Asessing the male body image: Spanish validation of two instruments

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ABSTRACT

Despite the literature suggesting that body dissatisfaction is increasing among males, only few measures on specific body image concerns in men have been validated in Spanish male populations. The aim of this study was to reassess the factor structure of the Spanish versions of the Muscle Dysmorphic Disorder Inventory (MMDI) and the Adonis Complex Questionnaire (ACQ). A cross-sectional study was conducted among 298 Sport Sciences male students to examine: reliability, the factorial structure, and several evidences of validity -concurrent and convergent- of both scales. The questionnaires present adequate reliability. The three-factor structure proposed for the MMDI was replicated. Nevertheless, the confirmatory factor analysis supports a second-order factor structure for the ACQ instead of the three-factor structure proposed. Moreover, the MDDI shows greater association than ACQ with the variables studied. This study represents an advance in the use of adequate and reliable scales of body image tools in the Hispanic population.

1. Introduction

Body image is a complex concept, which comprises different dimensions (perceptual, cognitive-affective and behavioral) of personal experience (Raich, 2001; Sepúlveda et al., 2001). A negative body image evaluation has proved to play a key role in the onset and maintenance of eating disorders (ED) (Fairburn, 2008). Consistent with its complex nature, gender differences have previously been described across the different dimensions of body image. However, most of what we know about body dissatisfaction and ED comes from studies using measures and methodologies based on the female experience of body image (Darcy and Lin, 2012; Strother et al., 2012). It is therefore possible that this problem in males has been underdiagnosed.

Body dissatisfaction in women is mainly aimed at weight loss and is concerned with obtaining a physical aspect consistent with the thin aesthetic ideal (Karazsia et al., 2017). In contrast, body dissatisfaction in males is often oriented toward increasing their muscle mass and reducing fat mass as much as possible, in order to pursue a mesomorphic ideal (Hildebrandt et al., 2010). The pursuit of this aesthetic ideal gives rise to behaviors that alter eating habits (e.g., restriction or increase of certain foods or macronutrients) or excessive physical exercise (Heath et al., 2016), in order to change one's shape and body weight. At first, similarities between these symptoms of males and symptoms of anorexia nervosa produced the clinical picture renamed "reverse anorexia" (Pope, Katz and Hudson, 1993).

However, a few years later the same team reconceptualized the term and called it muscular dysmorphic disorder or muscle dysmorphia (MD) (Pope et al., 1997). The nuclear aspects of the pathology are the presence of: (1) concern with the idea that his body is not sufficiently developed and muscular, spending a lot of hours lifting weights and paying excessive attention to diet and (2) clinical distress, interfering in social activities, occupational or other important areas of personal functioning (e.g., reduction of social and occupational activity due to the compulsive need to train or maintain a diet and/or avoidance of situations in which he must to show his body) (Pope et al., 1997). In addition to the risk attending these behaviors (e.g., poor nutrition, injuries, etc.) (Murray et al., 2016a; Murray et al., 2017b), there is a high degree of comorbidity with other pathologies such as anxiety disorders, mood disorders, and substance misuse (i.e., anabolic-androgenic steroids) (Hildebrandt et al., 2010; Murray et al., 2016a; Hildebrandt et al., 2004; Olivardia et al., 2004; Mitchell et al., 2017), which complicates the clinical situation and makes therapeutic interventions challenging.

Despite the fact that MD resembles ED, given shared risk factors (Compte et al., 2018), clinical presentation (Murray et al., 2012) and diagnostic crossover (Murray et al., 2016b). MD is currently classed as a subtype of body dysmorphic disorder (i.e., BDD), among the Obsessive-Compulsive and related Disorders in the last edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM) of the American Psychiatric Association (2013). The DSM system aims to provide clinical information for the accurate diagnosis and treatment of

mental disorders; however, the current description of MD neglects concerns about food, eating, and body weight (Murray et al., 2017a). In this regard, it has been argued elsewhere that the lack of appropriate assessment methods for men's experience of body image could impact research and clinical interventions relating to males suffering from an ED (Strother et al., 2012; Suffolk et al., 2013).

It has been a common practice to modify available measures, developed and validated in female populations, in a way that would be more sensitive for men (Blouin and Goldfield, 1995; Hildebrandt et al., 2004; Hildebrandt et al., 2006; Yelland and Tiggemann, 2003). In this regard, Murray et al. (2012) a modified version of the Eating Disorders Examination Questionnaire (Fairburn and Beglin, 1994) has been used where, for example, the item *"Have you had a definite fear that you might gain weight or become fat?"* was modified to *"Have you had a definite fear that you might lose weight or become not muscular enough?"*

Over the last years, a variety of measures have been developed in order to capture men's experience with body image. According to a review by Cafri and Thompson (2004), the Drive for Muscularity Scale (DMS) (McCreary and Sasse, 2000) is highlighted as one of the most appropriate measures to evaluate behaviors and attitudes associated with male body dissatisfaction. However, it was later criticized by Tylka et al. (2005), given that it failed to consider aspects of body image unrelated to muscularity. These authors developed the Male Body Attitudes Scale (MBAS) which, in addition to assessing the desire to become more muscular, also includes subscales about body fat and height concerns. In fact, Pope et al. (2000) used the term *the Adonis Complex* to include the variety of body image and related disorders that currently affect males, and which are not limited to the desire to become more muscular.

Both the DMS (Sepúlveda et al., 2016b) and the MBAS (Sepúlveda et al., 2016a) have been validated in Spanish male populations, with good psychometric properties; through confirmatory factor analyses (CFA) a two-factor solution showed the best fit on each case. Also, the Muscular Appearance Satisfaction Scale (MASS; Mayville et al., 2002), designed from a conceptualization of MD as a subtype of BDD, was validated among Spanish men through exploratory factor analysis (EFA) at the first study, and through confirmatory analysis (CFA) at the second study, both with adequate psychometric properties (González-Martí et al., 2012). However, despite certain limitations associated with the MASS (Parent, 2013), it has been argued elsewhere that, when there is some knowledge of the underlying latent variable structure.

The Adonis Complex Questionnaire (ACQ; Pope et al., 2000) was originally developed to assess different body image disturbances among males, as well as their impact on daily life. However, it is rarely mentioned in the literature in discussions regarding specific instruments assessing this pathology (Compte and Sepúlveda, 2014; Parent, 2013). The ACQ is a scale of 13 Likert-type response items with three response alternatives depending of the items (e.g. frequency of behaviors or money spent). The answers are scored with 0, 1 or 3 points and scores between 0 (rarely or not at all) and 3 (frequently) in which high scores indicate a higher level of body image concerns (Baile et al., 2005). The first version of the ACQ in Spanish by Baile et al. (2005) evaluated the degree of concern for body image in a sample of male gym users in Mexico. However, it was only later that the psychometric properties of the scale were explored in a sample of 99 male Spanish gym users (Latorre-Román et al., 2015). Using an EFA, Latorre-Román et al. (2015) developed a three-factor structure with the following subscales: Psychosocial Effect of Physical Appearance, Control of Physical Appearance and Concern about Physical Appearance. The ACQ shows a good internal consistency (range between $\alpha = 0.70$ and $\alpha = 0.88$), and the three-factor structure explains 65.29% of the variance. In addition, the total score of the ACQ is related to dependence on physical exercise and ED symptoms. Given the scarce use of the ACQ in empirical research, though, its real validity as a measure of MD is not clear.

Across the shortage of specific instruments that explore MD, another instrument stands out, the Muscle Dysmorphic Disorder Inventory (MDDI; Hildebrandt et al., 2004), although it is not validated in Spanish. It is a questionnaire of 13 Likert-type items with a response range of 1 (never) to 5 (always), developed according to the four dimensions of the body image (i.e., perceptive, cognitive, affective and behavioral). Likewise, the MDDI is divided into three subscales: drive for size (DFS), appearance intolerance (AI) and functional impairment (FI). The DFS subscale refers to the perception of not being sufficiently muscular, looking small and the desire to increase body size. This subscale is associated with the characteristic thought pattern of people with MD (Pope et al., 1997). On the other hand, the AI subscale evaluates the presence of avoidance behaviors of displaying one's own body (e.g., wearing loose clothing). Finally, the FI subscale contains items related to maintaining a routine of excessive exercise, the discomfort of altering this behavior, and the avoidance of social situations. This last subscale fits with the DSM criterion about the negative impact of the disorder (APA, 2013). In the first development study of the questionnaire, conducted in a sample of male weightlifters (Hildebrandt et al., 2004), the instrument showed adequate reliability indexes (range between $\alpha = 0.77$ and $\alpha = 0.85$). The items explain 63.02% of the variance in the MDDI scores. Regarding subscales, the DFS subscale showed significant correlations with measures of drive for bulk and desired muscles. On the other hand, the AI subscale was associated with body dissatisfaction and anxiety, while the FI subscale was associated with episodes of overeating, use of supplements and excessive exercise time, and obsessive-compulsive features.

Subsequent studies have confirmed the psychometric properties of MDDI in other populations diagnosed with MD or anorexia nervosa (Murray et al., 2012), including bodybuilders or gym users (Hildebrandt et al., 2006; Murray et al., 2012) and undergraduate university students (including exercise and sports sciences students) (Hildebrandt et al., 2006; Murray et al., 2013; Hildebrandt et al., 2012; Lamanna et al., 2010). In 2012 Santarnecchi and Dèttore validated an Italian version, to date the only translation of the MDDI. In this study, the authors divided the sample of males among competitor bodybuilders, noncompetitors, and those who did not practice this activity. The three-factor structure was only confirmed in the group of competitors, with good reliability indexes, except on the AI subscale, which showed a low internal consistency. Recently, Galiana-Linares et al. (2017) carried out a validation into Spanish of the MDDI in a sample of 279 psychology students. Although this study shows adequate indexes of reliability in the three factors, it only explains 51.69% of the variance of the MDDI scores, below the mentioned results of the original author. The authors had to remove Item 5 of the questionnaire ("I think my breasts are too small") because it did not have an adequate saturation index (Galiana-Linares et al., 2017). These differences in the results may be due to the fact that the study sample was composed of 71.9% of women.

Despite the differences between the ACQ and the MDDI, both scales are considered adequate measures of body dissatisfaction in males and its possible impact on daily life (Hildebrandt et al., 2004; Latorre-Román et al., 2015). However, their use in both clinical and research is usually restricted to English-speaking countries (Tod et al., 2016). The Spanish-speaking community is huge, thus having versions validated in Spanish is necessary in the clinical area, to assist in the evaluation and treatment of people with potential MD problems in this population.

Therefore, the present study has two main objectives. On the one hand, it is aimed at providing a specific and widely used measure for MD for Spanish-speaking populations, such as the MDDI. On the other hand, to test through CFA the original three-factors proposal of Hildebrandt et al. (2004) for the MDDI and the three-factor model proposed by Latorre-Román et al. (2015) for the ACQ in a sample of male university students. Also, we evaluated the internal consistency of the Spanish version of the MDDI and the ACQ, and the validity of the two instruments by assessing the convergent (i.e., how the MDDI and

ACQ correlate with another similar measure of male body dissatisfaction (i.e., MBAS)) and concurrent (i.e., how the MDDI and ACQ correlate with other psychological variables such as muscularity-oriented eating disorders symptomatology (i.e. EDE-Q modified), obsessive-compulsive symptoms (i.e. OCI-R), weekly frequency of physical exercise (i.e. IPAQ-SF) validity. Thus, we expected that the scores of MDDI and the ACQ questionnaires would correlate positively with all the scales.

2. Method

2.1. Participants

A sample of 298 male students pursuing a degree in Physical Activity and Sports Sciences of the Technical University of Madrid were recruited. The age of the participants ranged from 18 to 28 years ($M = 21.17$, $SD = 2.94$), with two students over 28 years (33 and 47 years old). The BMI [weight (kg) / (height)^2 (m)] was based in self-report measures; scores were between 17.90 and 30.46 kg/m^2 ($M = 22.75$, $SD = 1.96$). About 157 of the participants did not practice sports activities at the competition level (52.7%), while 41.3% participated in national competitions and 6% in international competitions. The average of intense physical activity performed by the participants was 8.4 h per week ($SD = 7.7$ h per week).

2.2. Measures

Participants completed the MDDI and the ACQ and self-reported sociodemographic information on their age, course, nationality, height, weight, and sports level (i.e., non-competitor, national competitor and international competitor). Participants also reported if they had problems with their eating and if they had been diagnosed and / or treated for an eating disorder. In addition, they completed the following measures:

Male Body Attitudes Scale (MBAS; Tylka et al., 2005; Sepúlveda et al., 2016a). The MBAS measures body dissatisfaction in men and consists of 24 items on a Likert-type scale, with scores between 1 (i.e. never) and 6 (i.e. always). In the Spanish version of the questionnaire (Sepúlveda et al., 2016a) the two only items of the Height subscale were excluded. In the validation in the Spanish adolescent sample, the internal consistency levels for the total score of the MBAS were good ($\alpha = 0.86$), as well as for the subscales of Musculature ($\alpha = 0.85$) and Low Body Fat ($\alpha = 0.88$).

Eating Disorder Examination Questionnaire Modified (EDE-Qm; Fairburn and Beglin, 1994; Peláez-Fernández et al., 2012). The EDE-Q derives from the Eating Disorder Examination interview (EDE, Fairburn and Cooper, 1993). The questionnaire has 36 items, of which 22 measure attitudes related to eating disorders. The answers are collected on a Likert-type scale with scores between 0 (never) and 6 (every day), referring to the previous 28 days. The total score is obtained by the average of the scores of the four subscales (dietary restraint, eating concern, shape concern and weight concern); high scores indicate a greater degree of ED symptomatology. The remaining 14 items evaluate the presence and frequency of behaviors characteristic of an ED (e.g., use of laxatives or physical exercise). The Spanish version shows adequate levels of internal consistency (between $\alpha = 0.74$ to $\alpha = 0.91$). According to Murray et al. (2012), 11 items were added to the classic version of EDE-Q. These items are oriented to the obsession to increase musculature, which evaluates altered patterns of behaviors of males (e.g., increments of food quantities, concern to increase weight, concern for protein content and concern for the muscles), including anabolic-steroids use, and shows good internal consistency indexes ($\alpha = 0.87$).

Obsessive Compulsive Inventory Revised Short Version (OCI-R; Foa et al., 2002; Fullana et al., 2005). The short version has been translated into Spanish by Fullana et al. (2005) and consists of 18 items, designed to measure the severity of obsessive-compulsive symptoms. The responses are recorded on a Likert-type scale of 0 (i.e., not at all) to 4 (i.e., extremely). The range of total score is from 0 to 72, with the highest scores indicating the greatest severity of symptoms. The Spanish version has shown good internal consistency (range from $\alpha = 0.61$ to $\alpha = 0.86$), in a sample of university students.

International Physical Activity Questionnaire-Short Form (IPAQ-SF; Craig et al., 2003). The IPAQ-SF is a 7-item scale used in the evaluation of physical activity. The inventory is divided into four levels of activity (i.e. intense/vigorous physical activity, moderate physical activity, walking and sitting time). The scores are obtained by multiplying the duration of the physical activity per day by its weekly frequency and the intensity of a metabolically equivalent task (i.e., MET) (i.e. amount of oxygen consumed), for all activity levels except the sitting time. Physical activity is then calculated by adding the scores of the three activity levels, so that higher scores will indicate a higher level of physical activity. The translation into Spanish is obtained from the official IPAQ website (www.ipaq.ki.se).

2.3. Procedure

In order to obtain the Spanish version of the MDDI, a back-translation process, following international guidelines, was carried out (Muñiz and Bartram, 2007). A forward-to-back translation procedure was conducted for the MDDI by two bilingual researchers (RR and MB). Specifically, a researcher made a translation of the original English version into Spanish, while a second translated this version back into English. No significant discrepancies were found between the English translation and the original version.

Given the high proportion of male students, authorization to recruit students was requested from the Technical University of Madrid. This study below to an ongoing prevalence study in male university students, thus, the sample design was proportionally stratified according to academic year (first and fourth year), assuming a 95% confidence interval and 0.05 of sampling error. The study commenced once permission was granted by the University Dean and by the teachers of the different classes. Teachers from the participating university were then contacted by email to request authorization to administer a battery of questionnaires in the classroom. The students had the option of completing the self-administered battery of questionnaires in pencil-and-paper format or through an online tool; the battery of questionnaires in both formats took approximately 45–60 min. The sample was made up exclusively of students from classes whose teacher agreed to participate. In addition, the study was approved by the Ethics Committee of the Autonomous University of Madrid (CEI-75-1368). Informed writing consent was obtained from all participants and confidentiality was emphasized. The students were included in a raffle for a tablet.

2.4. Statistical analysis

All data are presented as mean ± standard deviation. The Kolmogorov-Smirnov test was used to assess normal distribution of the data; in all cases the null hypothesis of normal distribution was rejected. In addition, Mardia's test was computed to assess multivariate normality. The outcomes of the Mardia's test for the MDDI (Skewness = 76.31; Kurtosis = 313.67) and ACQ (Skewness = 171.56; Kurtosis = 449.23) were higher than 5. Therefore, non-parametric tests were applied.

A series of confirmatory factor analyses (CFA) were conducted to assess the underlying factor structure of the MDDI and the ACQ. The maximum likelihood method (MLM) estimation was used given the non-normal distribution of the data (Satorra and Bentler, 1994). Model fit was assessed using root mean square error of approximation (RMSEA) with its 90% confidence interval, comparative fit index (CFI), Tucker-Lewis Index (TLI), and standardized root mean square residual (SRMR). For the CFI and TLI, values above 0.95 are considered a good fit; and in the case of RMSEA and SRMR, values of < 0.06 were

expected (Hu and Bentler, 1999). A web platform (http://www.quantpsy.org/rmsea/rmsea.htm; Preacher and Coffman, 2006) was employed to compute the power level achieved with our data in each CFA model. The outcome showed a power level of 0.96 for both CFA models (MDDI and ACQ). The data included in the estimation were: degree of freedom = 61, sample size = 298, alpha = 0.05; null RMSEA = 0.05; alternative RMSEA = 0.10.

Internal consistency was calculated by Cronbach's alpha for all measures; according to Nunnally (1978), values above 0.70 were considered acceptable. In addition, Spearman coefficient was used to assess correlation among variables. According to the recommendations by Cohen (1992), correlations of 0.10 were considered small, correlations of 0.30 were considered medium, and correlations of 0.50 were considered large. Finally, Z-Fisher transformation was used to compare the correlation values among the studied variables and the MDDI and ACQ. Fisher's *z*-transformations were employed because simulation studies showed that using Spearman coefficients as Pearson coefficients for the standard Fisher's *z*-transformation is a more robust approach than other procedures (Myers and Sirois, 2004). *Z*-values higher than [1.96] are statistically significant (*p* < .05). Positive values depict a higher correlation between MDDI and validation measures in comparison with the correlation between ACQ and those measures. Negative values show higher correlations between ACQ and validation measures than the correlation between MDDI and those measures. All *p* values were two-tailed and the threshold for statistical significance was set at *p* < .05.

3. Results

3.1. Confirmatory factor analysis (CFA)

Fit statistics for each of the tested models are presented in Table 1. A model with three factors was computed for the MDDI. Specifically, the three factors estimated were: DFS = drive for size, AI = appearance intolerance, and FI = functional impairment, following the structure suggested by previous studies.

The original factorial structure of MDDI showed in our study a not acceptable model fit indexes (see Fig. A1). An inspection of the modification indexes (M.I. = 91.85) depicted a high correlation between Item 11 (*I pass up social activities with friends because of my workout schedule*) and Item 13 (*I pass up chances to meet new people because of my workout schedule*).

Therefore, we computed a second model allowing the correlation between both items; the fit indexes for this model were good (results are shown in Fig. 1). Note that factors were moderated correlated with the highest correlation value found between DFS and AI factors; both factors were lower related with FI factor. This last three-factors model was retained.

Regarding ACQ, the three-factor model suggested by Latorre-Román et al. (2015) through EFA showed a non-acceptable fit to the data. An exploration of MI (M.I. = 24.009) showed a high correlation between Item 1 *(How much time do you spend each day worrying about some aspect of your appearance [not just thinking about it, but actually worrying about it]?)* and Item 2 *(How often are you distressed by your appearance concerns [that is, feeling upset, anxious or depressed?).* The new model including the correlation between these items showed an acceptable fit (see Table 1). However, the three factors were highly
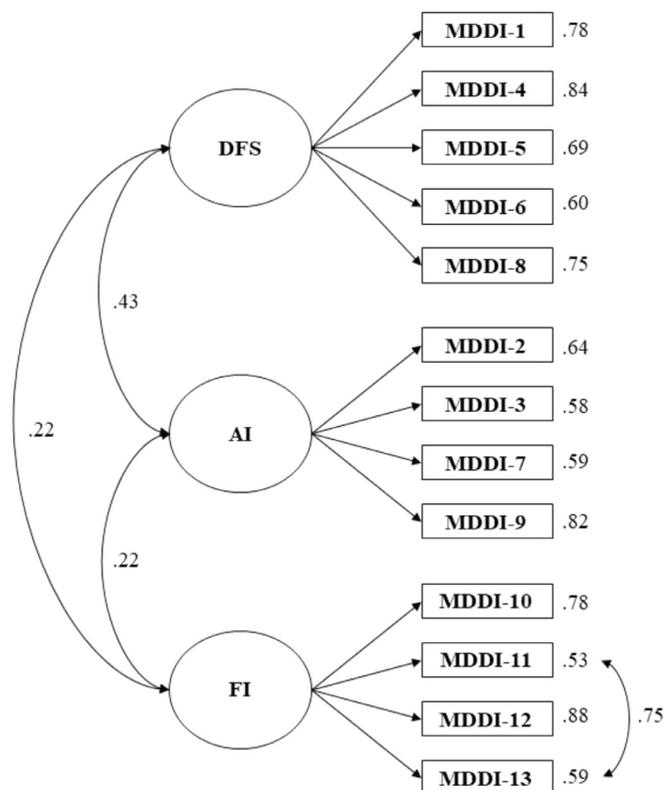

Fig. 1. Confirmatory factor analysis for the Muscle Dysmorphic Disorder Inventory (MDDI).

related to each other (see Fig. A1). A new model with a second-order factor was computed due to the high correlation between factors. Thus, the final model explored included a second-order factor (ACQ$_{total}$) and the correlation between Item 1 and Item 2. The results of fit indexes were equal to that presented in the previous model (see Table 1) and represent an improvement over the original model tested. This second-order factor model was finally retained (see Fig. 2).

3.2. Means scores, internal consistency, convergent and concurrent validity

Table 2 presents means scores, standard deviations and internal consistency for the used measures, and correlations among all evaluated variables. For the MDDI, adequate indexes were found for both total scale and the three subscales (between $\alpha = 0.73$ and $\alpha = 0.85$). The ACQ for its part, also has an excellent reliability index.

Table 2 also shows the associations between all measures. First, the mean score of the ACQ was moderately related with the total MDDI score (*rho* = 0.33, *p* < .01) and its subscales. Second, the MDDI scales were related to all measures employed for the validation of the scale, except with the frequency of physical activity. Regarding convergent validity, the highest correlation values were found between MDDI scales and the total MBAS and subscales (total MDDI and total MBAS, *rho* = 0.66, *p* < .01); the association between MBAS and MDDI-FI was lower (*rho* = 0.39, *p* < .01). In addition, regarding concurrent validity, the MDDI was also highly related with the muscularity-oriented eating

Table 1
Fit index values for the tested models.

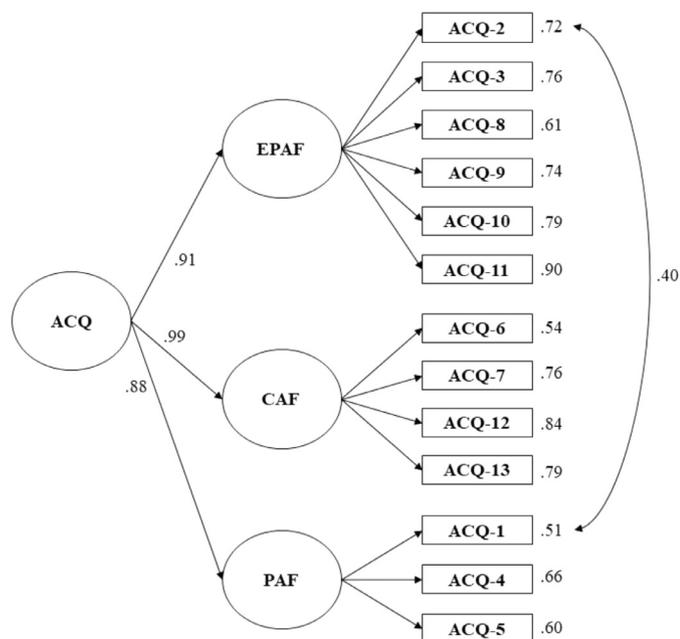| Models	RMSEA [C.I.; 90%]	CFI	TLI	SRMR
1. MDDI	0.088 [0.750–0.102]	0.876	0.844	0.073
2. MDDI with correlation between it11-it13	0.050 [0.034–0.066]	0.960	0.949	0.052
3. ACQ	0.081 [0.068–0.095]	0.906	0.882	0.057
4. ACQ with correlation between it1-it2	0.073 [0.059–0.087]	0.926	0.905	0.053

Fig. 2. Confirmatory factor analysis for the Adonis Complex Questionnaire (ACQ).

disorders symptomatology measured by the total EDE-Qm and its four subscales. The association between the MDDI with the obsessive-compulsive symptoms measured by OCI-R was also significant, but with a moderate value. Third, the associations between the ACQ and the validation measures were also positive and significant, although the magnitudes of the associations were lower than those obtained for the MDDI scales. For example, the convergent validity with the total MBAS mean score was low ($rho = 0.25$, $p < .01$) and with its subscales.

Table 3 depicts the results of Fisher's z-comparison. Fisher's z-transformation for repeated measures (Meng et al., 1992) was employed to determine if the magnitude of the correlation between MDDI with the other measures administered was equal to the correlations

between the ACQ and those measures (e.g., $r_{\text{MDDI-MBAS}} = 0.66$ vs $r_{\text{ACQ-MBAS}} = 0.25$). Overall, the correlation values between the MDDI scales and the validation measures were higher than the obtained for the ACQ with those measures. The main exception was the FI subscale of the MDDI, with similar correlation values to the ACQ with the other measures ($Z < 1.96$).

4. Discussion

The main goal of this study was to evaluate the factorial structure of the MDDI (Hildebrandt et al., 2004) and the ACQ (Baile et al., 2005; Latorre-Román et al., 2015), by CFA, in a representative sample of male university students of Physical Activity and Sports Sciences. In both cases, the questionnaires present adequate internal consistency, confirming in the case of the MDDI the factorial structure proposed by the original authors. The ACQ, on the other hand, shows goodness of fit indexes close to the level of acceptance, although not sufficient.

In particular, the results of the MDDI show that the three-factor model is appropriate and presents adequate fit indexes. It also presents excellent internal consistency indexes. Although our participant group of students of Physical Activity and Sports Sciences differs from those used in other research, mainly gym users (Hildebrandt et al., 2004; Santarnecchi and Dètorre, 2012), no differences were observed between different samples. The Italian version of the MDDI (Santarnecchi and Dètorre, 2012) offers similar results in terms of the reliability of both total scale and different subscales except the AI subscale, which shows a low internal consistency, although its sample size is questionable. The recent Spanish validation of Galiana-Linares et al. (2017) shows lower percentages of variance explained compared to other similar studies in a sample composed mainly of women. This may affect the results of a questionnaire aimed at capturing the corporal reality of males. In addition, it does not provide any data about the correlation with other instruments. Therefore, we still have an absence of an MDDI validation that may be useful for Spanish-speaking males. For its part, in connection with the original study by Hildebrandt et al. (2004), our Spanish version obtains similar reliability indexes, with slightly higher scores than the North American sample in the FI subscale. The present study, conducted in a sample composed exclusively of males is, as mentioned, the first to date to use a CFA to verify the factorial structure
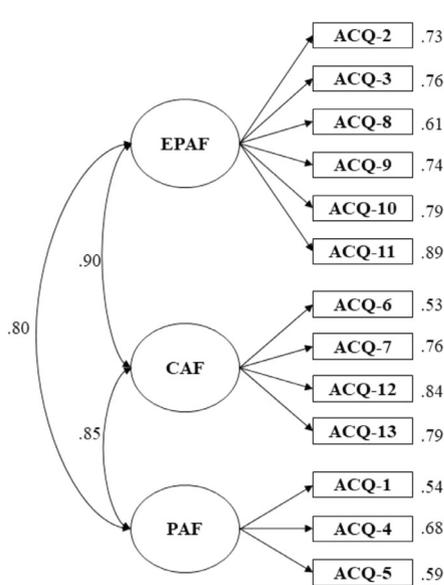
A.
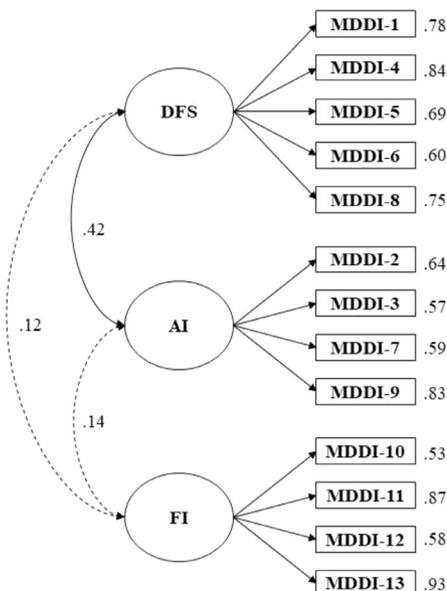
B.

Fig. A1. The initial proposal of factorial structure for the Muscle Dysmorphic Disorder Inventory (MDDI). (B) The initial proposal of factorial structure for the Adonis Complex Questionnaire (ACQ). The dashed lines depict a non-significant relationship between factors.

Table 2
Means (standard deviations, internal consistency for all measures, and correlations among variables.

	M (SD)	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
1. MDDI	23.17 (7.03)	**0.80**	.80**	.72**	.75**	.33**	.66**	.65**	.39**	.64**	.46**	.35**	.58**	.54**	.35**	.11
2. MDDI: DFS	10.11 (4.16)		**0.85**	.66**	.34**	.21**	.76**	.80**	.32**	.54**	.33**	.15**	.56**	.52**	.33**	−0.05
3. MDDI: AI	5.12 (1.99)			**0.73**	.42**	.20**	.67**	.51**	.58**	.58**	.38**	.40**	.58**	.49**	.27**	−0.04
4. MDDI: FI	7.95 (3.84)				**0.83**	.34**	.28**	.24**	.24**	.46**	.41**	.33**	.34**	.35**	.23**	.26**
5. ACQ	6.34 (6.69)					**0.90**	.25**	.23**	.12*	.35**	.35**	.18**	.26**	.24**	.15*	.25**
6. MBAS	4.27 (2.25)						**0.90**	.89**	.68**	.64**	.41**	.35**	.67**	.58**	.31**	−0.12*
7. MBAS: MF	5.90 (2.61)							**0.89**	.33**	.54**	.33**	.19**	.58**	.49**	.33**	−0.12*
8. MBAS: LFF	5.38 (1.93)								**0.85**	.50**	.37**	.49**	.47**	.42**	.21**	−0.08
9. EDE-Qm	0.92 (0.78)									**0.86**	.79**	.54**	.84**	.82**	.32**	.11
10. EDE-Qm: IFQ	1.32 (1.40)										**0.72**	.42**	.51**	.09	.21**
11. EDE-Qm: CPC	0.34 (0.62)											**0.71**	.45**	.41**	.25**	.00
12. EDE-Qm: CM	1.04 (0.92)												**0.74**	.72**	.39**	−0.03
13. EDE-Qm: CIW	0.79 (0.87)													**0.60**	.32**	.03
14. OCI-R	13.98 (8.70)														**0.84**	−0.01
15. IPAQ-SF: IA	4012.66 (3690.63)															**N. A.**

Notes: Cronbach's alpha are presented along the diagonal in bold. MDDI = Muscle Dysmorphic Disorder Inventory; DFS = drive for size; AI = appearance intolerance; FI = functional impairment; ACQ = Adonis Complex Questionnaire; MBAS = Male Body Attitudes Scale; MF = muscularity factor; LFF = low fat factor; EDE-Qm = Eating Disorder Examination Questionnaire Modified; IFQ = increment of food quantities; CPC = concern for protein content; CM = concern for the muscles; CIW = concern to increase weight; OCI-R = Obsessive Compulsive Inventory Revised; IPAQ-SF: IA = International Physical Activity Questionnaire-Short Form. Intense physical activity. N.A. = not applied. *$p < .05$ **$p < .01$

Table 3
Comparison of the correlations obtained between MDDI and validation measures (MBAS, EDEQ and OCI-R) with the obtained between the ACQ with the same measures.

	MDDI: Total vs ACQ	MDDI: DFS vs ACQ	MDDI: AI vs ACQ	MDDI: FI vs ACQ
MBAS	**7.30***	**9.25***	**7.00***	0.47
MBAS: MF	**7.41***	**10.74***	**4.26***	0.16
MBAS: LFF	**4.20***	**2.83***	**6.99***	1.83
EDE-Qm	**5.33***	**3.07***	**3.77***	1.86
EDE-Qm: IFQ	1.85	−0.30	0.45	1.00
EDE-Qm: CPC	**4.32***	−0.42	**3.19***	**2.35***
EDE-Qm: CM	**5.50***	**4.73***	**5.07***	1.28
EDE-Qm: CIW	**5.03***	**4.31***	**3.78***	1.75
OCI-R	**3.11***	**2.57***	1.68	1.23
IPAQ: Intense activity	**−2.12***	**−4.13***	**−3.97***	0.16

Notes. Fisher's z-transformation values higher than |1.96| are statistically significant ($p < .05$). Positive values depict a higher correlation for MDDI, and negative values show higher correlations for the ACQ.

of the questionnaire.

Regarding the ACQ, the theoretical structure proposed by the original author and its subsequent validation into Spanish, which found a three-factors factorial structure (Pope et al., 2000; Latorre-Román et al., 2015), was not confirmed in our sample. For the male student population of the present study, the ACQ shows correlations higher than 0.80 among the three factors, suggesting a second order one-factor structure. Although data did not present an acceptable fit, values for the fit indexes used were close to the acceptance cutoff scores proposed. With this one-factor structure, the ACQ shows an adequate level of internal consistency, with a Cronbach's alpha of 0.90, higher than the study of Latorre-Román et al. (2015) and higher than the MDDI in the sample of the present study.

Evidence for the convergent validity between the single-factor ACQ and the MDDI has been demonstrated through significant associations between the total and the subscales scores, although with low to moderate strength ($r = 0.20–0.34$). Concerning concurrent validity, in general the MDDI shows a greater association with the variables studied than the ACQ, with larger effect sizes. However, in the case of the level of intense physical activity measured through the IPAQ-SF, the ACQ shows higher levels of association than the MDDI. This may be due to the fact that both questionnaires explicitly refer to the time invested in certain behaviors, while the MDDI does not evaluate this aspect. The data therefore present sufficient evidence to support the construct validity of the MDDI. However, the difference in the factor structure puts into question the construct validity of the ACQ, which seems to present a single dimension related to general aspects of body dissatisfaction, not only related to the muscular level. The students of the Sports Sciences at the university that made up our sample were required to pass several exams that required, high academic performance, and significant physical and fitness performance. For these students, their body is a tool that allows them to develop correctly the activity and sports they practice. Previous studies suggested that athletes have been considered as a high-risk population for eating disorders given sport-related pressures toward weight and performance (Petrie et al., 2008). Therefore, levels of body dissatisfaction as measured by the MDDI were to be expected, but up to what extent this would have an impact in general appearance evaluation as captured by the ACQ was unknown.

Although MD is not currently conceptualized within ED, it has been observed that people with MD also alter their eating behavior to achieve their goal of muscle mass gain; it is therefore expected that the scores of MD questionnaires would correlate positively with the ED scales. In this regard, the scores of the MDDI correlate moderately to strongly with the scores in the modified version for MD of the EDE-Q questionnaire (Murray et al., 2012), both in the total score and in the different subscales related to the presence of eating alterations oriented to the musculature. Compared to the study of Murray et al. (2012), correlations between the MDDI and the modified EDE-Q are slightly lower. This may be related to the fact that the sample used by Murray et al. (2012) was formed by males with anorexia nervosa and MD, with male gym users as controls. However, some discrepancies should be noted with the study of Murray et al. (2012). The correlation between the MDDI DFS subscale and EDE-Q Eating Concern Modified (i.e., concern about proteins) in the first study is negative and very low, while in our study it is positive but also low. On the other hand, in our study the DFS subscale of the MDDI correlates strongly with the Weight Concern Modified subscale of the modified EDE-Q, unlike the results obtained by Murray and his team. The ACQ, on the other hand, only relates to the total score of the modified EDE-Q and the subscale Dietary Restraint Modified (i.e., increase of food). However, the power of the relationship is low.

According to the results obtained, the low correlations between both instruments indicate that, although there is a relationship between them, they measure different issues related to body dissatisfaction. Although both questions are useful to show the impact of body dissatisfaction on people's lives, the main difference is in the strength of

the correlation with other measures previously used and validated in this area. Although MD is currently considered a BDD, the MDDI shows a high association with measures of body dissatisfaction from the perspective of eating disorders, related to diet, body fat or muscle size, factors adjustable by physical exercise and eating behaviors. These aspects are also compatible with MD. The ACQ, for its part, includes more general aspects of male body dissatisfaction not related to diet or exercise.

The concept of the Adonis Complex (Pope et al., 2000) refers to general aspects related to male body dissatisfaction. Although MD is contemplated within this spectrum, the Adonis Complex goes further and includes other reasons for body dissatisfaction such as alopecia or penis size (Pope et al., 1997; Pope et al., 2000). However, there is confusion between the terms. In fact, the ACQ, although not presented as a measure of MD, is designed for this purpose (Baile et al., 2005). In a recent meta-analysis on MD symptomatology and associated traits that included a total of 31 empirical studies, it was observed that the use of MDDI was double the ACQ as a measure of MD assessment (Mitchell et al., 2017). In short, it is more useful to evaluate MD using specific measures such as the MDDI, instead of general measures of different aspects of male dissatisfaction such as the ACQ.

Despite its contributions, the present study is not exempt from limitations. First, the analysis sample consists exclusively of male university students completing a degree in Physical Activity and Sports Sciences. Although data were also taken from the female population, the number of women enrolled in these studies is low and its answers was not processed in this study. The particular academic load related to physical exercise and nutrition makes the sample of Sports Sciences students a population of interest for the study of MD (Bo et al., 2014). However, precisely these particularities can alter the epidemiological view of MD in the general university population. Thus, a sample from other careers would be helpful to evaluate the sensitivity of questionnaires in disciplines that have less relation to physical activity, body image, or nutrition. On the other hand, it should be noted that the sampling of this study is broad and representative of the population of students of the Degree in Physical Activity and Sports Sciences of the Technical University of Madrid. Given that the age of start of MD is around 18 years, studies in the university population are of particular interest in order to assess the magnitude of the problem related to male body image and alterations in eating behavior related to gaining muscle mass, as well as future preventive actions pertaining to these problems.

Few studies have explored the psychometric properties of the scales related to male body image or MD in Spanish speakers, making a confirmatory analysis of the factorial structure of the questionnaire (González-Martí et al., 2012; Sepúlveda et al., 2016a; Sepúlveda et al., 2016b). Despite the existence of a recent validation study of the MDDI in Spain (Galiana-Linares et al., 2017), the high proportion of women in the study may have altered the results of scales aimed at male body image. Thus, our research can provide a more specific view of males' reality in this area. The contributions of this study represent an advance in the use of adequate and reliable scales of MD measures in the Hispanic population, which in turn allows the possibility of carrying out cross-cultural studies with Spanish and Latin American samples.

Acknowledgments

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