

Establishing The Optimal Male Cut-Off Point: Confirmatory Factor Analysis of The Eating Disorder Examination-Questionnaire (EDE-Q) in a Representative Sample of Spanish University Students

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Abstract

Purpose Although the EDE-Q is derived from the “gold standard” for the assessment of Eating Disorders (ED), its factor structure is controversial, particularly in male samples. The aim of the study was to examine the psychometric properties and factor structure of the EDE-Q, as well to establish a sensitive and specific cut-off point validated by EDE clinical interview.

Methods A series of Confirmatory Factor Analyses were performed among a representative sample of 796 male university students, of whom 139 were interviewed. Sensitivity and specificity were calculated by Receiver Operating Characteristic (ROC) analysis to determine the most appropriate cut-off value.

Results The original factor structure was not confirmed, showing a better fit with a 2-factor solution. For the Spanish male sample, a cut-off ≥ 1.09 for at-risk of ED cases and ≥ 2.41 for clinical cases presents an optimal balance between sensitivity and specificity.

Conclusions The establishment of specific cut-off points for males may help to reduce the under-diagnosis of ED in this population.

Level of evidence III Evidence obtained from well-designed case-control study.

1. Introduction

The Eating Disorders Examination Questionnaire (EDE-Q) [1] is derived from the “gold standard” for the assessment and diagnosis of eating disorders (ED), the Eating Disorders Examination interview (EDE) [2]. In addition to the cognitive features of ED, the EDE-Q includes items that assess behavioral symptoms as self-induced vomit, binge eating or excessive exercise, and is a brief, cost-efficient self-report instrument for exploring possible occurrence and severity of ED [3]. The EDE-Q has been widely used and has shown to be a valid and reliable instrument in both general population and clinical samples [4, 5, 6].

Originally, the theoretical structure of the EDE-Q is composed by 4 factors (i.e., Restraint, Eating Concern, Weight Concern and Shape Concern) and a global score. However, this structure has found little empirical support and is controversial [6, 7]. Since its development, the factor model of the EDE-Q has been tested through Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) in multiple studies with samples differing in nationality, age, sex, sexual orientation or clinical status. Overall, of the more than 20 studies that have been conducted on this topic, only 2 have confirmed the original 4-factor, 22-item model. Retaining the original 22 items, there are 12 proposed factorial structures, from unifactorial to 4-factor alternatives, with those proposing factor models that merge the “Concern” subscales in some way being common. For short models there are also at least 9 alternatives to the original factorial model with fewer items [see 6 and 8 for review].

In recent years, ED behaviors are growing faster in men than in women [9]. Although the rates of anorexia nervosa and bulimia nervosa are lower than in women [10], the dual nature of male body dissatisfaction

(i.e., low body fat and high muscularity) lay them at risk for disordered eating [9, 11], with the average age of onset being around 19–20 years [12, 13]. Despite the need for robust instruments to explore this pathology among men and reduce the problem of under-diagnosed of male ED [9], research on the psychometric properties of EDE-Q in men remains low and samples are generally scarce [6]. Recent studies on male samples show different factor structures for the EDE-Q [8], supporting the hypothesis that the original factor model is not sensitive enough for males and more research is needed to clarify the weak and unstable structure [5, 14].

Screening for low prevalence pathologies such as ED inherently involves challenges [15], particularly in male samples where results with the usual cut-off points may not be adequately detecting at-risk cases [16, 17]. Sensitive and specific screening instruments validated with clinical interview are essential. In the Spanish population, studies that have examined the psychometric properties of the EDE-Q, including EFA and CFA, in males have been conducted mainly in samples of adolescents [18, 19]. The few that have collected adult samples have not conducted a clinical interview to contrast the findings [20, 16].

This wide range of alternative versions of the EDE-Q may make communication between researchers and clinicians difficult and affect the interpretation of findings [21]. The aim of this study is to extend the current literature by examining the psychometric properties and factor structure of the EDE-Q, as well to determine/stablish a sensitive and specific cut-off point validated by EDE clinical interview in a large non-clinical representative sample of Spanish university men.

2. Method

2.1. Participants

The data were obtained in an epidemiologic study of the prevalence of ED and Muscle Dysmorphia (MD) among male university students at Autonomous University of Madrid using a two-phase study with a control group. The first phase, the sample population was screened by questionnaire to detect students at risk of developing an ED or MD. The second phase, clinical interviews were conducted with the risk group (above a cut-off point). The control group was selected randomly from the students who scored below of risk cut-off point, using two students pairing stratified by academic year and school.

The survey was carried out in a sample of male students enrolled in the first and fourth academic year, between 2016-19 academic years. Of the 21 schools on the campus, 5 schools (i.e., Physical Activity and Sports Sciences, Physics, Computer Science Engineering, Business Administration and Management and Economics) with the highest number of male students enrolled were selected (i.e., over 70%). A total of 1634 students were targeted. To achieve a representative sample of the university campus by academic year and school, the sample design was proportionally stratified according to academic year and school, assuming a 95% confidence interval and 0.05 of sampling error. A total of 1088 students was identified as the desired sample size [22]. The final sample collected consisted of 850 Spanish male university students from different degrees (i.e., 78,1% response rate): (1) Physical Activity and Sports Sciences from

Polytechnic ($n = 297$, 91,1% response rate), (2) Physics ($n = 92$, 96,8% response rate), (3) Economics ($n = 171$, 77,7% response rate), (4) Computer Science Engineering ($n = 114$, 49,6% response rate) and (5) Business Administration and Management ($n = 176$, 81,1% response rate). The mean age of the sample was 19.8 ($SD = 2.8$).

Specifically for this study, to examine psychometric properties of EDEQ, fifty-four participants demonstrated > 5% of missing data on the questionnaire or were non-Spanish students and were excluded ($n = 796$). Overall, 528 (66.3 %) participants practiced sports at a non-competitive level (recreational exercisers) and the remaining 268 (33.7 %) students competed at a national or international level in some sport (e.g., football, swimming, etc.). The mean Body Mass Index (BMI) was 22.4 ($SD = 2.9$).

Tests were administered at the classroom collectively and completed individually in electronic or paper. Permission to conduct the study was granted by the university's deans and the participant's teachers.

2.2. Measures

In addition to self-reported sociodemographic data on age, weight and height, participants also respond to:

Eating Disorder Examination (EDE-12, Version 12.0) [2, 23] The EDE is a clinical interview developed to measure ED psychopathology over a 28-day period. It consists of 35 questions in which 22 items comprises four subscales, with the same response format of seven-points (i.e., 0–6): Restraint, Eating Concern, Shape Concern, and Weight Concern. The EDE-Global score is obtained by averaging subscales' scores. The presence and frequencies of key ED behaviors are not included neither subscales nor global score, however, these questions are used for coding the ED diagnosis. The interview manual indicates the diagnostic items of the EDE to establish a DSM-IV diagnosis, which has been adapted to DSM-5 diagnoses.

Eating Disorder Examination-Questionnaire (EDE-Q) [1, 16], asks directly about attitudes related to key features of ED psychopathology in a 28-day time frame. The 22 attitudinal items comprise the same four subscales, and responses are given on a 7-point Likert-type scale (0 = never to 6 = every day). The EDEQ-Global score is obtained by averaging subscales' scores. The remaining items assess the frequency of specific eating behaviors are not included in the subscales or in the global score. Studies of convergent validity comparing the EDE-Q with its interview equivalent (the EDE) have generally demonstrated good agreement between measures [24, 25, 26]. The Cronbach's alpha was .93 for the EDEQ-Global score for non-clinical men [10] The EDE-Q has a clinical significance cut-off point of ≥ 4 for EDEQ-Global score for both sexes [27]. In the current sample, the Omega coefficient was .93 for the EDE-Global score.

Muscle Dysmorphic Disorder Inventory (MDDI) [28, 29] is a questionnaire of 13 items with a response range from 1 (never) to 5 (always) that evaluates body dissatisfaction from a male perspective related to muscle development. Likewise, the MDDI is divided into three subscales: drive for size (DFS), appearance intolerance (AI) and functional impairment (FI). The original version showed adequate reliability indexes

(range: $\alpha = .77$ to $.85$), as well as the Spanish version (range: $\alpha = .73$ to $.85$). In the current sample, the Omega coefficient was $.89$ for the MDDI total score.

2.3. Data Analysis

Statistical analyses were carried out using SPSS 25.0, Mplus 7.11 and RStudio, employing the *MNV* [30], *psych* [31], and *ROCit* [32] packages. Descriptive statistics ($M \pm SD$) were calculated for all scale scores. The Mardia's test revealed that the EDE-Q items did not follow a multivariate normal distribution (skewness = 38873.39 , $p < .001$; kurtosis = 256.93 , $p < .001$). Since data were categorical and followed a non-normal distribution, CFAs were performed using robust Unweighted Least Squares (ULSMV). Items were set to load freely, except for one item per factor, which was set to 1 to ensure an identified model. The models under investigation were as follows: Model I: 4-factor structure [1]; Model II: 3-factor structure that retains two EDE-Q subscales (Restraint, Eating Concern) but collapses Weight and Shape Concern items [33]; Model III: 2-factor model that retains one EDE-Q subscale (Restraint) but collapses Eating, Weight and Shape Concern items [34]; and Model-IV: an unidimensional model for all EDE-Q subscale items [7]. Several fit indexes were considered: Root Mean Square Error of Approximation (RMSEA) and its 90% confidence interval, Tucker Lewis Index (TLI), and Comparative Fit Index (CFI). Values of CFI and TLI values close to $.90$, and RMSEA values $< .08$ were indicative of good fit [35, 36]. A Chi-square difference test ($\Delta\chi^2$) was used to compare models. Given the Likert-type nature of the EDE-Q [37], internal consistency was assessed through the Omega coefficient [38]; values of $\geq .80$ were considered adequate [39]. Kolmogorov-Smirnov tests showed that all scale scores were not normally distributed. Therefore, their concurrent validity was assessed using Spearman correlations with the MDDI scores. We also carried out sensitivity and specificity analyses for the EDE-Q total score with 139 interviewed males with the EDE. We used receiver operating characteristic (ROC) curves to determine the optimum cut-off score for males with ED diagnosis and risk of ED according to EDE interview criteria, using Youden's index, which indicates the balance between sensitivity/specificity. We estimated the Area Under the Curve (AUC) to assess the discrimination quality. In general, $AUC = .70-.80$ are considered acceptable, $AUC = .80-.90$ are considered as good, and $AUC = .90 - 1.00$ as excellent [40]. Lastly, we calculated the sensitivity as the true positive rate, the specificity as the true negative rate, the positive predictive value (PPV), and the negative predictive value (NPV).

3. Results

The first CFA (Model I) tested the fit of the original theoretical proposal [1]. Results of this analysis revealed a not positive definite matrix solution, indicating that this model was not acceptable. Fit statistic for the remaining model (II-IV) are presented in Table 1. Model IV showed poor fit to our data, while models II and III resulted in acceptable fit. The Chi-square difference test ($\Delta\chi^2$) revealed that Model-II showed better fit than Model-I. However, although $\Delta\chi^2$ indicated that Model-II showed better fit than Model-III, the difference in the remaining fit indexes was small (e.g., $\Delta TLI < .01$) [41]. Thus, we retained Model-III, as it was the model with better fit/parsimony balance (see Fig. 1). This retained two-factor model shows significant positive moderate to high correlations with the EDE interview (see Table 2).

Means scores, standard deviations and internal consistency, as well as correlations among EDE-Q and MDDI scores, are presented in Table 3. The EDE-Q and its subscales showed acceptable to excellent internal consistency, with omega coefficient values above .70 for the Restrain subscale, and above .90 for the remaining scales.

Regarding the concurrent validity, the MDDI total score showed positive moderate significant correlation with the EDE-Q and its subscales (.35 – .52). There were also positive moderate to high correlations between the MDDI-AI subscale and the EDE-Q, especially with the EWSC subscale ($\rho = .62$; $p < .01$) and the total score ($\rho = .60$; $p < .01$). On the other hand, the EDE-Q showed low to moderate positive correlations with the MDDI-DFS and the MDDI-AI subscales (see Table 3).

ROC curves are presented in Figs. 2 and 3. The figures show the optimum cut-off scores for males with ED diagnosis and at risk of ED, respectively. The cut-off score for ED diagnosis males was an EDE-Q-Global score = 2.41, whereas for risk-of-ED males was an EDE-Q-Global score = 1.09.

Descriptive statistics for each group and AUCs are presented in Table 4. As shown, AUCs indicate that the probability for an ED male to obtain a higher EDE-Q-Global score than control males is 76.9%, whereas the probability for a risk-of-ED male to obtain a higher EDE-Q-Global score than control males is 77.4%. These values are considered acceptable. Sensitivity, specificity, PPV and NPV values for the optimum cut-off scores are presented in Table 5, alongside the values for the classic EDE-Q diagnostic score (i.e., EDE-Q total ≥ 4.00).

4. Discussion

To our knowledge this is the first study to examine the factor structure of the questionnaire EDE-Q, contrasting the findings with the EDE interview in a representative university sample of Spanish men to establish a cut-off point for optimal ED detection in this population.

In the present study, the EDE-Q shows good internal consistency, with high Omega coefficient values for both the total scale and the two subscales of the EDE-Q, similar to those obtained in other studies [5, 17]. Therefore, the EDE-Q is shown to be a valid and reliable instrument for use as a screening tool in Spanish males.

Consistent with other studies [42, 7], the original 4-factor structure of the EDE-Q was not confirmed. For the Spanish male sample, the EDE-Q showed a better fit in a two-factor solution with a Restraint subscale and a Weight-Shape-Eating Concern subscale without removing any items [34]. Both the EDE interview and the EDE-Q were constructed on a rational basis to represent the key psychopathology of eating disorders. Subsequent factor studies, however, mostly do not support the initial structure [1]. These first theoretical approaches are based on a female-centric approach that may not fit the male perspective in which cognitive aspects seem to belong to a single dimension of body image concern.

Given the dual nature of male body dissatisfaction and its associated behaviors, it is suggested that the EDE-Q be used in males in conjunction with more specific measures of male body reality [43]. The EDE-Q shows moderate to high convergence with the MDDI, indicating overlap between ED and MD symptomatology, except for the Restraint subscale which shows a lower association with the Drive For Size subscale of the MDDI. This difference is not surprising, as this subscale is aimed at exploring the desire for muscle mass gain, for which dietary restriction is counterproductive [11, 9].

The EDE-Q mean scores observed in our sample are consistent with those obtained in research with similar samples of men in Spain [16, 19] and in other countries [44, 42, 43, 45, 46]. In general, men score lower than women in studies using the EDE-Q [15, 20, 47, 44, 46]. However, this does not necessarily imply that there is no ED symptomatology in males, so it is systematically questioned whether the cut-off points established for the questionnaires imply a risk of under-diagnosis [9, 45]. This risk is particularly salient when exploring male samples, where body image concerns and behaviors differ from those of women and the difficulty of detecting at-risk cases is greater [9, 11]. The use of a proposed initially cut-off ≥ 4 [27] as a marker of clinical significance has been criticized in the literature, suggesting downward rectification for both female [20] and male samples [16]. In fact, studies using ROC curve analyses contrasting EDE-Q scores with EDE interview scores point in this direction. In female samples there is a variability of cut-off proposals for the EDE-Q (EDE-Q-Global Score range: 1.98-2.80) [15, 48, 49, 50], all below the Carter et al. [1] proposal, including the cut-off ≥ 3.10 proposed by Mond et al. [48] for overweight individuals. For male samples, the cut-off ≥ 1.68 proposed by Schaefer et al. [45] is also far from the original proposal. The analysis performed in the present study suggests that, for the Spanish male sample, a cut-off ≥ 1.09 for at-risk of ED cases and ≥ 2.41 for clinical cases presents an optimal balance between sensitivity and specificity.

In conclusion, there are gender differences in levels of eating pathology that are indicative of clinical concern [45]. However, most research using the EDE-Q, including many in recent years, continues to use cut-off ≥ 4 in males [3, 5], leaving significant numbers of potentially at-risk participants undetected and therefore untreated. In men, body image and eating pathology is more complex and the EDE-Q is limited in detecting muscle-oriented eating risk behaviours. In this sense, the development and further examination of a modified muscle-oriented version of the EDE-Q [51] that captures the domains of disordered eating relevant to males may be promising.

Strength and limits

The main strength of the study is its big sample size and the representativeness of the sample of undergraduate men students of Spain. Conducting clinical interviews in research is an indispensable requirement to contrast the results of the questionnaires and establish a correct diagnosis. However, its high cost makes it difficult to carry out, so the high number of clinical interviews conducted is another important strength of the study. However, results of this study should consider some limitations. Although the sample provided level-sport data, no invariance studies have been carried out in this respect. Also, no

data was collected on the ethnic or sexual diversity of the participants, so the results obtained in university students do not allow generalization of the results to other samples of males.

What is already known on this subject?

The factor structure of the EDE-Q has been explored in different samples with contradictory results. Particularly in the male population, the interview-based cut-off point is not sensitive for males, aggravating the problem of underdiagnosis.

What does this study add?

Our study explores the factor structure of the EDE-Q in a large representative sample of males, who also participated in a clinical interview. Our results provide the scientific community with a sensitive and specific cut-off point of the EDE-Q for males and represent a potential advance in the detection of ED in Spanish-speaking males.

Declarations

Compliance with ethical standards

Ethical approval Ethical approval was obtained from the Research Ethics Committee of the Autonomous University of Madrid (UAM, CEI-75-1368).. All procedures performed in this study involving human participants were in accordance with the ethical standards and with de Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent Written informed consent was obtained from all the surveyed participant

Conflict of interest The authors declare that they have not conflict of interest.

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Availability of data and material Not applicable

Code availability Not applicable

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Tables

Table 1 to 5 is not available in this version of the manuscript.

Figures

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Figure 1

The first CFA (Model I) tested the fit of the original theoretical proposal [1]. Results of this analysis revealed a not positive definite matrix solution, indicating that this model was not acceptable. Fit statistic for the remaining model (II-IV) are presented in Table 1. Model IV showed poor fit to our data, while models II and III resulted in acceptable fit. The Chi-square difference test ($\Delta\chi^2$) revealed that Model-II showed better fit than Model-I. However, although $\Delta\chi^2$ indicated that Model-II showed better fit than

Model-III, the difference in the remaining fit indexes was small (e.g., $\Delta TLI < .01$) [41]. Thus, we retained Model-III, as it was the model with better fit/parsimony balance (see Figure 1). This retained two-factor model shows significant positive moderate to high correlations with the EDE interview (see Table 2).

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Figure 2

ROC curves are presented in Figures 2 and 3. The figures show the optimum cut-off scores for males with ED diagnosis and at risk of ED, respectively. The cut-off score for ED diagnosis males was an EDE-Q-Global score = 2.41, whereas for risk-of-ED males was an EDE-Q-Global score = 1.09.

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Figure 3

ROC curves are presented in Figures 2 and 3. The figures show the optimum cut-off scores for males with ED diagnosis and at risk of ED, respectively. The cut-off score for ED diagnosis males was an EDE-Q-Global score = 2.41, whereas for risk-of-ED males was an EDE-Q-Global score = 1.09.