegal or banned pharmacological aids; d) exercise behaviors (8 items) – exercising compulsively and feeling guilty when the exercise schedule is violated; e) dietary behavior (8 items) – dieting behaviors predicated solely on gaining muscle size, strength, and definition; and f) physique concealment (4 items) – engaging in behaviors designed to hide perceived defects of the body, *e.g.*, camouflanging with clothing. Responses to each item were based on a 6-point Likert response format ranging from "never" (1) to "always" (4) [6].

Item analysis

Preliminary item analysis consisted of four separate evaluations. First, 2 sport and exercise psychology faculty evaluated the initial item pool for readability and content. Based on their feedback, minor wording modifications were made to some of the items, however no items were eliminated or added. The 2nd analysis involved a panel of experts (including 3 university faculty in sport psychology and 3 former competitive body builders) who evaluated the appropriateness of the items assigned to each factor and had the opportunity to propose any new items. The 3rd analysis was based on the recommendations of Riemer and Chelladurai.[11] Twenty-five undergraduate sport psychology students were provided with a list of the factors, their definitions and a separate randomized list of the items. The students were then asked to match each item with the factor they thought it best represented. Participants were also told that the minimum and maximum number of items to be placed in any one dimension were 3 and 9 respectively.

The 4th analysis involved administering the 46-item MDI to 77 experienced (*i.e.*, at least 3 times per week for at least the previous year) male free weight lifters in 3 weight training facilities in the Midwest (age range 18-22 years). Following the procedures of Mueller,[12] item analyses of these responses were conducted, including percentage of respondents selecting

each response option, item means and standard deviations, item-to-subscale total correlations, and internal consistencies (Cronbach's α).

Item revision

As a result of feedback from the panel of experts, student classifications, and the item analyses, several items were reworded, 6 items were eliminated, 1 item was moved to another factor, body dissatisfaction was removed as a factor and the pathogenic weight control factor was split into 2 factors (supplement use and pharmacological use), which added 9 new items. Supplement use was defined as the use of nutritional supplements and energy drinks to help achieve desired physique and muscular development. Pharmacological use was now defined as the use of steroids and other illegal synthetic hormones in order to increase muscular size and strength. As a result of these procedures, the scale was reduced from 46 items to 38 items and had maintained 6 subscales. The revised 6 subscales were labeled as body size/symmetry, supplement use, exercise dependence, pharmacological use, dietary behavior, and physique concealment (Figure 1).

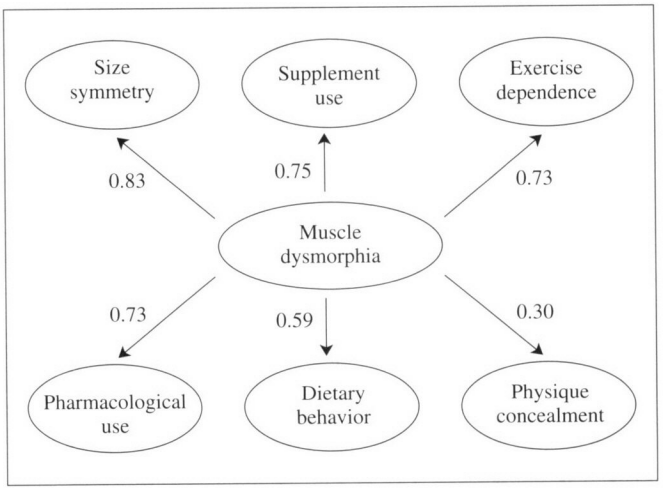

Figure 1.—Path coefficients of 6 factors representing muscle dysmorphia model.

Study 2: Scale refinement

Study 2 in the development of the MDI was concerned with further refining the scale through item analyses and factor analyses. These analyses were conducted in 2 phases with refinement of the questionnaire at each phase. The 1st phase examined non-competitive weightlifters and the 2nd phase examined competitive bodybuilders and powerlifters.

Phase I — Participants and procedures

The Phase I participants were 156 male self-identified non-competitive body builders and weight lifters who were recruited through posted flyers and personal solicitation in their respective training facilities. They ranged in age from 18-40 years and represented 4 weight training facilities in the Midwest no utilized in the preliminary analysis. Participants completed the 38 items resulting from Study 1 immediately prior to or following their training session.

Phase I — Principal components analysis and internal consistencies

Initial item evaluation of Phase I was conducted through an exploratory principal components factor analysis with varimax rotation (PCA) and assessing internal consistencies of the resulting subscales. Item retention for the PCA was based on the work of Conroy *et al.*[13] who suggest that retained items should fit at least 1 of 2 criteria. First, salient items should have a primary loading greater than 0.40, a secondary loading less than 0.40 and a difference between the primary and secondary loading of no less than 0.10. Second, salient items should have a primary loading greater than 0.40, secondary loading greater than 0.40 but less than 0.50 and the difference in loading greater than 0.20. Items failing to meet either of these criteria were subsequently eliminated from further analysis. Subscale reliabilities (Cronbach's α) and α if item deleted were calculated for the items loading on each respective subscale. In situations where the internal consistency for a given set of items failed to attain the 0.70 criteria, α if item deleted procedures were employed. Individual items were removed based on the resultant improved α level. Item deletion continued until α reached 0.70 for each subscale.

Phase I — Results

The PCA supported the 6-factor model and accounted for 54.17% of the known variance. Dietary behavior was identified as the most salient factor contributing 21.1% of the known variance. Body size/symmetry, pharmacological use, physique concealment, supplement use, and exercise dependence factors con-

tributed 10.37%, 8.39%, 5.74%, 4.48%, and 4.08% of the common variance, respectively. The internal consistency of the items for each of the six subscales ranged from 0.42 to 0.88 with three of the six subscales exceeding 0.7 (dietary behavior, body size/symmetry, and pharamacological use). Based on the results of the above analyses, 7 items were deleted from various subscales and 2 items were added to the physique protection subscale resulting in a 33-item measure assessing 6 subscales.

Phase II — Participants and procedures

Phase II participants were elite-level powerlifters (n=68) and elite-level body builders (n=100). Powerlifters (m=63; f=5) were competitors in a national championship meet and represented all weight classes. They averaged 31.68 (SD=6.62) years of age and reported an average of 15.53 (SD=7.74) years of active training for competition. Fifty-seven (84%) powerlifters identified themselves as Caucasian while the remaining 11 (16%) identified themselves as either African-American or Asian. Participants were contacted through announcements at precompetition weigh-ins and completed the scale immediately following their competition. Bodybuilders (m=79; f=21) competed at a national qualifying meet or were currently training for regional or national competition at one of three training facilities located in the central United States. They averaged 30.99 (SD=7.22) years of age and reported an average of 12.75 (4.49) years of active training for competition. Seventy-one bodybuilders identified themselves as Caucasian while the remaining 29 identified themselves as either African-American or Asian.

Phase II — Confirmatory factor analysis and model modification

The covariance matrix for the MDI items was analyzed by AMOS version 4.0 (SmallWaters Corporation, Chicago, IL). The goodness-of-fit evaluation of the model was based on several criteria. The χ^2 goodness-of-fit test statistic is the traditional measure of fit for CFA models, but is recognized to be overly sensitive when sample sizes are large [14] and it is customary to examine other indices of model fit. One useful index is the standardized root-mean-square residual (SRMR), which measures the difference between the sample covariances and the model-derived covariances. If the model fits the data perfectly, SMSR is 0. Another index is the comparative fit index (CFI). The CFI indicates the proportion of improvement in fit of the model compared to a null or completely independent model. An acceptably fitting model should have an SRMR less than 0.1 and a CFI value greater than 0.9.[14] Goodness-of-fit indices evaluate the fit of the overall model, but give no indication of the fit or magnitude of specific parameters. Therefore, factor loadings were also examined to evaluate the fit for individual MDI items.

Phase II — Results

From the confirmatory factor analysis, the fit indices for the proposed model were not acceptable (x^2=834.90, df=427, CFI=0.78, SRMR=0.15), suggesting that the model failed to adequately explain the relationships between the items (Figure 1). However, AMOS recommended a model modification that involved introducing multiple latent factors rather a single factor.[15] The new model (Figure 2) included one latent factor labeled "nutritional concerns" and was defined by the dietary behavior, supplements, and pharamacological use subscales. The 2nd latent factor was labeled "physique concerns" and was defined by the body size/symmetry, physique concealment, and exercise dependence subscales. The fit indices were acceptable using this model (χ^2=701.25, df=350, CFI=0.99, SRMR=0.07) and the path coefficients exceeded 0.7 for all but one (physique concealment) subscale. This new model served as the basis of analysis for Study 3.

The internal consistency of the items for each of the six subscales improved to a range of 0.59-0.88 with all but physique protection exceeding 0.7. While the physique concealment subscale continued to be problematic (α=0.59), it was retained as a factor associated with muscle dysmorphia because of its theoretical importance. On closer examination, the physique concealment factor may have been problematic because of the definition used. Therefore, physique concealment changed from measuring concealment of the body to protecting oneself from negative evaluation, hence a factor name change to physique protection.[10] The same internal consistency strategy that was employed in Phase I was employed in this phase as well. Based on the results of the above analyses, 8 items were deleted, 2 items were revised from physique protection, and 2 new items were added to physique protection leaving each subscale with at least 3

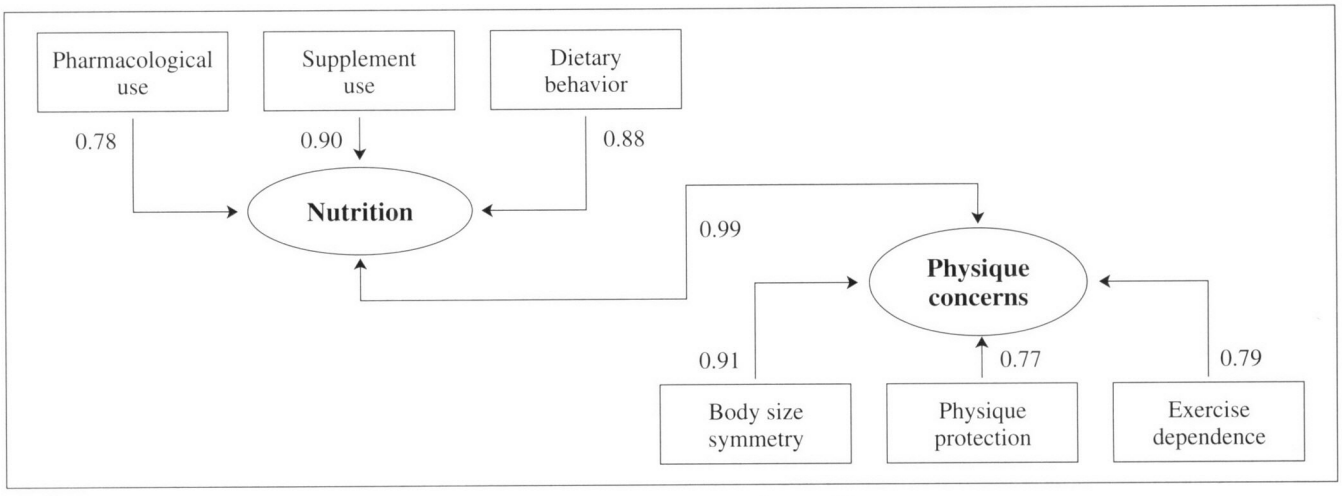

Figure 2.—Coefficients of 2 component model with 6 factors representing muscle dysmorphia.

items and the total MDI at 27-items assessing 6 subscales.

Study 3: confirmatory factor analysis and convergent validity

Study 3 examined the factor structure of the final version of the MDI through structural equation modeling and examined preliminary evidence of the convergent validity through correlations with established related scales. To examine the convergent validity of the MDI, correlations were calculated between the Drive for Thinness subscale of the Eating Disorder Inventory,[16] the Body Building Dependence Scale,[17] and the subscales of the MDI.

Participants

The participants of Study 3 were 151 male and female self-identified body builders (n=58) and dedicated weight lifters (n=93). A dedicated weight lifter was defined in this study as one that lifts weights no less than 4 days a week most weeks of the year. The dedicated weight lifters, all males, ranged in age from 20-38 years (M=26.5, SD=8.6) and represented football players (n=40), cheerleaders (n=15), and individuals attending 3 gyms in the southern region of the United States (n=38). The bodybuilders ranged in age from 21-40 years (M=30.45, SD=8.23) with 45 males and 13 females represented. Ninety percent of the sample self-reported as Caucasian while the remaining 10% self-reported as African-American, Hispanic or Asian. The bodybuilders were currently training for regional or national competition at one of three training facilities. All of the participants were solicited personally or through flyers at the respective training facilities and completed the questionnaire immediately prior to or following a training session.

Measures

Drive for Thinness—The Drive for Thinness subscale of the Eating Disorder Inventory [16] is highly respected as a measuring tool assessing a relentless pursuit of thinness for patient and nonpatient samples and should correlate with the body size/symmetry subscale of the MDI. The drive for thinness subscale was also correlated with all other MDI subscales in an effort to explore other relationships. Internal consistencies for the drive for thinness subscale have been high for nonpatient samples (α=0.87-0.92).[18-21] The internal consistency (Cronbach's α) of 0.88 for this study was consistent with those reports. Since the initial validation of the EDI, there have been many other investigations that have provided data pertinent to convergent validity for the drive for thinness subscale.[16, 20, 22]

Bodybuilding dependence— The Training Dependency subscale of the Body Building Dependence Scale [17] measures a similar construct to the exercise dependence subscale of the MDI and should correlate highly with this and other scales of the MDI. Smith

TABLE I.—*Study 3 means, standard deviations, Cronbach's α coefficients, and correlation matrix between latent factors and internal consistencies of the MDI.*

Subscale (n=151)	Mean	SD	α	Correlation matrix 1	2	3	4	5	6
Size/symmetry	18.22	6.19	0.88	—					
Physique protection	24.58	10.6	0.94	0.77*	—				
Exercise dependence	19.81	4.75	0.72	0.87*	0.55*	—			
Supplement use	13.89	6.19	0.94	0.89*	0.62*	0.83*	—		
Dietary behavior	30.16	10.0	0.94	0.88*	0.70*	0.85*	0.85*	—	
Pharmacological use	11.09	6.31	0.89	0.54*	0.53*	0.54*	0.53*	0.56*	—

*. Correlation is significant at the 0.01 level.

TABLE II.—*Correlations between MDI subscales and subscales of drive for thinness and training dependence.*

Subscale	Drive for thinness	Training dependence
Size/symmetry	0.388*	0.765*
Physique protection	0.596*	0.671*
Exercise dependence	0.330*	0.764*
Supplement use	0.350*	0.713*
Dietary behavior	0.569*	0.763*
Pharmacological use	0.487*	0.574*

*. Correlation is significant at the 0.01 level.

et al. have provided initial psychometric support for this subscale of the BDS through factor analysis, internal consistency (α=0.75) and correlations with the Athletic Identity Measurement Scale (r=0.30) and the frequency of one's training sessions. The internal consistency (Cronbach's α) of 0.92 for this study was consistent with previously reported figures.[17]

Results

Descriptive statistics, Cronbach's α, and correlations among the MDI subscales were calculated and are presented in Table I. Confirmatory factor analysis was again used to determine model fit. All of the internal consistencies were acceptable (>0.7) and the correlations among the subscales were high, which is what would be expected if they are measuring an undelying construct.

From the confirmatory factor analysis, the fit indices for the final model were acceptable (χ^2=659.75, df=309, CFI=0.96, SRMR=0.04), suggesting that the model adequately explains the relationships between the items. All items had factor loadings of 0.70 or higher on the designated factor (Figure 2). This suggests that the final model provides an acceptable fit to the data with items loading substantially on the appropriate factor. The 27-item questionnaire was supported through Study 3 analyses and maintained the same 6 latent factors: Drive for Size/Symmetry (5 items), Physique Protection (6 items), Exercise Dependence (4 items), Supplement Use (4 items), Dietary Behavior (5 items), Pharmacological Use (3 items) (Figure 2).

The correlations between the subscales of the MDI and the Drive for Thinness subscale of the Eating Disorder Inventory [16] and the Training Dependency Subscale of the Body Building Dependence Scale [17] are presented in Table II. All correlations were significant and positive, indicating that the MDI subscales measure constructs similar to preoccupation with size and exercise dependence.

Discussion

Using the comprehensive description and classification of muscle dysmorphia factors provided by Lantz *et al.*[2] as the foundation, the goal was to develop an instrument that measured characteristics associated with muscle dysmorphia. The qualitative and quantitative processes employed resulted in a 27-item, 6-subscale measure that demonstrates early evidence of being psychometrically sound. The Muscle Dysmorphia Inventory (MDI) has shown that it can empirically distinguish between the various known factors associated with muscle dysmorphia, it is reliable across several non-clinical settings or populations (*i.e.* variety of exercise types), and is understandable, short, and easy to respond to.

The 6 subscales of the MDI address the most salient aspects of muscle dysmorphia as known at this juncture: nutritional aspects and physique concerns. The nutritional component includes questions related to aspects of one's eating habits, nutritional supplements to enhance one's performance, and illegal synthetic hormones to increase muscular size and strength. The physique concerns component includes questions related to preoccupation with the size of one's body, exercise dependence, and hiding defects of one's body.

Much of the energy of scale validation was focused on construct validity. The MDI's construct validity was verified through item-to-total correlations and the more rigorous confirmatory factor analysis to confirm whether the subscale structure was supported by different data sets. The confirmatory factor analysis of the final version of the scale provides preliminary evidence of construct validity. The convergent validity of the MDI was also supported by the significant correlations among the 6 subscales of the MDI and training dependency, and drive for thinness.

Utility of the scale

The MDI was designed for use with non-clinical adult samples to measure at-risk behaviors associated with muscle dysmorphia as developed from Lantz *et al.*'s conceptual framework.[2] At this time, norm-referenced standards of a clinical population are not available from which to compare scores of individuals that might be considered at higher risk of muscle dysmorphia. This scale was derived from a variety of weight lifting populations, hence this scale can be generalized to those types (*i.e.* bodybuilders, recreational weightlifters). The scale should be useful in any population where body image and exercise are key components of success. This scale has not been tested on children or young adult populations, so the impact with these populations is not known.

Scoring. The 6 subscales use a 6-point Likert scale of "always", "usually", "often", "sometimes", "rarely", or "never". Responses for each item are scored from 1 to 6, with a score of 6 assigned to the responses farthest in the "symptomatic" direction ("always" or "never" depending on whether the item is keyed in the posivive or negative direction) and a score of 1 for the response farthest in the "asymptomatic" direction. Thus, positively scored items are scored as follows: always=6, usually=5, often=4, sometimes=3, rarely=2, and never=1. Item scores contribute to only one subscale score. Subscale scores are computed by simply summing all item scores for that particular subscale. The higher the score per subscale translates into a higher risk of characteristics associated with muscle dysmorphia.[23]

Issues and future directions

The MDI was developed to measure known characteristics associated with muscle dysmorphia. The author's primary purpose was to establish a sound scale that could be used to confirm a theoretical framework established previously.[2] In so doing, some researchers might assume that this scale could be used in many different settings. The MDI scale was developed from non-clinical adult populations. Therefore, future directions would include examining adolescent populations, gender differences, and clinical populations. At this juncture, the MDI strictly measures psychological correlates associated with muscle dysmorphia, but should not be considered a diagnostic tool. Without developing referenced standards from clinical samples, the intent of this scale should be purely educational in nature.

Another issue relates to the development of a global measure of muscle dysmorphia. The sum or average of the scores on the various muscle dysmorphia factors has been used, but not the sum or average of the entire scale. Other researchers have suggested it is inappropriate to assume that the sum of the parts will provide an adequate assessment of a global measure such as muscle dysmorphia.[24, 25] That assessment holds true for this questionnaire as well. The subscales should remain completely independent entities for scoring, although future research might consider how many of the subscales should have inflated scores to be considered at higher risk of developing muscle dysmorphia.

Conclusions

Finally, one might argue that several occupations — athletes, actors, and models — may meet these criteria simply because the subculture they are associated with identifies so strongly with muscularity and leanness.[6, 26] The results of this study showed that a smaller percentage of bodybuilders reported high scores on each of the factors associated with muscle dysmor-

phia than one would expect if these characteristics were embedded in the subculture. Therefore, one might consider that individuals in this subculture who score higher on several of the subscales might have characteristics associated with a psychological disorder. As is, this scale is a tool that provides an understanding of psychological correlates of muscle dysmorphia. Further examination of this scale with clinical and non-clinical samples will help to determine the number of correlates and which correlates are a necessary blend in order to use this as a diagnostic tool.

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