



Universidad Autónoma
de Madrid

Biblos-e Archivo
Repositorio Institucional UAM

Repositorio Institucional de la Universidad Autónoma de Madrid

<https://repositorio.uam.es>

Esta es la **versión de autor** del artículo publicado en:
This is an **author produced version** of a paper published in:

Body Image 31 (2019): 24 – 34

DOI: <https://doi.org/10.1016/j.bodyim.2019.08.002>

Copyright: © 2019 Elsevier Ltd. All rights reserved. This manuscript version is made available under the CC-BY- NC-ND 4.0 licence

<http://creativecommons.org/licenses/by-nc-nd/4.0/>

El acceso a la versión del editor puede requerir la suscripción del recurso

Access to the published version may require subscription

Manuscript Details

Manuscript number	BODYIMAGE_2019_19_R2
Title	Assessment and Validation of a Spanish Version of the Muscle Dysmorphia Disorder Inventory in Argentinian Men who Exercise: Inventario de Dismorfia Muscular
Article type	Full Length Article

Abstract

Despite an increase in body dissatisfaction and muscularity concerns among Latin American men, there is a paucity of research relating to muscle dysmorphia in this population. In this study we aimed to evaluate, for the first time in Latin America, the factor structure of the Muscle Dysmorphic Disorder Inventory (MDDI). A sample of 551 men who exercise completed measures of body dissatisfaction, disordered eating, and the MDDI. Exploratory factor analysis in a first split-half sample revealed a 3-factor solution similar to the original version, which was then tested through confirmatory factor analysis (CFA) in a second split-half sample. A re-specified model (allowing for error correlations between items 10-13 and 11-13) presented adequate fit. Omega coefficients revealed adequate internal consistency ($> .80$) for the Drive for size and Functional Impairment subscales. The internal consistency for the Appearance Intolerance factor was .74 and .72 across subset samples. Associations with body dissatisfaction, disordered eating, body mass index, and frequency of training and rest days are presented as evidence of construct validity. Finally, multi-group CFA indicated that the model was invariant across type of exercise. Overall, these data suggest that the MDDI is suitable for use in Spanish-speaking Latin American male populations.

Keywords	Muscle dysmorphia; muscle dysmorphia disorder inventory; inventario de dismorfia muscular; male body image; Argentina
Corresponding Author	Emilio Compte
Corresponding Author's Institution	Favaloro University
Order of Authors	Emilio Compte, Jason Nagata, Ana R. Sepúlveda, Andrés Rivas, Lara S. Sbdar, Sol Menga, Robin Rica, Fernando Torrente, Stuart Murray

Submission Files Included in this PDF

File Name [File Type]

MDDI resubmission Cover Letter.docx [Cover Letter]
Comments responses.docx [Response to Reviewers (without Author Details)]
Highlights-R.docx [Highlights]
Title Page.docx [Title Page (with Author Details)]
Argentine MDDI - R2.docx [Manuscript (without Author Details)]
Table 1-R.docx [Figure]
Table 2-R.docx [Figure]
Table 3-R.docx [Figure]
Table 4-R.docx [Figure]
Table 5-R.docx [Figure]
Table 6-R.docx [Figure]
Table 7.docx [Figure]
Figure 1.docx [Figure]
Figure 2.docx [Figure]

To view all the submission files, including those not included in the PDF, click on the manuscript title on your EVISE Homepage, then click 'Download zip file'.

Research Data Related to this Submission

Data set <https://osf.io/q5be4/>

Argentinian MDDI

Argentine validation of the MDDI among men who exercise

Emilio J. Compte, PhD
Assistant Professor
School of Human and Behavioral Sciences
Favaloro University, Argentina
July 15th, 2019

Tracy Tylka, Ph.D.,
Editor-in-Chief
Body Image, An International Journal of Research

Dear Dr. Tylka,

RE: Assessment and Validation of a Spanish Version of the Muscle Dysmorphic Disorder Inventory in Argentinian Men who Exercise: Inventario de Dismorfia Muscular

Thank you for the opportunity to revise and resubmit our manuscript referenced above. We are grateful for the Associate Editor's and Reviewers' thoughtful comments, and we have endeavored to address all comments and queries in this revised manuscript. In particular, we have (i) gather extra *post hoc* data from a group of Argentinian men who exercise ($N = 31$) to assess the understanding of the translated version of the MDDI used, (ii) re-written the introduction, method and discussion sections in order to address all comments, (iii) further outlined the limitations presented by the non-clinical sample, and (iv) corrected all typographical errors and cumbersome language.

We have outlined our responses to the Reviewers' comments in the order these were presented (Please see Response to the Reviewers document attached).

Once again, we are grateful for the opportunity to present you with an improved manuscript as a result of these revisions, and we trust that we have adequately addressed the Reviewers' concerns. We hope that you will find this revised manuscript suitable for consideration as an Original Article in the *Body Image, An International Journal of Research*

Sincerely,

Emilio J. Compte, PhD
Assistant Professor
School of Human and Behavioral Sciences
Favaloro University, Argentina

Email: ecompte@favaloro.edu.ar

Associate Editor:

In line with suggestions by the Associate Editor the following modifications have been included in the manuscript:

- The final manuscript was carefully reviewed by two native English-speaking co-authors, in order to avoid spelling, word choice, and punctuation errors.
- Highlights were re-written in order to conform the journal's requirement.
- A detailed review of APA style requirements was conducted and changes has been done all over the manuscript, for example:
 - Spaces before and after “ = “, “ < “, etc., signs were included
 - All text has been left-justified
 - *N*, *n*, *df* have been italicized
 - A zero has been used only in front of the decimal place for numbers that are less than 1, but the value could exceed 1.
 - Changes in how statistical results have been reported have been conducted. For example $(\chi^2(78) = 1311.67, p < .001)$, has been changed to $(\chi^2(78, n = 272) = 1311.67, p < .001)$.
- Recent studies that have conducted psychometric evaluations of MDDI have been included in the Introduction section:
 - Sandgren, S. S., Giske, R., & Shalfawi, S. A. I. (2019). Muscle dysmorphia in Norwegian gym-going men. *Kinesiology*, 51(1), 12–21. <https://doi.org/10.26582/k.51.1.3>
 - Subaşı, B., Okray, Z., & Çakıcı, M. (2018). Validity and reliability of Turkish Form of Muscle Dysmorphia Disorder Inventory among elite bodybuilder men. *Anatolian Journal of Psychiatry*, (0), 47. <https://doi.org/10.5455/apd.298210>
- Other studies that have used translations of the MDDI but have not conducted psychometric evaluations have also been included:
 - Almeida, M., Campos, P.F., Gonçalves Moura Gomes, V.M., Neves, C.M., Carrenho Queiroz, A.C., Brito, Ç.C.J., Miarka, B., Caputo Ferreira, M.E., Carvalho, P.H.B. (2019). Muscle dysmorphia, body image disturbances and commitment to exercise: A comparison between sedentary and physical active undergraduate men. *Journal of Physical Education and Sports*, 19, 507-513. <https://doi.org/10.7752/jpes.2019.01074>
 - Khorramabady, Y. (2017). The Effect of Muscle Dysmorphia and Social Physique Anxiety on the Use of Supplements and Drugs. *Zahedan Journal of Research in Medical Sciences*, 19(9). <https://doi.org/10.5812/zjrms.13541>
 - Pourshahbaz, A., Nonahal, S., Dolatshahi, B., & Omidian, M. (2014). The Role of the Media, Perfectionism, and Difficulties in Emotion Regulation in Prediction of Muscle Dysmorphia Symptoms. *Practice in Clinical Psychology*, 2(2), 135–139. Retrieved from <http://jpcp.uswr.ac.ir/article-1-166-en.html&sw=Pourshahbaz>
- As suggested by the Associate Editor, a *post hoc* translation testing with weightlifters (*n* = 14) and CrossFit users (*n* = 17) was conducted in order to assess the understanding of the translated version of the MDDI.

- The reference of the published validation of the Brief-EDE-Q among Argentinian men has also been included:

- Compte, E. J., Nagata, J. M., Sepúlveda, A. R., Schweiger, S., Sbdar, L. S., Silva, B. C., ... Murray, S. B. (2019). Confirmatory factor analysis and measurement invariance of the eating disorders examination-questionnaire across four male samples in Argentina. *International Journal of Eating Disorders*, 52(6), 740-745. <https://doi.org/10.1002/eat.23075>

- As suggested by the Associate Editor, given that no analyses were conducted to suggest that the total score of the MDDI should be used, results pertaining MDDI total score have been removed.

Reviewer 1:

I have completed the review process for the manuscript title “Assessment and Validation of a Spanish Version of the Muscle Dysmorphia Disorder Inventory in Argentinian Men who Exercise: Inventario de Dismorfia Muscular”. This paper sought to validate a Spanish translation in Argentinian men of the Muscle Dysmorphia Disorder Inventory in two steps. In my opinion authors should did an initial study to translate the items and conduct an EFA to determine the factor structure of the newly created MDDI, therefore the second study will show the replication of the factor structure using an EFA and to assess the construct validity and various forms of reliability of the MDDI. I do have several concerns regarding the content and analyses that are outlined below.

OVERALL

1. Authors should very closely follow the details of the 6th edition of the APA style manual in preparing the revision (e.g. title, cites, times new roman...)

- A detailed review of APA style requirements was conducted and changes have been done all over the manuscript.

2. There are mistakes of writing in the manuscript, please check it before send a manuscript to a journal (lines 575, 649, 1034, 1086, 1152, 1169, 1272, Table 5, 6).

- The final manuscript was carefully reviewed by two native English-speaking co-authors, in order to avoid spelling, word choice, and punctuation errors.

SPECIFIC

3. Introduction

The authors should be more explicit in their hypotheses regarding the expected relationships between the MDDI subscales and the other measures selected to assess construct validity. They might consider specifying these hypotheses earlier (either in the introduction or in the measures section when they discuss each of the measures/scales).

- At the end of the closing paragraph of the introduction, we have included more explicit hypotheses regarding the expected relationships between the MDDI subscales and the other measures selected to assess construct validity.

Method

4. I recommend the authors to write a procedure into method section. The information of procedure on participants section is not clear (e.g. include a need for more detail regarding the procedure of administration of the scale, greater clarity about how participants were identified and recruited, description of how to interpret scores for measures, ...).

- A detailed procedure section was included in the Method section.

5. Authors administered an argentine version of the Brief-Eating Disorder Examination-Questionnaire which is not published yet. I don't know the psychometric properties of this version because the manuscript is in preparation by Compte et al. Consequently in this manuscript the validation process of MDDI there is only MBA instrument validated.

- During the review process of the current article, the Brief-EDE-Q validation paper has been published and the appropriate reference has been included:

- Compte, E. J., Nagata, J. M., Sepúlveda, A. R., Schweiger, S., Sbdar, L. S., Silva, B. C., ... Murray, S. B. (2019). Confirmatory factor analysis and measurement invariance of the eating disorders examination-questionnaire across four male samples in Argentina. *International Journal of Eating Disorders*, 52(6), 740-745. <https://doi.org/10.1002/eat.23075>

Results

6. I don't understand why the authors divided the sample for doing an EFA and CFA analysis. When you do an EFA is for knowing where factor loaded the items and if you have an item that doesn't work remove it, and then with the CFA you confirmed the factor structure of the final questionnaire. Authors administered the same questionnaire to the total sample and therefore they divided it for doing those analyses, in my opinion is wrong.

- Following Swami and Baron (2018), the EFA-to-CFA strategy has been used, as it is considered to be "effective at exploring the extent to which the source factor structure exists in a new population" (Swami & Baron, 2018, p.6). This is also consistent with best practices in scale development for health, social, and behavioral research suggested by Boateng et al. (2018). The sample was divided in two in order to follow the before-mentioned guidelines. Both Swami and Baron (2018) and Boateng et al. (2018) suggest that exploratory and confirmatory analyses should be performed in different samples. If a different solution would have been observed in the exploratory analysis, a different model would have been tested through confirmatory analysis (always using different samples, in order to follow the suggested guidelines).

7. In this sense the limitation that authors expose "Guidelines suggested by Swami and Barron (2018) recommend pre-testing any novel translation with a minimum sample of 30-40 respondents who are probed for their understanding of the items; however given that the design of the current study was previous to the publication of these guidelines, no pilot study on the understating of the items was conducted" is a very important impediment.

- Following suggestions from the Associate Editor, a *post hoc* translation testing with weightlifters ($n = 14$) and CrossFit users ($n = 17$) was conducted in order to assess the understanding of the translated version of the MDDI. Modifications in this regard have been included in the Method section.

8. Information about the measurement of BMI is needed. The first time that BMI appears in the manuscripts is on results section. I don't know if that measure is self-reported or measure by some researcher. Also Fat-Free Mass Index (FFMI) is the most common measure for assessing muscle dysmorphia. In this sense the statement of "Consistent with this, BMI was found to be negatively correlated to MDDI-DFS" may be a consequence of people who suffer from MD has a BMI higher because the mass muscle is heavy this is the reason to used FFMI instead BMI

- We agree with the reviewer in that BMI was not properly introduced. In the previous version of the manuscript, after the "Measures" heading (Method section) it was vaguely mentioned that participants completed self-reported data on current weight and height. In the revised version of the manuscript a more detailed description has been included: "In addition to the MDDI, participants completed socio-demographic data on age, self-reported weight and height (which was used to calculate BMI (kg/m^2)) ..."

- We also agree with the reviewer that the FFMI would be a more accurate index to assess in MD than BMI, as individuals with high muscle development could present a BMI commonly associated with obesity (>30). However, for the current study only self-reported weight and height were asked. Thus FFMI was not calculated as measures of body fat were not gathered. Nevertheless, the current study has targeted a community sample of men who exercise, and not a clinical sample of men with MD.

- On the other hand, male body image is a complex construct. While some men want to gain weight there are others who want to lose weight. In this line, Cafri et al (2005) suggested that "BMI is thought to be related to the pursuit of muscularity because a low body mass would suggest small size and, thus, a desire to get bigger and more muscular, while a high BMI might suggest a person who is excessively obese and thus looking to reduce body fat" (p. 226). In this regard, taking into consideration the content of items of the DFS (e.g., "*I wish I could get bigger*") and AI (e.g., "*I feel like I have too much body fat*") subscales, it was expected that BMI would present significant negative and positive correlations with DFS and AI subscales, respectively. Modifications in this regard have been included in the manuscript.

Discussion

9. How the authors analyses the convergent and divergent validation?

- On the one hand, in order to analyze the convergent and divergent validation, several measures had been included in the original version of the manuscript. For example, the EDI-Drive for thinness subscale had been considered to assess divergent validity for the MDDI-Drive for size subscale, etc. However, the inclusion of those measures was questioned given the lack of validation among Argentinian/Latino populations, and most of them were thus removed from the manuscript. Consequently, divergent validity was not able to be considered in the revised version. Unfortunately, Hispanic populations are under-represented in body image research, and many instruments are yet to be validated. The fact that there are limited measures validated in Hispanic populations is in a way a limitation for the current study, but also one of its major accomplishments.

-For the final version of the manuscript, only published measures validated in Argentinian males were included. A more detailed rationale of the inclusion of the Brief-Eating Disorders Examination Questionnaire (Brief-EDEQ) and the Male Body Attitudes Scale (MBAS) has been included in the Introduction Section. Briefly, both measures were included given previous associations between Muscle Dysmorphia, and disordered eating and body dissatisfaction. Given the content of the subscales items, high correlations between the MDDI-Drive for Size subscale and the MBAS-

Muscularity subscale, and between the MBAS-Low Body Fat and MDDI-Appearance Intolerance were expected. Also based on item content, disordered eating (Brief-EDEQ) was expected to show moderate to high correlations with both MDDI-Drive for size and MDDI-Appearance Intolerance, and less strength of correlation with the MDDI-Functional Impairment subscale. As mentioned above (in comment 8), self-reported BMI was also considered and a negative significant association was expected with the MDDI-Drive for Size subscale, and a positive significant correlation was expected with the MDDI-Appearance Intolerance. Finally, self-reported weekly frequencies of training sessions and resting days were considered to address convergent validity for the MDDI-Functional Impairment subscale. As expected, a positive significant correlation was observed between MDDI-Functional Impairment and weekly frequency of training sessions, and a negative significant correlation was observed between MDDI-Functional Impairment and weekly frequency of resting days.

- A detailed rationale for the use of the Brief-EDEQ, MBAS, self-reported BMI, and self-reported weekly frequencies of training sessions and resting days to assess the convergent validation of the MDDI was included in the Introduction and Discussion sections.

10. The discussion repeat the information of results, I recommend the authors to summarize it.

- The Discussion section has been modified in order to address the reviewer's previous comments, and also to reduce redundancy.

11. The authors should be more explicit in their hypotheses regarding the expected relationships between the MDDI subscales and the other measures selected to assess construct validity. They might consider specifying these hypotheses earlier (either in the introduction or in the measures section when they discuss each of the measures/scales).

- As mentioned in the previous comment, in order to address the reviewer's concerns modifications have been don all over the manuscript. This has included the expected relationships between the MDDI subscales and the other measures selected (i.e., Brief-EDEQ, MBAS, self-reported BMI, and self-reported weekly frequencies of training sessions and resting days).

Reviewer: 2

The present manuscript, entitled "*Assessment and Validation of a Spanish Version of the Muscle Dysmorphia Disorder Inventory in Argentinian Men who Exercise: Inventario de Dismorfia Muscular*" aims at validating a self-report questionnaire (the Inventario de Dismorfia Muscular) to assess Muscle Dysmorphia (MD) among Argentinian men who exercise. The study focuses on an important research topic.

Indeed, the validation of a self-report questionnaire to assess MD in Argentinian men who exercise is crucial for our understanding of MD in that population.

The manuscript is well written and I believe that it fits the aims of Body Image. I have a few concerns that might need to be addressed in a potential revision which I hope will help to improve the quality of the manuscript.

The manuscript is well written and I believe that it fits the aims of Body Image. I have a few concerns that might need to be addressed in a potential revision which I hope will help to improve the quality of the manuscript.

- We thank the reviewer for this comment and the suggestions made to our work. We hope these revisions have enhanced the final manuscript.

Abstract

Please correct the typo: Cross Fit gym users.

- It has been corrected.

Introduction

1) Page 2, lines 79-81: Please provide references for the statement: “it is well known that the nature of male body image is qualitatively different than female body dissatisfaction”. Furthermore, authors should talk about “male body image dissatisfaction” instead of “male body image”.

- As requested by the reviewer, references have been provided and the text was changed to male body image dissatisfaction.

2) Page 2-3, lines 111-130: When describe features of MD, please also include psychological and psychopathological features associated to MD such as low self-esteem, high perfectionism, and social anxiety. I direct the authors to the work conducted by Cerea et al., 2018 and Mitchell et al., 2017. Authors should include these references in their paper:

- Cerea et al., 2018. Muscle Dysmorphia and its Associated Psychological Features in Three Groups of Recreational Athletes. *Scientific Reports*, 8:8877;
- Mitchell et al., 2017. Muscle dysmorphia symptomatology and associated psychological features in bodybuilders and non-bodybuilder resistance trainers: A systematic review and meta-analysis. *Sports Medicine*, 47, 233-259.

- Both references have been included.

3) Page 3, line 130: Please provide the prevalence of MD in different settings such as general population and men who exercise (e. g., Babusa et al., 2015; Cerea et al., 2018). This will help in understanding the importance of developing a self-report questionnaire to assess MD.

- Given that there is no formal diagnostic criteria (and/or validated clinical interview), no formal epidemiological study on MD has been conducted. The estimated prevalence rates across previous studies are associated with a variety of methodologies, and differences across settings may also be due to the differences in the methodology used. In line with the reviewer’s comment, we believe that availability of the Argentinian validation of the MDDI would undoubtedly contribute to develop evidence-based knowledge on MD, including formal epidemiological studies. The fact that the underlying factor structure of the MDDI remains stable in all the validations conducted, despite the different methodological approaches used and the differences in populations assessed, gives the opportunity of developing further research aiming to arrive at a consensus regarding the conceptualization, clinical assessment, and treatment options of MD. Moreover, this would allow researchers to develop cross-cultural studies that could help identify specific sociocultural risk factors across different populations and race/ethnic groups.

4) Page 3, lines 130-134: The authors stated the importance of empirical inquiry of MD, particularly when considering the absence of empirically supported treatment options. I

do agree with the importance of empirical inquiry of MD, but I do not agree with the absence of supported treatment options for MD. Indeed, Cognitive Behavioral Therapy is an effective treatment option for both BDD and MD (e. g., modular interventions; Wilhelm et al., 2011). Please rephrase your sentence.

- We thank the reviewer for the reference. We agree with the reviewer that Cognitive Behavioral Therapy is an effective treatment option for BDD. However, to our knowledge no specific RCT in MD patients has been conducted. Despite that (according to DSM 5) MD is a form of BDD, treatment for MD individuals may require specific modifications specifically given the resemblance with ED. In this regard, Phillips et al. (2010) has suggested that: “Muscle dysmorphia also appears to have a number of notable, clinically significant differences from other forms of BDD that are important to its identification and treatment. Although treatment studies that focus specifically on muscle dysmorphia have not been done, clinical experience suggests that psychosocial treatment for BDD may need some modification for muscle dysmorphia. Indeed, muscle dysmorphia may be more closely linked than other forms of BDD are to eating disorders.” (Phillips, K. a, Wilhelm, S., Koran, L. M., Didie, E. R., Fallon, B. a, Feusner, J., & Stein, D. J. (2010). Body dysmorphic disorder: some key issues for DSM-V. *Depression and Anxiety*, 27(6), 573–91. <https://doi.org/10.1002/da.20709>).

5) Page 3, lines 141-145: The authors affirmed that weight-related concerns and behaviors may be more prevalent among non-white groups. Please explain why.

- We have mentioned that although previous research suggests ethnic/racial differences in weight-related concerns and behaviors, with non-white groups showing higher prevalence, most research on MD has been conducted among Caucasian English-speaking men. In this regard, and also highlighting the relevance of the current study, further research in broader cultural settings (e.g., Lantinamerican populations) is needed in order to improve our understanding of MD.

6) Page 4, line 207: Please clarify what kind of clinical population showed adequate internal consistency values of the MDDI.

- We would like to acknowledge the reviewer for this observation. The sentence “and in studies using this instrument in clinical populations (Murray et al., 2012)” has been removed given that the full MDDI in clinical research has been used in case reports (where is not possible to calculate internal consistency).

7) Page 4, lines 216-220: When explain that the MDDI is widely utilized to index symptoms severity in both clinical and community population of males please include the recent work conducted by Cerea et al., 2018.

- Cerea et al. (2018) has been included among the supportive references.

8) Page 5, lines 252: Please provide internal consistency values also for the non-competitive bodybuilders sample and for the non-training sample of Santarnecchi & Dettore.

- Santarnecchi & Dettore did not report internal consistency values for the non-competitive bodybuilders sample and for the non-training sample, which is why that information was not included in our manuscript.

- 9) Page 5, line 265: Include the percentage of the variance explained by the DFS subscale of the MDDI in the study by Later et al., 2017.
- Variance explained by the DFS subscale of the MDDI in the study by Galiana-Llinares et al. (2017) has been included in the manuscript.

Methods

Translation

- 1) Page 6, line 355: Authors should briefly explain how the translation by a committee procedure works.
- The description of the translation by committee process was already included in the manuscript. However, we have re organized the paragraph to ensure that the translation process is clearly described and easily understood.
- 2) Page 7, lines 383-384: Please correct the typo: “omitted for peer review, omitted for peer review”.
- Web link was omitted in order to ensure blind review.

Participants

- 1) Page 8, line 439: Please explain why authors decided to recruit participants from Cross Fit centers (e .g. higher prevalence of MD in that context).
- We have explained why CrossFit users were also considered in the introduction section: “Therefore, the aim of the present study was to validate the MDDI through an exploratory-confirmatory factor approach in two separate subset samples of Argentinian men who exercise, as physical exercise participation may increase the risk of MD (Cafri et al., 2005; Lantz, Rhea, & Cornelius, 2002; Suffolk, Dovey, Goodwin, & Meyer, 2013). In addition to weightlifters, men attending CrossFit centers were also considered in the present study, given the increasing participation in this type of physical training in Latin-American men over the last year (Sprey et al., 2016).”
- 2) Page 8 and 9, lines 453-497: How many participants took part in the study? Authors affirmed that 286 weightlifters and 279 Cross Fit users agreed to participate (total 565). Then authors explained that they excluded 14 participants from the study because they presented more than the 5% of missing data. But $565 - 14 = 551$ and not 552 as authors said.
- We would like to thank the reviewer for this observation. A typing mistake occurred, the final sample consisted in 551 participants as the reviewer pointed out. The manuscript was modified in this regards: “Fourteen participants presented > 5% of missing data and were thus excluded from the subsequent analysis. The final sample consisted of 551 participants, of whom 50.1% ($n = 276$) were weightlifters and 49.9% ($n = 275$) were CrossFit users. “
- 3) Page 9, lines 486-492: Authors should include age as a socio-demographic data like employment and educational status instead of considering it as a different variable.

- The paragraph was re-written in order to address an observation from other reviewer. Age has been listed among the socio-demographic variables.

Measures

- 1) Page 9, lines 507-509: Please correct the typo: “[...] employment and educational and employment status [...]”.
- It has been corrected.
- 2) Page 10, line 546: Please correct the typo concerning the Low Body Fat factor (MBAS-LBF) that has been expressed as MBAS-LBT.
- It has been corrected.

Results

- 1) Internal consistency and construct validity for the EFA and CFA subsample: Authors should include information about bivariate correlation only in Table 3. If authors decide to include bivariate correlations also in the text, they should describe each of them and not only some of them (e. g. the correlations pertaining the total score of the MDDI are not reported in the text even though they are significant).
- As suggested by the reviewer, information about bivariate correlations was limited to tables 3 and 5, no bivariate correlation has been included in the text. Also, as suggested by the Associate Editor, given that no analyses were conducted to suggest that the total score of the MDDI should be used, correlations and internal consistency results pertaining MDDI total score have been removed.
- 3) Page 17, lines 966-989: Authors should include sensitive analysis results in a table instead of in the text.
- As suggested by the reviewer, sensitivity analyses involving group comparisons (first split-half vs. second split-half subsamples) have been included in table 6.

Discussion:

- 1) Page 20, lines 1146-1150: I don't understand the meaning of this sentence. Please rephrase it.
- Given modifications in the discussion section the whole sentence has been removed.
- 2) Page 22, line 1279: Please explain and provide references for the high risk of Cross Fit users to develop MD. Furthermore, include as a limitation that the MDDI was not administered to a sample of bodybuilders. Indeed, literature studies underlined that bodybuilders are at high risk of developing MD.
- Modifications in this regard has been included in the discussion (limitations) section: “Given that weightlifters and CrossFit participants are considered among the populations at risk for MD, due to their involvement in physical activity (Cafri et al., 2005; Grieve, 2007), they may not be representative of the general male population, or other at risk populations such as bodybuilders, in Argentina or in Latin America.”
- 3) Page 22, lines 1283-1287: Authors affirmed that the MDDI is not sufficient on its own for a clinical diagnosis of MD. I do agree with that, but I don't understand why the absence of a clinical interview to confirm the diagnosis of MD should represent a limitation of the study: authors did not assess the presence of MD in the study.

- We acknowledge the reviewer this comment. This was beyond the scope and design of the current study. The sentence was removed.

4) Page 22, lines 1298-1310: Please provide clinical implication for the current study. For example, the importance of assessing MD features in Argentinian men who exercise.

- We agree with the reviewer that clinical implications for the currently study were not properly highlighted. Clinical implications of current findings have been included at the end of the introduction section: “In this regard, we believe that availability of the Argentinian validation of the MDDI would undoubtedly contribute to develop evidence-based knowledge on MD. The fact that, despite the different methodological approaches used and the differences in populations assessed, the original underline 3-factor structure of the MDDI remains stable across all studies (Hildebrandt et al., 2004; Sepúlveda et al., 2019; Zeeck et al., 2018) gives the opportunity of developing further research aiming to arrive to a more consensus conceptualization, clinical assessment, and treatment options of MD. Moreover, would allow researchers to develop cross-cultural studies that could help identify specific sociocultural risk factors across different populations and race/ethnic groups.”

5) Page 23, lines 1324-1330: I don't understand the last section of the sentence: “Future research may include additional Latin American populations such as female weightlifters or Cross Fit users, sexual minorities, a clinical sample of Spanish-speaking MD patients, and in other regions of Latin America”. Furthermore, authors should include as future perspective to administer the MDDI to a sample of bodybuilders.

- The sentence has been modified: “Future research may include additional Latin American populations such as female weightlifters or CrossFit users, sexual minorities, a clinical sample of Spanish-speaking MD patients, and bodybuilders, as a primary consideration.”

Tables:

Table 1: How did the authors categorize supplement use, professional supervision, injuries, higher education, and employment status? Are this information reported in the table as percentage or as means?

- In regards to how supplement use, professional supervision, injuries, higher education, and employment status were categorized, modifications have been included in the Measures section: “In addition to the MDDI, participants completed socio-demographic data on age, self-reported weight and height (which was used to calculate Body Mass Index (BMI; kg/m²)), weekly frequency of training and rest days, supplement intake use (yes/no), any occurrence of exercise-related injuries (yes/no), physical activity supervised by a health professional (yes/no), employment (currently working yes/no) and educational status (some degree of college education yes/no).”

-Table 1 summarizes group comparisons for quantitative and qualitative (Yes/No) data. Below the where sample sizes are reported it is specified that, depending on the nature of the data, results could be presented as either *M* (SD) / % (n). Also depending on the nature of the data, the statistical test used was Wilcoxon Rank Sum Test or ?? test. To guide readers when they should considered *M* (SD) or % (n), continuous variables were

listed first, and then categorical variables were enumerated. Also, we also assumed the differences in the number representing the statistical test between the Wilcoxon Rank Sum Test or χ^2 test would have helped readers understand the table. To enhance the understanding of table 1, a footnote has been included in each case indicating whether Wilcoxon Rank Sum Test or χ^2 test was used and then M (SD) or % (n) should be considered.

Table 6: Please correct the typo (weightliffers vs cross fit users).

- It has been corrected.

References:

There are mistakes in the references (e. g., Galiana-Llinares, L., Badenes-Rivera, L., Fuentes-Durán, M.C., 2017; Hayton, J. C., Allen, D. G., & Scarpello, V, 2004). Please correct them.

- All references were reviewed and corrected when necessary.

Other small typo:

Page 2: line 102 & line 115; page 3: line 124: Please correct the references: H. G. Pope, Gruber, Choi, Olivardia, & Phillips, 1997; C. G. Pope et al., 2005.

Page 3, line 130: Please insert a space.

- Initials for H.G. Pope and for C.G. Pope have been included following APA Style that suggest that for same last name authors initials should be included among the in

- Typing mistakes have been corrected.

Reviewer 3

Authors mentioned that *muscularity-oriented body image concerns are increasingly well documented*, but cited one paper only (*Compte et al., 2015*). Please include more references.

- More references have been included.

- Exploratory factor analysis revealed a 3-factor model similar to the original MDDI
- Confirmatory factor analysis of the re-specified 3-factor model showed adequate fit
- Measurement invariance was observed across different type of exercise

**Assessment and Validation of a Spanish Version of the Muscle Dysmorphia
Disorder Inventory in Argentinian Men who Exercise: *Inventario de Dismorfia
Muscular***

Emilio J. Compte, Ph.D.^{1, 2, 3 *}, Jason M. Nagata, MD.⁴, Ana R. Sepúlveda, Ph.D.⁵,
Andrés Rivas, Lic.², Lara S. Sbdar, Lic.², Sol Menga, Lic.², Robin Rica, M.Sc.⁵,
Fernando Torrente, Ph.D.⁶, Stuart B. Murray, Ph.D.¹

¹ Department of Psychiatry, University of California, San Francisco, San Francisco, CA, USA

² School of Human and Behavioral Sciences, Favaloro University, Buenos Aires, Argentina

³ DBT-Eating Disorders Team, Fundación Foro, Buenos Aires, Argentina

⁴ Division of Adolescent and Young Adult Medicine, Department of Pediatrics, University of California, San Francisco, San Francisco, CA, USA

⁵ Department of Biological and Health Psychology, School of Psychology, Autonomous University of Madrid, Madrid, Spain

⁶ Laboratory of Psychopathology Research, Institute of Cognitive and Translational Neuroscience (INCyT), INECO Foundation, Favaloro University, Buenos Aires, Argentina

* Corresponding Author:

Dr. Emilio J. Compte - School of Human and Behavioral Sciences, Favaloro University, Sarmiento 1853 (C1044AAA), Buenos Aires, Argentina. Email: ecompte@favaloro.edu.ar

Acknowledgements: Dr. Emilio J. Compte holds a postdoctoral fellowship at the University of California, San Francisco from the Fulbright Commission and the Argentine Ministry of Education. Dr. Jason Nagata is a Fellow in the Pediatric Scientist Development Program (NIH K12HD000850-33), with funding from the American Academy of Pediatrics (AAP) and the American Pediatric Society (APS).

Abstract

Despite an increase in body dissatisfaction and muscularity concerns among Latin American men, there is a paucity of research relating to muscle dysmorphia in this population. In this study we aimed to evaluate, for the first time in Latin America, the factor structure of the Muscle Dysmorphic Disorder Inventory (MDDI). A sample of 551 men who exercise completed measures of body dissatisfaction, disordered eating, and the MDDI. Exploratory factor analysis in a first split-half sample revealed a 3-factor solution similar to the original version, which was then tested through confirmatory factor analysis (CFA) in a second split-half sample. A re-specified model (allowing for error correlations between items 10-13 and 11-13) presented adequate fit. Omega coefficients revealed adequate internal consistency ($\geq .80$) for the *Drive for size* and *Functional Impairment* subscales. The internal consistency for the *Appearance Intolerance* factor was .74 and .72 across subset samples. Associations with body dissatisfaction, disordered eating, body mass index, and frequency of training and rest days are presented as evidence of construct validity. Finally, multi-group CFA indicated that the model was invariant across type of exercise. Overall, these data suggest that the MDDI is suitable for use in Spanish-speaking Latin American male populations.

Keywords: Muscle dysmorphia; muscle dysmorphic disorder inventory; inventario de dismorfia muscular; male body image; Argentina

Assessment and Validation of a Spanish Version of the Muscle Dysmorphic Disorder
Inventory in Argentinian Men who Exercise: *Inventario de Dismorfia Muscular*

Despite a pervasive increase in male body image dissatisfaction and disordered eating over recent decades, empirical research focusing specifically on males still represents less than 1% of the overall evidence base relating to body image (Murray et al., 2017). Notwithstanding this relative paucity of male-oriented body image-oriented research, it is well known that the nature of male body image dissatisfaction is qualitatively different than female body dissatisfaction (Murray et al., 2017). For instance, the ideal body image portrayed to females is typically thin and slender, whereas that portrayed to males is typically lean and muscular (Cohane & Pope, 2000; Murray et al., 2017). As such, up to 90% of college-age American males report a preference for a more muscular body ideal, as opposed to a thinner ideal body, and even boys as young as six years of age demonstrate a strong preference for a muscular body type (Baghurst, Carlston, Wood, & Wyatt, 2007).

Muscle dysmorphia (MD) represents the pathological extreme pursuit of muscularity, which is characterized by a pervasive belief/fear around insufficient muscularity, in concert with an elevated drive for muscularity, as it relates to muscular density or definition, or both (H. G. Pope, Gruber, Choi, Olivardia, & Phillips, 1997). Central to presentations of MD are pathological exercise and dietary practices, both of which are exclusively oriented towards the development of one's musculature, and an overvaluation of shape and weight (Murray, Rieger, Touyz, & de la Garza García, 2010). Importantly, MD has also been linked to (i) transdiagnostic shift across other eating disorder phenotypes (Olivardia, Pope, & Hudson, 2000), (ii) impaired mood and quality of life (H. G. Pope, Phillips, & Olivardia, 2000) and (iii)

elevated suicidality (C. G. Pope et al., 2005). It has also been suggested that those suffering from MD may persist with exercise despite injuries and recommendations to reduce or stop weight training (Murray & Baghurst, 2013).

MD was originally considered as the male analogue of anorexia nervosa, called *reverse anorexia* given the inverse direction of the symptoms (i.e., desire to increase body size) (H. G. Pope, Katz, & Hudson, 1993). Nevertheless, it was later conceptualized a subtype of the body dysmorphic disorders as individuals with MD “tend to be primarily concerned with achieving greater size and muscularity; they develop a primary focus on exercise with only a secondary focus on diet” (H. G. Pope et al., 1997, p. 551). However, subsequent research has shown similar features between MD and ED (Cerea, Bottesi, Pacelli, Paoli, & Ghisi, 2018; Murray, Rieger, et al., 2012; Murray et al., 2017). In keeping, a recent meta-analysis found that MD symptoms among bodybuilders and in non-bodybuilder resistance trainers are associated with anxiety, social physique anxiety and depression, personality traits such as neuroticism and perfectionism, and inversely associated with self-concept and self-esteem (Mitchell, Murray, Cobley, et al., 2017) – a constellation of traits also seen in those with ED (Núñez-Navarro et al., 2012).

Of note, almost all empirical research pertaining to clinical presentations of MD has emanated from samples comprising Caucasian males in the United States or Australia (Murray et al., 2017). In contrast, broader epidemiological surveillance in the United States suggests that weight-related concerns and behaviors may be more prevalent among non-white groups (Neumark-Sztainer et al., 2002), and the investigation of MD symptomatology in broader cultural settings has been outlined as a key target for the further development of the current evidence-based knowledge (Murray et al., 2017). Of particular note, evidence in Latin American populations

suggests a pervasive perceived pressure among males to acquire vast musculature (Mellor, McCabe, Ricciardelli, & Merino, 2008). Perhaps most notably, emerging evidence in Argentina suggests that muscularity-oriented body image concerns among male college-age students are comparable to the rate of eating disorder presentations in female college-age students (Compte, Sepulveda, & Torrente, 2015). As such, the need for validated measures of clinical MD and muscularity-oriented psychopathology in Latin American nations is clear, since research into these clinical populations has been stymied by the absence of systematic research validating gold standard symptom measures.

The Muscle Dysmorphic Disorder Inventory (MDDI) (Hildebrandt, Langenbucher, & Schlundt, 2004) is considered the gold standard symptom measure for MD symptomatology, and has been broadly used in clinical studies across English speaking nations (e.g., Murray et al., 2012). In the development of this instrument, a principal component analysis (PCA) revealed an underlying structure with 3 dimensions, named *Drive for size* (DFS; 5 items; 28.50% explained variance), *Appearance intolerance* (AI; 4 items; 18.34% explained variance), and *Functional Impairment* (FI; 4 items; 16.19% explained variance). The DFS measures a desire to increase the size of specific body parts, the AI subscale captures body dissatisfaction as well as avoidance associated with appearance, and the FI subscale was designed to address the impairment associated with the symptoms of MD. Adequate internal consistency was demonstrated across all subscales and total MDDI score in this original validation paper (Cronbach's $\alpha = .77-.85$) (Hildebrandt et al., 2004). Importantly, while the MDDI was initially developed in a community sample of male weightlifters, it has since been widely utilized to index symptom severity in both clinical and community populations of males engaging in a broad array of exercise

practices (Cerea et al., 2018; Hildebrandt, Alfano, & Langenbucher, 2010; Mitchell, Murray, Hoon, et al., 2017; Murray & Griffiths, 2014; Murray, Maguire, Russell, & Touyz, 2012; Wolke & Sapouna, 2008).

Over recent years, and in conjunction with the widespread use of the MDDI in English-speaking populations, several attempts to validate the MDDI across different populations have been conducted. Firstly, Santarnecchi and Dèttore (2012) proposed an Italian version of the MDDI, utilizing samples of competing ($n = 60$) and non-competing ($n = 60$) bodybuilding males, as well as non-training males ($n = 60$). Also through PCA, the competitive bodybuilder sample showed an underlying structure similar to the one described by Hildebrandt et al (2004). However, despite adequate levels of internal consistency for the DFS and FI subscales and MDDI total score (Cronbach's $\alpha = .80 - .85$), the AI subscale failed to present acceptable internal consistency (Cronbach's $\alpha = .45$). For non-competing bodybuilders and non-training subjects, PCA revealed two different 4 dimension solutions in the Italian validation of the MDDI (Santarnecchi & Dèttore, 2012). Later, Galiana-Llinares, Badenes-Rivera, & Fuentes-Durán (2017) conducted an Exploratory Factor Analysis (EFA) on the MDDI in a sample of Spanish psychology university students ($N = 279$), of whom 72.4% were women. In this study, a similar underlying structure was found among Spanish psychology students, although the DFS subscale accounted for the least percentage of variance explained among factors (19.38%), contrary to what has been observed in the original MDDI (Galiana-Llinares et al., 2017). However, the validity of using a predominantly female psychology undergraduate sample to validate an instrument designed to assess the pathological pursuit of muscularity has been questioned (Sepúlveda, Rica, Moreno, Román, & Compte, 2019). More recently and also through PCA, a similar factor solution was observed among 176 Turkish elite

bodybuilder men, where levels of internal consistency (Cronbach's alpha) ranged from .76 to .84 across subscales (Subaşı, Okray, & Çakıcı, 2018).

Further, two studies have conducted a confirmatory factor analysis (CFA) to confirm the original 3-factor underlying structure of the MDDI. In a German validation, Zeeck et al. (2018) replicated the original factor structure among people who exercise ≥ 3 times a week (53% women), recruited from interest groups (fitness, bodybuilding) in social media. The German version was found to be invariant across genders, and presented adequate levels of internal consistency across subscales of the MDDI (Cronbach's alpha = .75-.84) (Zeeck et al., 2018). Recently, Sepúlveda et al. (2019) have also found supportive evidence for the original 3-factor solution among Spanish male university students studying Sports Sciences, with also adequate levels of internal consistency (Cronbach's alpha = .75-.84).

Other studies have used translations of the MDDI but have not conducted psychometric evaluations (Campos, Holden, Baleizão, Caçador, & Fragata, 2018; Khorramabady, 2017; Pourshahbaz, Nonahal, Dolatshahi, & Omidian, 2014). For instance, Khorramabady (2017) conducted a Persian translation of the MDDI and assessed the content validity of the scale among 438 bodybuilders in Hamedan, Iran. Also, a Portuguese version was used among 265 undergraduate men in Brazil where an overall internal consistency (Cronbach's alpha) of .74 was reported.

Simultaneously, recent guidelines suggest cross-cultural adaptations of symptom measures to first conduct a principal-axis EFA, followed by a CFA in separate subset samples of the same sample of a determined population (Boateng, Neilands, Frongillo, Melgar-Quinonez, & Young, 2018; Swami & Barron, 2018). In line with this, a recent study among Norwegian gym-going men ($N = 124$) has provided evidence for the original 3-factor structure through a combined exploratory-

confirmatory approach; however, with PCA and CFA analyses conducted over the same sample (Sandgren, Giske, & Shalfawi, 2019).

The validation of this instrument in Spanish is necessary to allow for greater scope of research inquiry in Spanish speaking populations, where muscularity-oriented body image concerns are increasingly well documented (Behar & Molinari, 2010; Compte et al., 2015 Lima, Moraes, & Kirsten, 2010). Alarming, recent evidence suggests that the prevalence of MD symptomatology observed among male Hispanic American university students (Compte et al., 2015) and weightlifters (Behar & Molinari, 2010) are similar to the 12-month prevalence of those suffering from any mental disorder in this population (Stagnaro et al., 2018). Therefore, the aim of the present study was to validate the MDDI through an exploratory-confirmatory factor approach in two separate subset samples of Argentinian men who exercise, as physical exercise participation may increase the risk of MD (Cafri et al., 2005; Lantz, Rhea, & Cornelius, 2002; Suffolk, Dovey, Goodwin, & Meyer, 2013). In addition to weightlifters, men attending CrossFit centers were also considered in the present study, given the increasing participation in this type of physical training in Latin-American men over the last year (Sprey et al., 2016).

Given the consistent findings across studies, a 3-factor structure similar to Hildebrandt et al. (2004) was expected to be described and confirmed, by exploratory and confirmatory factor analyses. Further in keeping with emerging findings, body dissatisfaction and disordered eating measures were expected to be more associated with the DFS and AI, since these items focused on appearance (e.g., body size, body fat, body exposure). In addition, FI was expected to be associated with frequency of training sessions and resting days, as items are focused on distress during off-training days and social impairment due to training schedule. Also, based on previous

evidence suggesting that a low BMI “would suggest small size and, thus, a desire to get bigger and more muscular” (Cafri et al. 2005, p. 226), a negative association between DFS and BMI was to be expected. Finally, we expected that, regardless of potential differences between training activities, the underlying factor model would remain invariant across weightlifters and CrossFit users.

Method

Translation

In order to validate a Spanish-language version of the MDDI suitable for different Spanish-speaking/Hispanic populations, and in keeping guidelines from the International Test Commission (2017), combined translation techniques were used in this study. Team members in Argentina conducted a translation by committee procedure, and a back-translated version of the MDDI conducted in Spain by Sepúlveda et al. (2019) was also considered. Briefly, for the translation by committee procedure (McKay et al., 1996) two bilingual researchers in Argentina carried out separate English-to-Spanish translations, and then compared and reconciled their translations. Also, for the back-translation procedure (Muñiz & Bartram, 2007) conducted in Sepulveda et al. (2019), a bilingual researcher made a translation of the original English version into Spanish while a second bilingual team member translated the Spanish version back into English, and finally both English versions were compared in terms of conceptual meaning. For the purpose of this study, two experienced researchers and clinicians in the body image field (ARS, EJC) compared and reconciled both versions (derived from the translation by committee and the back-translation approaches). Minor differences were observed between the Argentinian and the Spanish translated versions of the MDDI. For example in item 5 “*I think my*

chest is too small”, in the Spanish back-translation procedure the word *small* was translated as “*pequeño*”, and in the Argentinian translation by committee procedure it was translated as “*chico*”. Both words have similar uses in Spain and Argentina, however “*pequeño*” has been considered to be less ambiguous for both populations. A *post hoc* assessment of the translated version of the MDDI was conducted among 14 weightlifters ($M_{\text{age}} = 26.65$, $SD_{\text{age}} = 5.56$) and 17 CrossFit users ($M_{\text{age}} = 31.93$, $SD_{\text{age}} = 10.59$). These participants were asked to rate each item for understanding on a 5-point scale (1 = *do not understand at all*, 5 = *understanding completely*). The mean responses per item were then assessed (overall $M = 4.46$, $SD = 0.33$, range = 3.62–5.00). The Spanish-speaking items of the final translation used in the present study are reported in Table 1.

Procedure

In determining sample size for the EFA, guidelines to recruit as large a sample as possible were followed, given that accurate sample adequacy is best determined after data analyses (communalities $\geq .50$) (Swami & Barron, 2018). However, prior to the analysis, a minimum sample size of 260 participants was considered suitable, offering a 20:1 ratio per item (Hair, Black, Babin, & Anderson, 2014). In determining sample size requirements for the CFA, guidelines to estimate power according to the Root Mean Square Error (RMSEA) of approximation of the model were followed (MacCallum, Browne, & Sugawara, 1996). To this end, a minimum sample size of 209 participants was required for a power of .80, a RMSEA value of .05, and an alpha level of .05.

Participants were recruited from fitness centers that were advertised as either weight-lifting and/or CrossFit centers, which were chosen at random in Buenos Aires

City and two major suburban districts located north and south of Buenos Aires City, respectively. Participants were required to be male and ≥ 18 years of age. Permission to approach potential participants was requested from all of the weightlifting/CrossFit centers. Three members of the research team (LSS, SM, AR) approached candidates after their training sessions for a face-to-face assessment. The study followed the ethical guidelines of the Declaration of Helsinki and was approved by Favaloro University. All participants were required to read and sign an informed consent form.

Participants

Permission was obtained in 18 of the 21 randomly selected weightlifting centers (85.7%) and the study was presented to 408 weightlifters, of whom 286 (70.1%) agreed to participate. Also, permission was obtained in 16 of the 20 randomly selected CrossFit centers (80.0%) and the study was presented to 383 CrossFit users, of whom 279 (72.9%) agreed to participate. Of the total sample, 14 participants had $> 5\%$ of missing data and were thus excluded from the subsequent analysis. The final sample consisted of 551 participants, of whom 50.1% ($n = 276$) were weightlifters and 49.9% ($n = 275$) were CrossFit users. A 0.002% of missing values was observed, and the nonparametric test of homoscedasticity suggested that the mechanism was consistent with missing completely at random ($p = .567$). Data imputation was performed using multivariate imputation by chained equations. Sociodemographic features for the weightlifter sample, the CrossFit users sample, and the total sample are presented in Table 2. Given the lack of differences in key sociodemographic variables, participants were then considered as a large sample of men who exercise and were randomly divided into a first split-half ($n = 275$) and a second split-half ($n = 276$) subsample, in a 1:1 ratio.

Measures

In addition to the MDDI, participants completed socio-demographic questions on age, self-reported weight and height (which was used to calculate the BMI (kg/m^2)), weekly frequency of training and rest days, supplement use (yes/no), any occurrence of exercise-related injuries (yes/no), physical activity supervised by a health professional (yes/no), employment (currently working yes/no) and educational status (some degree of college education yes/no). Additional measures included:

Male Body Attitudes Scale (MBAS; Tylka, Bergeron, & Schwartz, 2005; Argentine version: Compte, Sepúlveda, de Pellegrin, & Blanco, 2015) is a 22-item self-report instrument that measures males' attitudes toward their bodies. Item responses are a Likert-type 6-point scale (1 = *never*, 6 = *always*), with higher scores denoting more body dissatisfaction. The Argentine validation confirmed a 2-factor structure, with 10 items loading in the *Muscularity* concern factor (MBAS-M; e.g., *I think I have too little muscle on my body*), 8 items loading in the *Low Body Fat* factor (MBAS-LBF; e.g., *Has eating sweets, cakes, or other high calorie food made you feel fat or weak?*), and a total score including other 4 items of general body image concerns (MBAS Total Score; e.g., *Has seeing your reflection (e.g., in a mirror or window) made you feel badly about your size or shape?*). Adequate levels of internal consistency were observed among Argentinian college men (Cronbach's $\alpha = .91$) for both subscales and total score of the MBAS. Also, the MBAS-M and the MBAS-LBF were found to be strongly correlated with the *Drive for Muscularity Scale* (McCreary & Sasse, 2000) and the Dieting Subscale from the *Eating Attitudes Test-26* (Garner, Olmsted, Bohr, & Garfinkel, 1982), respectively among Argentinian men (Compte et al., 2015). Internal consistency in the current study is reported in Table 3

for the first split-half sample (EFA) and in Table 5 for the second split-half sample (CFA).

Brief-Eating Disorder Examination-Questionnaire (Brief-EDE-Q; Fairburn & Beglin, 1994. Argentine version: Compte et al., 2019) is a widely used questionnaire for assessing ED, where 22 attitudinal items are divided into four subscales and a Global Score. The answers are rated on a 7-point Likert-type scale, in a time frame of 28 days, with higher scores indicating higher eating pathology. Despite its broad use, further research failed to support the theoretical 4-factor structure, and several models have been tested among different female populations. A recent study among four community male samples in Argentina failed to support previous models for the whole 22-items version of the EDE-Q, and supportive evidence for an 8-item single-factor model invariant across samples was described (Compte et al., 2019). Adequate levels of internal consistency was observed across the male samples ($\omega = .86-.91$). The Brief-EDE-Q consist of eight Weight Concern and Shape Concern items, which reflect constructs considered to be core to the psychopathology of eating disorders (Allen, Byrne, Lampard, Watson, & Fursland, 2011; Wade, Byrne, & Bryant-Waugh, 2008). Internal consistency in the current study is reported in Table 3 for the first split-half sample (EFA) and in Table 5 for the second split-half sample (CFA).

Data Analysis

The R software package (version 3.4.4) was used to conduct the analyses. Continuous variables were categorized as mean \pm SD or as median (interquartile range [IQR]) and categorical variables as frequency and percentage. The mechanism of missing data was examined using the nonparametric test of homoscedasticity from

the *MissMech* package (Jamshidian, Jalal, & Jansen, 2014). Missing data imputation was performed using the *Mice* package (Buuren & Groothuis-Oudshoorn, 2011). The *MVN* package (Korkmaz, Goksuluk, & Zararsiz, 2014) was used to assess multivariate normality through the Mardia's multivariate test across samples.

Given that the assumption of multivariate normality was not fulfilled in the first split-half subsample (Mardia's test of multivariate kurtosis was 31.38, $p < .001$), EFA was based on principal-axis factoring (Fabrigar, Wegener, MacCallum, & Strahan, 1999). Given that factors were assumed to be correlated, the Oblimin rotation was used. The Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity were used to determine if the data was appropriate for the analyses. Values of KMO $> .6$ and significant results in Bartlett's test were expected (Worthington & Whittaker, 2006). Extracted components were judged to be adequate when their eigenvalues exceeded 1.0 (Kaiser's criterion), and after examination of scree plot. In addition, parallel analyses (Horn, 1965) were conducted to confirm the number of factors to retain. Briefly, parallel analysis works by creating a random dataset with the same number of cases and variables as the actual dataset. Factors in the actual data are only retained if their eigenvalues are greater than the eigenvalues from the random data (Hayton, Allen, & Scarpello, 2004). Items were retained if they had an item-factor loading of at least .40 on a primary factor and cross-loadings $\leq .25$ on other factors (Tabachnick & Fidell, 2001). The *psych* (Revelle, 2018) and *hornpa* (Huang, 2015) packages were used to conduct these analyses.

The sample size calculation for the CFA was conducted using the *WebPower* (Zhang & Yuan, 2018) package. A CFA of the EFA model was conducted for the second split-half subsample. Given that the assumption of multivariate normality was not fulfilled (Mardia's test of multivariate kurtosis was 35.48, $p < .001$), the CFAs

were based on robust maximum likelihood estimation method with the Satorra-Bentler χ^2 scaled correction (Satorra & Bentler, 1994). Items were set to load freely, except for one item per factor, which was set to 1 to ensure an identified model. To evaluate the model the following robust fit indices were analyzed: comparative fit index (CFI), the Tucker-Lewis index (TLI), the Standardized Root Mean Square residual (SRMR), and the Root Mean Square Error of Approximation (RMSEA) with its 90% Confidence Interval. Values ≤ 3.00 for χ^2/df , CFI and TLI values close to .95, and SRMR values close to .08 were indicative of good fit. For the RMSEA, values close to .06 were indicative of good fit and values of about .07-.08 were indicative of adequate fit (Hu & Bentler, 1999; Swami & Barron, 2018). In addition, based on modification indices and given the highly similar wording, the model was re-specified allowing for covariance between the residual values in the following paired items: 10-13 and 11-13 (FI subscale). A scaled Chi-square difference test ($\Delta\chi^2$) was used to directly compare the original and re-specified models (Satorra & Bentler, 2001). The *Lavaan* (Rosseel, 2012) and *semPlot* (Epskamp, 2013) packages were used to conduct and represent the CFAs analyses.

Given the Likert-type nature of the used measures, internal consistency was assessed through the Omega coefficient and its 95% CI (Dunn, Baguley, & Brunsten, 2014); values of $\geq .80$ were considered adequate (Nunnally, 1976). Spearman's Rank Order Correlation coefficient was used to assess associations among studied variables. Following Cohen (1988), values of $r_s \geq .10$ were considered weak, $r_s \geq .30$ were considered moderate, and $r_s \geq .50$ were considered strong correlations.

As sensitivity analyses, Wilcoxon Signed-Rank and Chi-square tests for group comparisons between first split-half and second split-half subsamples were conducted, with the Bonferroni adjustment for multiple group comparisons. Also, a

multi-group CFA (Chen, 2007) for the CFA re-specified model was conducted to assess measurement invariance at the configural, metric, and scalar levels between weightlifters and CrossFit users. Configural invariance implies that the hypothesized factor structure is the same across groups (if this model does not fit the data, then measurement invariance does not hold at any level). Metric invariance implies the unstandardized factor loadings of each indicator are equal across the groups, and scalar invariance implies that both the item loadings and item intercepts are similar across groups. Both metric and scalar invariances are tested by comparing two nested models that are identical except for a target set of restrictions in one on them. $\Delta CFI < .01$ was considered as an indicator of metric invariance, and scalar invariance supported when $\Delta CFI < .01$ and $\Delta RMSEA < .015$ or $\Delta SRMR < .030$ (Chen, 2007; Cheung & Rensvold, 2002). The *psych* (Revelle, 2018) and *Hmisc* (Harrell, 2008) packages were used for descriptive and bivariate statistics, and the *semTools* (Jorgensen, Pornprasertmanit, Schoemann, & Rosseel, 2018) package was used to assess model invariance. Finally, a two-tailed threshold of $p < .05$ was considered. All data and analytic scripts are openly available and can be accessed at (link omitted for peer review).

Results

Exploratory Factor Analysis

An EFA for the first split-half subsample ($n = 275$) was conducted. The KMO index was .78, the Bartlett's test of sphericity was significant ($\chi^2(78, n = 275) = 1311.67, p < .001$), and the mean communality of 6.50 was $\geq .50$, suggesting that data and sample size were adequate for the analysis. Results from parallel analysis suggested the presence of 3 factors (see Figure 1); only the first 3 factors from the actual data had λ greater than the criterion λ (i.e., $\lambda_1 = 4.19 > 1.43$; $\lambda_2 = 1.95 > 1.35$;

$\lambda_3 = 1.72 > 1.26$). The fourth factor derived from the actual data had a λ that was lower than the corresponding criterion λ generated by the parallel analysis (i.e., $\lambda_4 = 0.86 < 1.26$). A 3-factor solution that accounted for the 50.0% of the variance was observed. The first factor observed (*Drive for Size*; DFS) explained the 20.1% of the variance, the second factor (*Appearance Intolerance*; AI) explained the 13.7% of the variance, and the third factor (*Functional Impairment*; FI) accounted for the 16.2% of the variance. Factor loadings are presented in Table 1.

Internal Consistency and Construct Validity for the EFA subsample

Table 3 presents internal consistency and correlations among variables for the first split-half subsample. The omega coefficient for the retained 3-factor model ranged between .75-.84, whereas the MDDI AI subscale scored below the proposed cut-off score of .80. The other measures used (MBAS and Brief EDE-Q) presented adequate levels of internal consistency (omega = .83-.91). We examined the construct validity of the 3-factor model of the MDDI from the first split-half subsample by computing bivariate correlations with measures of body dissatisfaction (MBAS), disordered eating (Brief EDE-Q), BMI, and weekly frequency of training and rest days (see Table 3). Body dissatisfaction presented weak to strong significant positive associations with all subscales and total score of the MDDI. In particular, the DFS and AI subscales presented strong correlations with muscularity (MBAS-M) and body fat (MBAS-LBF) concerns, respectively. Disordered eating was found to be positively associated with all MDDI dimensions, with a strong correlation with the AI subscale. Among the first split-half subsample of men who exercise, BMI was negatively associated with DFS and positively associated with AI, with moderate and weak strengths of associations, respectively. Finally, FI was positively correlated with mean

training days per week and negatively correlated to average rest days per week, with moderate and weak associations, respectively.

Confirmatory Factor Analysis

A CFA on the EFA model from the first split-half subsample was then conducted in the second split-half subsample ($n = 276$) of men who exercise. Fit statistics for the tested models are presented in Table 4. The original factor structure of the MDDI showed fit indices marginally above the acceptable threshold. An inspection of the modification indexes depicted a high correlation between Item 10 (*I feel anxious when I miss one or more workout days*) and Item 13 (*I pass up chances to meet new people because of my workout schedule*) (M.I. = 44.11), and between Item 11 (*I pass up social activities (e.g. watching football games, eating dinner, going to see a movie, etc.) with friends because of my workout schedule*) and Item 13 (M.I. = 37.06). The re-specified model significantly improved the model fit ($\Delta\chi^2(2, n = 276) = 39.834, p < .001$). Figure 2 shows standardized parameters (factor loadings, factor correlations) for the re-specified model. All factor loadings were statistically significant ($p < .001$) and $> .30$ (standardized parameters).

Internal Consistency and Construct Validity for the CFA subsample

Table 5 presents internal consistency and correlations among variables for the second split-half subsample. The omega coefficient for the retained 3-factor model ranged between .72 and .83, where the MDDI AI subscale scored below the proposed cut-off score of .80. The other measures (MBAS and Brief EDE-Q) used presented adequate levels of internal consistency. Bivariate correlations were also computed to examine the construct validity of the 3-factor model of the MDDI from the second

split-half subsample with measures of body dissatisfaction (MBAS), disordered eating (Brief EDE-Q), BMI, and weekly frequency of training and rest days (see Table 5).

Body dissatisfaction was found to be positively associated with all subscales of the MDDI, with weak to strong correlations. In particular, the DFS and AI subscales presented strong correlations with muscularity (MBAS-M) and body fat (MBAS-LBF) concerns, respectively. Also, disordered eating was found to be positively associated with all MDDI dimensions, with a strong correlation with the AI subscale. In the second split-half subsample of men who exercise, BMI was negatively associated with DFS and positively associated with AI, with moderate and weak strengths of associations, respectively. Finally, FI was positively correlated with mean training days per week and negatively correlated to average rest days per week, with a weak strength of the association.

Sensitivity analysis

Table 6 shows descriptive statistics for all measures and key socio-demographic variables for the first and second split-half subsamples. No group differences were observed between the randomized subsamples of men who exercise in any of the studied variables. Finally, measurement invariance was assessed for the final CFA re-specified model between weightlifters and CrossFit users. Indices for ΔCFI , $\Delta RMSEA$, and $\Delta SRMR$ indicted that configural, metric, and scalar invariance were observed, suggesting that the model structure (latent variables and loading patterns), the magnitude of the factor loadings, and item intercepts were invariant given the type of exercise practiced by the participants (see Table 7).

Discussion

The primary objective of this study was to evaluate, for the first time in Latin America, the factor structure of the MDDI, *Inventario de Dismorfia Muscular* (Spanish-language MDDI), among men who exercise in Argentina. Among a large sample that was divided into two split-half samples, we first evaluated the underlying latent structure through principal-axis EFA (first split-half sample), which was later assessed through CFA (second split-half sample). Analyses replicate the original 3-factor structure described by the original authors (Hildebrandt et al., 2004) and among subsequent studies (Galiana-Llinares et al., 2017; Sandgren et al., 2019; Santarnecchi & Dèttore, 2012; Sepúlveda et al., 2019; Subaşı et al., 2018; Zeeck et al., 2018). Overall, adequate levels of internal consistency, as well as associations with body dissatisfaction, disordered eating, participants' BMI, weekly frequency of training and rest days as evidence of construct validity, were observed for both split-half samples. Finally, sensitivity analyses have been considered; group comparison between the first and second split-half sub-samples and measurement invariance for the final model by type of exercise were conducted. No group differences were observed and the underlying factor model was invariant.

Although the original authors of the MDDI assessed the underlying latent structure through PCA (Hildebrandt et al., 2004), we evaluated factor structure through principal-axis EFA. This accords with more recent guidelines suggesting that EFA better identifies the latent constructs and underlying factor structure of a set of variables, and that factor loadings and correlation among factors tends to be overestimated and underestimated respectively in principal component analysis (Swami & Barron, 2018). In further extending the methodology employed in the original MDDI development, we employed an oblique rotation method (oblimin) that

assumed that factors were correlated was used in this study, rather than an orthogonal rotation method (varimax) which assumes that factors are not correlated. Despite these different statistical approaches, the current study replicates the 3-factor solution originally described for the MDDI (Hildebrandt et al., 2004). These findings add to previous exploratory studies, that replicated (Santarnecchi & Dèttore, 2012) and deviated (Galiana-Llinares et al., 2017) from the statistical approach of Hildebrandt et al (2004), yielding similar factor solutions. Cumulatively, these findings suggest that the 4-factor model reported by Santarnecchi & Dèttore (2012) in non-competitive male bodybuilders and non-training subjects should be interpreted with caution, since the small sample size and the inclusion of factors with only two items may cloud methodological robustness (Costello, & Osborne, 2005). Therefore, the 3-factor model was the most stable solution across exploratory studies irrespective of the specific statistical approach used.

Using the second split-half sample, a CFA was conducted for the 3-factor solution observed in the EFA in the first split-half sample. The first approach resulted in marginal fit and thus modification indices were inspected. The final model was re-specified allowing for error correlation between two pair of items (10-13 and 11-13) within the MDDI-FI subscale, which resulted in good fit and a significant improvement of the model. Consistent with current findings, re-specification of the 3-factor model allowing for error correlations among items 11 and 13 were observed in recent CFAs on German (Zeeck et al., 2018) and Spanish (Sepúlveda et al., 2019) populations. Zeeck et al. (2018) also including error correlations for items 1 and 5 from the MDDI-DFS subscale. Fit indices in the current study are similar to those observed in previous CFAs (Sepúlveda et al., 2019; Zeeck et al., 2018). Also, measurement invariance across genders in the German version (53% females) resulted

in weak invariance and different loadings and coefficients between males and females (Zeeck et al., 2018), suggesting that despite differences in the intercepts and means, the factor structure was invariant between German men and women.

In line with recent suggestions, given the Likert-type nature of the data, internal consistency was assessed using omega and its associated 95% CI (Dunn et al., 2014; Swami & Barron, 2018). Through this method, we found the internal consistency to be adequate for the MDDI-DFS and MDDI-FI subscale, across the first and second split-half samples. The MDDI-AI, however, failed to reach levels of internal consistency above the suggested threshold ($\geq .80$). Current findings are consistent with preceding research; although, given that previous work has considered an adequate threshold of $\geq .70$, internal consistency for all MDDI subscales was considered adequate (Galiana-Llinares et al., 2017; Sandgren et al., 2019; Santarnecchi & Dèttore, 2012; Sepúlveda et al., 2019; Subaşı et al., 2018; Zeeck et al., 2018). The internal consistency for the MDDI-AI in previous studies was the lowest amongst MDDI subscales, with values of Cronabach's alpha ranging from .73 to .77 (Hildebrandt et al., 2004; Sandgren et al., 2019; Sepúlveda et al., 2019; Zeeck et al., 2018), which is similar to current results.

Across first and second split-half subsamples in the present study, the MDDI subscales were found to be positively correlated with male body dissatisfaction (MBAS) and disordered eating (Brief EDE-Q). This is consistent with previous findings across male bodybuilders as well as in community and clinical samples (Lamanna, Grieve, Derryberry, Hakman, & McClure, 2010; Mitchell, Murray, Cobley, et al., 2017; Murray, Rieger, et al., 2012). A similar pattern of association was observed across subsamples as strong correlations were observed between the MDDI-DFS subscale and muscularity concerns (MBAS-M), the MDDI-AI subscale and body

fat concerns (MBAS-LBF), and both MDDI subscales (DFS and AI) and overall male body image concerns (MBAS total score). In addition, BMI was negatively associated with DFS and positively associated with AI. Given that a low body size was theoretically related to desire to increase body size among men (Cafri et al., 2005; H. G. Pope et al., 1997), a negative association between BMI and the DFS subscale was expected. Also, a positive association between BMI and AI was observed, which might have been due to subscale items content (e.g., *I feel like I have too much body fat*). Finally, FI was positively associated with training days, and negatively associated with rest days in both subset samples. This is consistent with previous conceptualizations that suggest that functional impairment in MD is associated with an overloaded training schedule which could have a negative impact on physical activity, an appropriate resting period, and the development of relevant social activities (Grieve, 2007; Lantz et al., 2002; H. G. Pope et al., 1997; Suffolk et al., 2013). The overall observed pattern of association is consistent with the conceptualization of MD as the pathological pursuit of muscularity (Murray et al., 2010; H. G. Pope et al., 1997). In this sense, it has been suggested that body dissatisfaction may trigger attitudinal and behavioral components of MD associated with body image, nutritional concerns and dysfunctional physical exercise (Compte & Sepúlveda, 2014; Lantz, Rhea, & Mayhew, 2001; Lantz et al., 2002).

Sensitivity analyses were conducted to assess: (i) subsample (first and second split-half) differences in key socio-demographics variables and measures scores and (ii) measurement invariance given the type of physical activity practiced by the participants (weightlifting vs. CrossFit). No differences across subset samples of men who exercise were observed, and measurement invariance resulted in an invariant model suggesting that the model structure, the magnitude of the factor loadings, and

item intercepts were invariant across weightlifters and CrossFit users. These findings not only support the split-sample procedure, but also suggest that the MDDI remains invariant across type of physical activity among men who exercise in Argentina.

Despite its contributions, this study has several limitations. Guidelines suggested by Swami and Barron (2018) recommend pre-testing any novel translation with a minimum sample of 30-40 respondents who are probed for their understanding of the items; however in the current study translation testing was conducted *pos hoc*. Also, the sample was exclusively male; thus findings may not be relevant to females who may have different muscularity and body image concerns. Given that weightlifters and CrossFit participants are considered to be populations at risk for MD due to their involvement in physical activity (Cafri et al., 2005; Grieve, 2007), they may not be representative of the general male population or other at-risk populations such as bodybuilders in Argentina or in Latin America. The MDDI is based on self-report, which may be subject to response bias. Also, we did not collect measures of fat-free mass index. Finally, given the cross-sectional nature of the data, we cannot draw conclusions about temporal relationships, as the test-retest reliability was not assessed in the current study. However, strengths of the study include adequately sized samples of weightlifters and CrossFit users in Argentina, a population in which the MDDI has not yet been evaluated.

In terms of clinical implications, this study's findings indicate that the MDDI may be suitable to assess MD in Spanish-speaking Latin American populations. Most previous research on MD has been limited to research among Caucasian males in the US and Australia (Murray et al., 2017); however Latin American men may also experience pressure to gain muscle bulk, especially in Argentina where 42% of university students presented with high levels of concern for their muscularity

(Compte et al., 2015). In conclusion, we demonstrate that the *Inventario de Dismorfia Muscular* (MDDI) is suitable for use in Hispanic populations by confirming the 3-factor structure, internal consistency, and convergent and divergent validity among men who exercise in Argentina. Future research may include additional Latin American populations such as female weightlifters or CrossFit users, sexual minorities, clinical samples of Spanish-speaking MD patients, and bodybuilders, as primary considerations. Further empirical inquiry into this relatively understudied psychiatric phenotype is therefore of considerable importance, particularly when considering the absence of empirically supported treatment options. To this end, we believe that availability of the Argentinian validation of the MDDI would undoubtedly contribute to efforts to develop evidence-based treatments for MD in Argentina. Despite the different methodological approaches used and the differences in populations assessed, the original underlying 3-factor structure of the MDDI remains stable across all studies (Galiana-Llinares et al., 2017; Hildebrandt et al., 2004; Sandgren et al., 2019; Santarnecchi & Dèttore, 2012; Sepúlveda et al., 2019; Subaşı et al., 2018; Zeeck et al., 2018). This will allow for a more unified consensus regarding the conceptualization, clinical assessment, and treatment of MD. Moreover, this will allow researchers to develop cross-cultural studies that can help identify specific sociocultural risk factors across different populations and race/ethnic groups.

References

- Allen, K. L., Byrne, S. M., Lampard, A., Watson, H., & Fursland, A. (2011).
Confirmatory factor analysis of the Eating Disorder Examination-Questionnaire
(EDE-Q). *Eating Behaviors*, 12(2), 143–51.
<https://doi.org/10.1016/j.eatbeh.2011.01.005>
- Baghurst, T., Carlston, D., Wood, J., & Wyatt, F. B. (2007). Preadolescent male
perceptions of action figure physiques. *The Journal of Adolescent Health :
Official Publication of the Society for Adolescent Medicine*, 41(6), 613–5.
<https://doi.org/10.1016/j.jadohealth.2007.07.013>
- Behar, R., & Molinari, D. (2010). [Muscle dysmorphia, body image and eating
behaviors in two male populations]. *Revista Medica de Chile*, 138(11), 1386–94.
<https://doi.org/S0034-98872010001200007>
- Boateng, G. O., Neilands, T. B., Frongillo, E. A., Melgar-Quinonez, H. R., & Young,
S. L. (2018). Best Practices for Developing and Validating Scales for Health,
Social, and Behavioral Research: A Primer. *Frontiers in Public Health*, 6, 149.
<https://doi.org/10.3389/fpubh.2018.00149>
- Buuren, S. van, & Groothuis-Oudshoorn, K. (2011). mice : Multivariate Imputation
by Chained Equations in R. *Journal of Statistical Software*, 45(3), 1–67.
<https://doi.org/10.18637/jss.v045.i03>
- Cafri, G., Thompson, J. K., Ricciardelli, L., McCabe, M., Smolak, L., & Yesalis, C.
(2005). Pursuit of the muscular ideal: Physical and psychological consequences
and putative risk factors. *Clinical Psychology Review*, 25(2), 215–39.
<https://doi.org/10.1016/j.cpr.2004.09.003>
- Campos, R. C., Holden, R. R., Baleizão, C., Caçador, B., & Fragata, A. S. (2018).
Self-Criticism, Neediness, and Distress in the Prediction of Suicide Ideation:

- Results from Cross-Sectional and Longitudinal Studies. *The Journal of Psychology*, 152(4), 237–255. <https://doi.org/10.1080/00223980.2018.1446895>
- Cerea, S., Bottesi, G., Pacelli, Q. F., Paoli, A., & Ghisi, M. (2018). Muscle Dysmorphia and its Associated Psychological Features in Three Groups of Recreational Athletes. *Scientific Reports*, 8(1), 8877. <https://doi.org/10.1038/s41598-018-27176-9>
- Chen, F. F. (2007). Sensitivity of Goodness of Fit Indexes to Lack of Measurement Invariance. *Structural Equation Modeling: A Multidisciplinary Journal*, 14(3), 464–504. <https://doi.org/10.1080/10705510701301834>
- Cheung, G. W., & Rensvold, R. B. (2002). Evaluating Goodness-of-Fit Indexes for Testing Measurement Invariance. *Structural Equation Modeling: A Multidisciplinary Journal*, 9(2), 233–255. https://doi.org/10.1207/S15328007SEM0902_5
- Cohane, G. H., & Pope, H. G. (2000). Body Image in Boys: A Review of the Literature. *International Journal of Eating Disorders*, 29, 373–379. <https://doi.org/10.1002/eat.1033>
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences (2nd ed.)*. (Erlbaum, Ed.). Hillsdale, NJ.
- Compte, E. J., Sepulveda, A. R., & Torrente, F. (2015). A two-stage epidemiological study of eating disorders and muscle dysmorphia in male university students in Buenos Aires. *International Journal of Eating Disorders*, 48 (8), 1092-1101. <https://doi.org/10.1002/eat.22448>
- Compte, E. J., Nagata, J. M., Sepúlveda, A. R., Schweiger, S., Sbdar, L. S., Silva, B. C., ... Murray, S. B. (2019). Confirmatory factor analysis and measurement invariance of the eating disorders examination-questionnaire across four male

samples in Argentina. *International Journal of Eating Disorders*, 52(6), 740-745.

<https://doi.org/10.1002/eat.23075>.

Compte, E. J., & Sepúlveda, A.R. (2014). Muscle Dysmorphia: Historical Review and Updates in Its Diagnostic, Assessment and Treatment. *Behavioral Psychology*, 22, 307–26.

Compte, E. J., Sepúlveda, A. R., de Pellegrin, Y., & Blanco, M. (2015). Confirmatory factor analysis of the Drive for Muscularity Scale-S(DMS-S) and Male Body Attitudes Scale-S (MBAS-S) among male university students in Buenos Aires. *Body Image*, 14. <https://doi.org/10.1016/j.bodyim.2015.02.005>

Compte, E. J., Sepúlveda, A. R., de Pellegrin, Y., & Blanco, M. (2015). Confirmatory factor analysis of the Drive for Muscularity Scale-S (DMS-S) and Male Body Attitudes Scale-S (MBAS-S) among male university students in Buenos Aires. *Body Image*, 14, 13–19. <https://doi.org/10.1016/j.bodyim.2015.02.005>

Costello, A. B., Costello, A. B., & Osborne, J. W. (2005). Best practices in exploratory factor analysis: Four recommendations for getting the most from your analysis. *Practical Assessment, Research & Evaluation*, 10, 173--178. Retrieved from <http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.110.9154>

Dunn, T. J., Baguley, T., & Brunsden, V. (2014). From alpha to omega: A practical solution to the pervasive problem of internal consistency estimation. *British Journal of Psychology*, 105(3), 399–412. <https://doi.org/10.1111/bjop.12046>

Epskamp, S. (2013). *semPlot: Path diagrams and visual analysis of various SEM packages' output*. R package version 0.3.2. <https://github.com/SachaEpskamp/semPlot>

Fabrigar, L. R., Wegener, D. T., MacCallum, R. C., & Strahan, E. J. (1999).

Evaluating the use of exploratory factor analysis in psychological research.

Psychological Methods, 4(3), 272–299. <https://doi.org/10.1037/1082->

989X.4.3.272

Fairburn, C. G., & Beglin, S. J. (1994). Assessment of eating disorders: interview or self-report questionnaire? *The International Journal of Eating Disorders*, 16(4), 363–370. [https://doi.org/10.1002/1098-108X\(199412\)](https://doi.org/10.1002/1098-108X(199412))

Galiana-Linares, L., Badenes-Rivera, L., Fuentes-Durán, M.C., (2017). Validación de la versión española del Inventario del Trastorno por Dismorfia Muscular en una muestra de estudiantes universitarios (Eds.) In: Nuñez, J.C., Molero, M.M., Gázquez, J.J., Pérez-Fuentes, M.C., Simón, M.M., Martos, A., Barragán, A.B. (Eds.), *Atención a Las Necesidades Comunitarias Para La Salud* (pp. 41–45). Almería: Scinfooper.

Garner, D. M., Olmsted, M. P., Bohr, Y., & Garfinkel, P. E. (1982). The Eating Attitudes Test: psychometric features and clinical correlates. *Psychological Medicine*, 12(04), 871. <https://doi.org/10.1017/S0033291700049163>

Grieve, F. G. (2007). A conceptual model of factors contributing to the development of muscle dysmorphia. *Eating Disorders*, 15(1), 63–80. <https://doi.org/10.1080/10640260601044535>

Hair, J.F., Black, W.C., Babin, B.J., & Anderson, R.E. (2010). *Multivariate Data Analysis. Seventh Edition*. Prentice Hall, Upper Saddle River, New Jersey.

Harrell, F. (2008). *Hmisc: Harrell Miscellaneous*. Retrieved from <http://biostat.mc.vanderbilt.edu/s/Hmisc>

Hayton, J. C., Allen, D. G., & Scarpello, V. (2004). Factor retention decisions in exploratory factor analysis: A tutorial on parallel analysis. *Organizational Research Methods*, 7, 191–205. <http://dx.doi.org/10.1177/1094428104263675>

- Hildebrandt, T., Alfano, L., & Langenbucher, J. W. (2010). Body image disturbance in 1000 male appearance and performance enhancing drug users. *Journal of Psychiatric Research*, 44(13), 841–6. <https://doi.org/10.1016/j.jpsychires.2010.01.001>
- Hildebrandt, T., Langenbucher, J., & Schlundt, D. G. (2004). Muscularity concerns among men: development of attitudinal and perceptual measures. *Body Image*, 1(2), 169–81. <https://doi.org/10.1016/j.bodyim.2004.01.001>
- Horn, J. L. (1965). A rationale and test for the number of factors in factor analysis. *Psychometrika*, 30(2), 179–185. <https://doi.org/10.1007/BF02289447>
- Hu, L. L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling*, 6(1), 1–55. <https://doi.org/10.1080/10705519909540118>
- Huang, F. (2015). *hornpa: Horn's test to determine the number of components/factors*. Retrieved from <http://CRAN.R-project.org/package=hornpa>
- International Test Commission (2017). *The ITC Guidelines for Translating and Adapting Tests (Second edition)*. [www.InTestCom.org]
- Jamshidian, M., Jalal, S., & Jansen, C. (2014). MissMech : An R Package for Testing Homoscedasticity, Multivariate Normality, and Missing Completely at Random (MCAR). *Journal of Statistical Software*, 56(6), 1–31. <https://doi.org/10.18637/jss.v056.i06>
- Jorgensen, T. D., Pornprasertmanit, S., Schoemann, A. M., & Rosseel, Y. (2018). *semTools: Useful tools for structural equation modeling*. R package version 0.5-1. Retrieved from <https://CRAN.R-project.org/package=semTools>
- Khorramabady, Y. (2017). The Effect of Muscle Dysmorphia and Social Physique Anxiety on the Use of Supplements and Drugs. *Zahedan Journal of Research in*

- Medical Sciences*, 19(9), 1-6. <https://doi.org/10.5812/zjrms.13541>
- Korkmaz, S., Goksuluk, D., & Zararsiz, G. (2014). MVN: Multivariate normality tests. R Package Version 3.7. Available at [http:// CRAN.R project.org/package=MVN](http://CRAN.R-project.org/package=MVN)
- Lamanna, J., Grieve, F. G., Derryberry, W. P., Hakman, M., & McClure, A. (2010). Antecedents of eating disorders and muscle dysmorphia in a non-clinical sample. *Eating and Weight Disorders*, 15, 23–33. <https://doi.org/10.1007/BF03325277>
- Lantz, C. D., Rhea, Deborah J., Mayhew, J. L. (2001). The drive for size a psycho-behavioral model of muscle dysmorphia. *International Sports Journal*, 5, 71–86.
- Lantz, C. D., Rhea, D. J., & Cornelius, A. E. (2002). Muscle Dysmorphia in Elite-Level Power Lifters and Bodybuilders : A Test of Differences Within a Conceptual Model, 16(4), 649–655.
- Lima, L. D. de, Moraes, C. M. B. de, & Kirsten, V. R. (2010). Dismorfia muscular e o uso de suplementos ergogênicos em desportistas. *Revista Brasileira de Medicina Do Esporte*, 16(6), 427–430. <https://doi.org/10.1590/S1517-86922010000600006>
- MacCallum, R. C., Browne, M. W., & Sugawara, H. M. (1996). Power analysis and determination of sample size for covariance structure modeling. *Psychological Methods*, 1(2), 130–149. <https://doi.org/10.1037/1082-989X.1.2.130>
- McCreary, D. R., & Sasse, D. K. (2000). An exploration of the drive for muscularity in adolescent boys and girls. *Journal of American College Health : J of ACH*, 48(6), 297–304. <https://doi.org/10.1080/07448480009596271>
- McKay, R. B., Breslow, M. J., Sangster, R. L., Gabbard, S. M., Reynolds, R. W., Nakamoto, J. M., & Tarnai, J. (1996). Translating survey questionnaires: Lessons learned. *New Directions for Evaluation*, 1996(70), 93–104. <https://doi.org/10.1002/ev.1037>

- Mellor, D., McCabe, M., Ricciardelli, L., & Merino, M. E. (2008). Body dissatisfaction and body change behaviors in Chile: The role of sociocultural factors. *Body Image*, 5(2), 205–215.
<https://doi.org/10.1016/J.BODYIM.2008.01.004>
- Mitchell, L., Murray, S. B., Cobley, S., Hackett, D., Gifford, J., Capling, L., & O'Connor, H. (2017). Muscle Dysmorphia Symptomatology and Associated Psychological Features in Bodybuilders and Non-Bodybuilder Resistance Trainers: A Systematic Review and Meta-Analysis. *Sports Medicine*, 47(2), 233–259. <https://doi.org/10.1007/s40279-016-0564-3>
- Mitchell, L., Murray, S. B., Hoon, M., Hackett, D., Prvan, T., & O'Connor, H. (2017). Correlates of muscle dysmorphia symptomatology in natural bodybuilders: Distinguishing factors in the pursuit of hyper-muscularity. *Body Image*, 22, 1–5.
<https://doi.org/10.1016/J.BODYIM.2017.04.003>
- Muñiz, J., & Bartram, D. (2007). Improving International Tests and Testing. *European Psychologist*, 12(3), 206–219. <https://doi.org/10.1027/1016-9040.12.3.206>
- Murray, S. B., & Baghurst, T. (2013). Revisiting the Diagnostic Criteria for Muscle Dysmorphia. *Strength and Conditioning Journal*, 35, 69–74.
<https://doi.org/10.1519/SSC.0b013e3182723f24>
- Murray, S. B., & Griffiths, S. (2014). Adolescent muscle dysmorphia and family-based treatment: A case report. *Clinical Child Psychology and Psychiatry*, 20(2), 324–330. <https://doi.org/10.1177/1359104514521639>
- Murray, S. B., Maguire, S., Russell, J., & Touyz, S. W. (2012). The emotional regulatory features of bulimic episodes and compulsive exercise in muscle dysmorphia: a case report. *European Eating Disorders Review*, 20(1), 68–73.

<https://doi.org/10.1002/erv.1088>

Murray, S. B., Nagata, J. M., Griffiths, S., Calzo, J. P., Brown, T. A., Mitchison, D.,

... Mond, J. M. (2017). The enigma of male eating disorders: A critical review and synthesis. *Clinical Psychology Review*, 57, 1–11.

<https://doi.org/10.1016/j.cpr.2017.08.001>

Murray, S. B., Rieger, E., Hildebrandt, T., Karlov, L., Russell, J., Boon, E., ... Touyz,

S. W. (2012). A comparison of eating, exercise, shape, and weight related symptomatology in males with muscle dysmorphia and anorexia nervosa. *Body Image*, 9(2), 193–200. <https://doi.org/10.1016/j.bodyim.2012.01.008>

Murray, S. B., Rieger, E., Touyz, S. W., & de la Garza García, Y. (2010). Muscle dysmorphia and the DSM-V conundrum: where does it belong? A review paper. *The International Journal of Eating Disorders*, 43(6), 483–91.

<https://doi.org/10.1002/eat.20828>

Neumark-Sztainer, D., Croll, J., Story, M., Hannan, P. J., French, S. A., & Perry, C.

(2002). Ethnic/racial differences in weight-related concerns and behaviors among adolescent girls and boys: Findings from Project EAT. *Journal of Psychosomatic Research*, 53(5), 963–974. [https://doi.org/10.1016/S0022-3999\(02\)00486-5](https://doi.org/10.1016/S0022-3999(02)00486-5)

Núñez-Navarro, A., Agüera, Z., Krug, I., Jiménez-Murcia, S., Sánchez, I., Araguz, N.,

... Fernández-Aranda, F. (2012). Do men with eating disorders differ from women in clinics, psychopathology and personality? *European Eating Disorders Review*, 20, 23–31. <https://doi.org/10.1002/erv.1146>

Nunnally, J. C. (1976). *Psychometric theory (2nd ed.)*. (McGraw-Hill, Ed.). New York, NY.

Olivardia, R., Pope, H.G., & Hudson, J. (2000). Muscle Dysmorphia in Male

- Weightlifters: A Case-control Study. *American Journal of Psychiatry*, 157, 1291–96. <https://doi.org/10.1176/appi.ajp.157.8.1291>
- Pope, C. G., Pope, H. G., Menard, W., Fay, C., Olivardia, R., & Phillips, K. (2005). Clinical features of muscle dysmorphia among males with body dysmorphic disorder. *Body Image*, 2(4), 395–400. <https://doi.org/10.1016/j.bodyim.2005.09.001>
- 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), 548–57. [https://doi.org/10.1016/S0033-3182\(97\)71400-2](https://doi.org/10.1016/S0033-3182(97)71400-2)
- Pope, H. G., Katz, D. L., & Hudson, J. I. (1993). Anorexia nervosa and “reverse anorexia” among 108 male bodybuilders. *Comprehensive Psychiatry*, 34(6), 406–409. [https://doi.org/10.1016/0010-440X\(93\)90066-D](https://doi.org/10.1016/0010-440X(93)90066-D)
- Pope, H. G., Jr, Phillips, K. A., & Olivardia, R. (2000). *The Adonis complex: The secret crisis of male body obsession*. New York, NY: Free Press.
- Pourshahbaz, A., Nonahal, S., Dolatshahi, B., & Omidian, M. (2014). The Role of the Media, Perfectionism, and Difficulties in Emotion Regulation in Prediction of Muscle Dysmorphia Symptoms. *Practice in Clinical Psychology*, 2(2), 135–139. Retrieved from <http://jpcp.uswr.ac.ir/article-1-166-en.html&sw=Pourshahbaz>
- Revelle, W. (2018) *psych: Procedures for Personality and Psychological Research*, Northwestern University, Evanston, Illinois, USA. Retrieved from <https://CRAN.R-project.org/package=psych>
- Rosseel, Y. (2012). lavaan: An R Package for Structural Equation Modeling. *Journal of Statistical Software*, 48(2), 1–36. <https://doi.org/10.18637/jss.v048.i02>
- Sandgren, S. S., Giske, R., & Shalfawi, S. A. I. (2019). Muscle dysmorphia in

Norwegian gym-going men. *Kinesiology*, 51(1), 12–21.

<https://doi.org/10.26582/k.51.1.3>

Santarneccchi, E., & Dèttore, D. (2012). Muscle dysmorphia in different degrees of bodybuilding activities: validation of the Italian version of Muscle Dysmorphia Disorder Inventory and Bodybuilder Image Grid. *Body Image*, 9(3), 396–403.

<https://doi.org/10.1016/j.bodyim.2012.03.006>

Satorra, A., & Bentler, P. M. (1994). Corrections to test statistics and standard errors in covariance structure analysis. In A. von Eye & C. C. Clogg (Eds.), *Latent variables analysis: Applications for developmental research* (pp. 399–419). Thousand Oaks, CA: Sage.

Satorra, A., & Bentler, P. M. (2001). A scaled difference chi-square test statistic for moment structure analysis. *Psychometrika*, 66(4), 507–514.

<https://doi.org/10.1007/BF02296192>

Sepúlveda, A. R., Rica, R., Moreno, A., Román, F. J., & Compte, E. J. (2019). Assessing the male body image: Spanish validation of two instruments. *Psychiatry Research*, 272, 483–490.

<https://doi.org/10.1016/J.PSYCHRES.2018.12.125>

Sprey, J. W. C., Ferreira, T., de Lima, M. V., Duarte, A., Jorge, P. B., & Santili, C. (2016). An Epidemiological Profile of CrossFit Athletes in Brazil. *Orthopaedic Journal of Sports Medicine*, 4(8), 1-8.

<https://doi.org/10.1177/2325967116663706>

Stagnaro, J. C., Cía, A. H., Aguilar Gaxiola, S., Vázquez, N., Sustas, S., Benjet, C., & Kessler, R. C. (2018). Twelve-month prevalence rates of mental disorders and service use in the Argentinean Study of Mental Health Epidemiology. *Social Psychiatry and Psychiatric Epidemiology*, 53(2), 121–129.

<https://doi.org/10.1007/s00127-017-1475-9>

Subaşı, B., Okray, Z., & Çakıcı, M. (2018). Validity and reliability of Turkish Form of Muscle Dysmorphia Disorder Inventory among elite bodybuilder men.

Anatolian Journal of Psychiatry, 19(2), 47-52.

<https://doi.org/10.5455/apd.298210>

Suffolk, M. T., Dovey, T. M., Goodwin, H., & Meyer, C. (2013). Muscle dysmorphia: methodological issues, implications for research. *Eating Disorders*, 21, 437–57.

<https://doi.org/10.1080/10640266.2013.828520>

Swami, V., & Barron, D. (2018). Translation and validation of body image

instruments: Challenges, good practice guidelines, and reporting

recommendations for test adaptation. *Body Image*.

<https://doi.org/10.1016/J.BODYIM.2018.08.014>

Tabachnick, B., & Fidell, G. L. S. (2001). *Using multivariate statistics (4th ed.)*. New York: Harper & Row.

Tylka, T. L., Bergeron, D., & Schwartz, J. P. (2005). Development and psychometric evaluation of the Male Body Attitudes Scale (MBAS). *Body Image*, 2(2), 161–

75. <https://doi.org/10.1016/j.bodyim.2005.03.001>

Wade, T. D., Byrne, S., & Bryant-Waugh, R. (2008). The eating disorder

examination: Norms and construct validity with young and middle adolescent

girls. *International Journal of Eating Disorders*, 41(6), 551–558.

<https://doi.org/10.1002/eat.20526>

Wolke, D., & Sapouna, M. (2008). Big men feeling small: Childhood bullying experience, muscle dysmorphia and other mental health problems in

bodybuilders. *Psychology of Sport and Exercise*, 9(5), 595–604.

<https://doi.org/10.1016/j.psychsport.2007.10.002>

- Worthington, R. L., & Whittaker, T. A. (2006). Scale Development Research. *The Counseling Psychologist*, 34(6), 806–838.
<https://doi.org/10.1177/0011000006288127>
- Zeeck, A., Welter, V., Alatas, H., Hildebrandt, T., Lahmann, C., & Hartmann, A. (2018). Muscle Dysmorphic Disorder Inventory (MDDI): Validation of a German version with a focus on gender. *PloS One*, 13(11), e0207535.
<https://doi.org/10.1371/journal.pone.0207535>
- Zhang, Z., & Yuan, K. H. (2018). *Practical Statistical Power Analysis Using Webpower and R*. Granger, IN: ISDSA.

Table 1

Factor loading for the Exploratory Factor Analysis in first split-half of the sample (n=275)

Item/Factor	Factor loadings		
	1	2	3
<i>Drive for Size</i>			
1 Creo que mi cuerpo es demasiado pequeño	.79		
4 Deseo poder hacerme mas grande	.78		
5 Creo que mi pecho es demasiado pequeño	.75		
6 Creo que mis piernas son demasiado delgadas	.74		
8 Desearía que mis brazos fuesen más grandes	.73		
<i>Appearance Intolerance</i>			
2 Llevo ropa suelta para que la gente no pueda ver mi cuerpo		.72	
3 Odio mi cuerpo		.66	
7 Siento que tengo demasiada grasa corporal		.68	
9 Tengo mucha timidez a la hora de permitir que otras personas me vean sin camisa		.74	
<i>Functional Impairment</i>			
10 Me siento ansioso cuando pierdo uno o más días de entrenamiento			.74
11 Dejo pasar actividades sociales con amigos debido a mi horario de entrenamiento			.85
12 Me siento deprimido cuando pierdo un día o más de entrenamiento			.76
13 Dejo pasar oportunidades para conocer gente nueva debido a mi horario de entrenamiento			.75

Table 2

Samples characteristics, and group differences by type of exercise

	Total (<i>n</i> = 551)	Weightlifters (<i>n</i> = 276)	CorssFit users (<i>n</i> = 275)	Wilcoxon Rank Sum Test / χ^2	<i>p</i>
	<i>M</i> (<i>SD</i>) / % (<i>n</i>)	<i>M</i> (<i>SD</i>) / % (<i>n</i>)	<i>M</i> (<i>SD</i>) / % (<i>n</i>)		
Age [†]	29.71 (8.51)	29.38 (9.37)	30.05 (7.54)	41912	.041
BMI [†]	25.24 (3.01)	25.11 (3.31)	25.38 (2.68)	43096	.008
Training days per week [†]	4.08 (1.15)	4.02 (1.16)	4.14 (1.13)	40414	.199
Rest days per week [†]	2.32 (1.03)	2.39 (1.07)	2.25 (0.98)	35233	.121
Supplement use ^{††}	34.24 (189)	29.50 (82)	39.05 (107)	5.595	.018
Professional supervision ^{††}	56.16 (310)	56.47 (157)	55.84 (153)	0.023	.880
Injuries ^{††}	31.34 (173)	27.34 (76)	35.40 (97)	4.169	.041
Higher education ^{††}	79.17 (437)	76.62 (213)	81.75 (224)	2.205	.138
Employment status ^{††}	70.65 (390)	67.63 (188)	73.72 (202)	2.474	.116

[†] Wilcoxon Rank Sum Test^{††} Chi-square Test**p* < .006 (after Bonferroni's correction)

Table 3

Internal consistency and correlations in the first split-half sample (n=275)

	Omega [CI 95%]	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1. MDDI-DFS	.84 [.80, .87]	-									
2. MDDI-AI	.75 [.68, .80]	.27**									
3. MDDI-FI	.80 [.76, .84]	.41**	.24**								
4. MDDI Total Score	.81 [.77, .85]	.81**	.54**	.77**							
5. MBAS-M	.90 [.87, .92]	.75**	.33**	.28**	.65**						
6. MBAS-LBF	.87 [.85, .90]	.26**	.66**	.35**	.42**	.43**					
7. MBAS Total Score	.91 [.88, .92]	.61**	.58**	.27**	.64**	.86**	.79**				
8. Brief EDE-Q	.83 [.78, .87]	.41**	.52**	.27**	.51**	.48**	.60**	.66**			
9. BMI	-	-.32**	.27**	-.01	-.10	-.26**	.29**	-.02	.04		
10. Training days (days/week)	-	.08	-.02	.31**	.19**	-.04	-.07	-.07	.02	.01	
11. Rest days (days/week)	-	-.05	.03	-.26**	-.14*	.07	.06	.09	.04	.02	-.64**

* $p < .05$ ** $p < .01$

Table 4

Goodness of fit (robust fit indices) for the tested models in the second split-half sample (n=276).

Models	χ^2/df	RMSEA [CI 90%]	CFI	TLI	SRMR
1. MDDI	2.34	.083 [.066, .101]	.903	.878	.054
2. MDDI Re-specified	1.66	.058 [.037, .078]	.954	.941	.047

Table 5

Internal consistency and correlations among variables in the second split-half sample (n=276)

	Omega (CI 95%)	1	2	3	4	5	6	7	8	9
1 MDDI-DFS	.82 (.78, .85)	-								
2 MDDI-AI	.72 (.62, .79)	.45**								
3 MDDI-FI	.82 (.77, .85)	.37**	.34**							
4 MBAS-M	.90 (.87, .91)	.79**	.51**	.28**						
5 MBAS-LBF	.86 (.83, .89)	.29**	.74**	.35**	.42**					
6 MBAS Total Score	.91 (.88, .93)	.67**	.74**	.36**	.86**	.78**				
7 Brief EDE-Q	.88 (.84, .91)	.41**	.62**	.34**	.46**	.62**	.65**			
8 BMI	-	-.32**	.20**	.07	-.20**	.35**	.03	.13*		
9 Training days (days/week)	-	.08	-.06	.25**	-.01	.00	.01	-.04	.03	
10 Rest days (days/week)	-	.03	.04	-.27**	.09	.01	.05	.02	-.07	-.71**

* $p < .05$ ** $p < .01$

Table 6

Mean scores, key socio-demographic data, and group differences for the first and second split-half subsamples

	First split-half sample (<i>n</i> = 275) <i>M</i> (SD) / % (n)	Second split-half sample (<i>n</i> = 276) <i>M</i> (SD) / % (n)	Wilcoxon Rank Sum Test / χ^2	<i>p</i>
Measures scores				
MDDI-DFS [†]	10.19 (4.48)	10.04 (4.37)	38986	.578
MDDI-AI [†]	6.29 (2.71)	6.30 (2.68)	39324	.452
MDDI-FI [†]	8.28 (3.86)	8.31 (4.09)	39870	.301
MBAS-M [†]	2.61 (1.02)	2.54 (0.99)	36592	.467
MBAS-LBF [†]	2.46 (0.98)	2.51 (1.02)	36254	.364
MBAS Total Score [†]	2.51 (0.81)	2.50 (0.82)	35901	.273
Brief EDE-Q [†]	0.85 (0.88)	0.89 (1.05)	37111	.651
Key socio-demographic data				
Age [†]	29.22 (802)	30.01 (8.79)	38233	.880
BMI [†]	25.12 (2.87)	25.35 (3.18)	35734	.236
Training days per week [†]	4.13 (1.14)	4.04 (1.16)	36170	.325
Rest days per week [†]	2.33 (1.05)	2.32 (1.00)	38978	.562
Supplement use ^{††}	36.36 (100)	33.33 (92)	0.432	.511
Professional supervision ^{††}	58.91 (148)	53.62 (148)	1.357	.244
Injuries ^{††}	29.45 (81)	32.97 (91)	0.638	.424
Higher education ^{††}	78.91 (217)	79.35 (219)	0.001	.983
Employment status ^{††}	67.27 (185)	73.55 (203)	2.314	.128

[†] Wilcoxon Rank Sum Test

^{††} Chi-square Test

Table 7

Measurement invariance (weightlifters vs. CrossFit users)

Fit	$SB\chi^2$	df	Robust CFI	Robust RMSEA	SRMR	Model Comparison	$\Delta SB\chi^2$	Δ Robust CFI	Δ Robust RMSEA	Δ SRMR	Δdf	p
Configural	288.76	120	.950	.061	.049	-	-	-	-	-	-	-
Metric	309.01	130	.948	.060	.057	Configural vs. Metric	14.26	.002	.001	.008	10	.161
Scalar	319.43	140	.947	.058	.058	Metric vs. Scalar	10.80	.001	.002	.001	10	.373

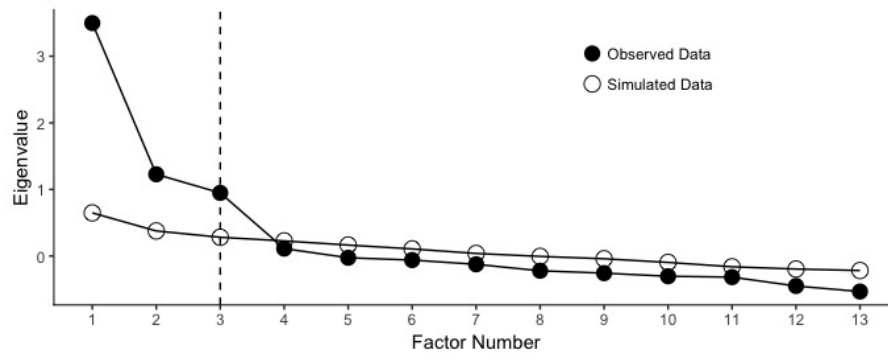


Figure 1. Factor retention: parallel analysis suggest a 3-factor structure

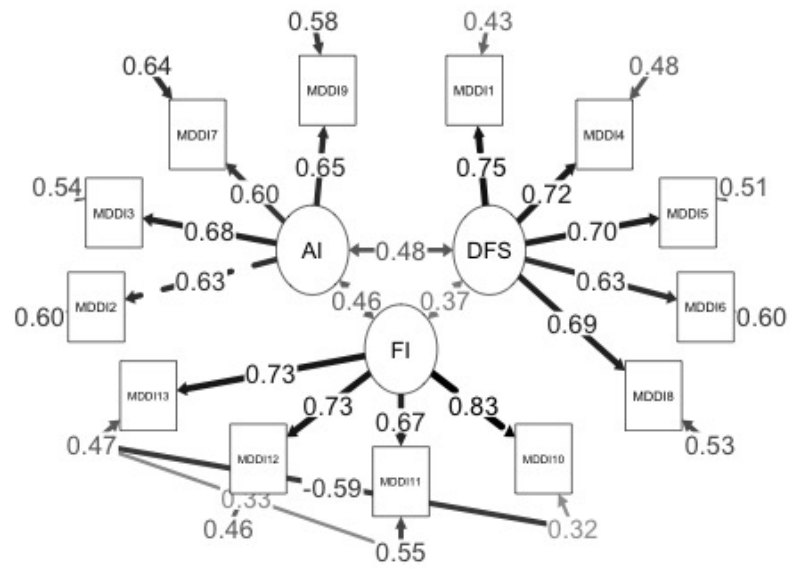


Figure 2. CFA of the re-specified retained 3-factor model for the MDDI