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Factorial structure and measurement invariance of the Bulimic Investigatory Test, Edinburgh across gender and age[1]

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ABSTRACT. The main purpose of this instrumental study was to examine the factorial structure and measurement invariance of the Bulimic Investigatory Test, Edinburgh (BITE) across gender and age in a community sample of nonclinical adolescents. The sample consisted of 1,794 adolescents (50.2 % males), with a mean age of 14.7 years (*SD* = 1.72). The results showed that the BITE is a measurement instrument which presents adequate psychometric properties. The level of internal consistency for the *Symptom* subscale was .95 whereas for the *Severity* subscale it was .70. The analysis of the dimensionality of the BITE using exploratory factor analysis revealed a one-factor solution. In addition, the confirmatory factor analysis showed adequate fit indices for the one-factor solution. This dimensional structure of the BITE proved to be invariant across gender and age. Statistically significant differences were found as a function of age and gender when the groups were compared in the latent means. Future studies should incorporate the new advances in psychological and educational assessment pertaining to Computerized Adaptive Testing as well as examine the measurement invariance of the tests which assess bulimic symptomatology across cultures.

KEYWORDS. BITE. Psychometric properties. Measurement invariance. Bulimic symptoms. Instrumental study.

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RESUMEN. El objetivo de este estudio instrumental fue examinar la estructura factorial y la invarianza de medición a través del sexo y la edad del *Bulimic Investigatory Test, Edinburgh* (BITE) en una muestra comunitaria de adolescentes no clínicos. La muestra la formaron 1.794 adolescentes (50,2% varones), con una edad media de 14,7 años (*DT* = 1,72). Los resultados mostraron que el BITE es un instrumento de medida que presenta adecuadas propiedades psicométricas. El nivel de consistencia interna para la subescala *Síntomas* fue 0,95, mientras que para la subescala de *Gravedad* fue de 0,70. El estudio de la dimensionalidad del BITE mediante análisis factorial exploratorio mostró una solución esencialmente unidimensional. Los índices de bondad de ajuste para el modelo unidimensional sometido a prueba en el análisis factorial confirmatorio fueron adecuados. Más aún, esta estructura dimensional del BITE se mostró invariante en función del género y la edad. Se encontraron diferencias estadísticamente significativas en función del género y la edad cuando se compararon las medias latentes. Futuros estudios deberían incorporar los avances relacionados con la evaluación psicológica y educativa como la construcción de tests adaptativos computerizados, así como examinar la invarianza de medición de la sintomatología bulímica a través de las culturas.

PALABRAS CLAVE. BITE. Propiedades psicométricas. Invarianza de medición. Sintomatología bulímica. Estudio instrumental.

Bulimia nervosa (BN), one of the two major eating disorders included in the DSM-IV-TR, is characterized by the presence of binge eating and maladaptive compensatory methods along with an excessive influence of body shape and weight on self-evaluation (American Psychiatric Association, 2000). Individuals with BN suffer from significant distress, role impairment and medical and psychological consequences which severely affect their quality of life. Although epidemiological data place lifetime prevalence of BN in 1-3% (American Psychiatric Association, 2000; Hudson, Hiripi, Pope, and Kessler, 2007; Preti *et al.*, 2009), many individuals with BN do not seek help, therefore, many cases may go undetected (Hoek, van Hoeken, and Katzman, 2003). Moreover, research shows that the percentage of individuals with subclinical forms of the disorder, that is, individuals suffering from bulimic symptoms associated with great distress but that may not meet the diagnostic criteria for BN is high (Chamay-Weber, Narring, and Michaud, 2005). In addition, bulimic symptomatology is not restricted to individuals with eating disorders but rather studies have shown that bulimic symptoms are also present in adults and nonclinical adolescents (de Souza Ferreira and Valeria da Veiga, 2008; Poyastro Pinheiro, Bulik, Sullivan, and Machado, 2008; Rodríguez *et al.*, 2001; Sierra-Baigrie, Lemos-Giráldez, and Fonseca-Pedrero, 2009). Therefore, as BN represents an important public-health concern, the understanding of the nature of this phenomenon, as well as finding ways of early detection of at-risk individuals, are vital for the prevention of the disorder.

The field of psychological assessment of eating disorders has advanced considerably in the last few years (Peterson and Mitchell, 2005). In this regard, in the scientific literature we can find numerous self-reports developed for the assessment of behaviors, symptomatology and beliefs related to BN. Specifically for the assessment of bulimic symptomatology we find the Bulimia Test (BULIT) (Smith and Thelen, 1984), and the

Bulimic Investigatory Test, Edinburgh **(**BITE) (Henderson and Freeman, 1987), or the Eating Disorders Examination-Questionnaire (EDE-Q) (Fairburn and Beglin, 1994)

Since Henderson and Freeman first developed the BITE, it has been widely used in different studies and cultures (Kiziltan, Karabudak, Unver, Sezgin, and Unal, 2006; le Grange, Louw, Russell, Nel, and Silkstone, 2006; Miotto, De Coppi, Frezza, and Preti, 2003; Rivas, Bersabé, and Jiménez, 2004; Sierra-Baigrie *et al.*, 2009), and its psychometric properties have also been widely investigated (Orlandi, Mannucci, and Cuzzolaro, 2005; Ricca *et al.*, 2000; Ricciardelli, Williams, and Kiernan, 1999; Rivas, *et al.*, 2004; Rueda-Jaimes, Camacho, and Rangel-Martínez-Villalba, 2008; Waller, 1992). In a pioneer study conducted by Henderson and Freeman (1987), where the construction and validation of the BITE was first presented, its psychometric properties were examined in different groups of patients with eating disorders and controls. When the reliability of the subscales of the BITE was analyzed using Cronbach's alpha coefficient, they found for all samples a value of .96 for the *Symptoms* subscale and .62 for the *Severity* subscale. Moreover, the test-retest reliability levels ranged from .86 to .68. Ricciardelly *et al.* (1999), using a sample of 427 Australian girls and 350 boys (age range 12-17 years), analyzed the internal structure of the *Symptom* subscale of the BITE. A general factor of bulimic symptomatology was found in the female sample which explained 20.85% of the variance; however, in the male sample two factors were found, namely: *Emotional and Rigid/Disruptive Eating Style* and *Food Preoccupation and Binging*, which respectively explained 13.8% and 8.4% of the total variance. On their part, Orlandi *et al.* (2005), in a more recent study using a general population sample ($N = 995$), another sample of 388 eating-disordered females and a third sample of 710 patients with obesity (575 female), found Cronbach's alpha coefficients which ranged from .82 to .93. When the internal structure of the BITE was analyzed, they found a general factor which explained 26-38% of the total variance depending on the group used in the analysis.

In a study by Rivas *et al.* (2004), the BITE was translated and adapted into Spanish using a sample of 1,122 nonclinical adolescents, with an age range of 12-19 years. They found an internal consistency (Cronbach's alpha) for the Symptom subscale of .82 and .63 for the Severity subscale. The analysis of the dimensional structure of the Symptom subscale revealed the presence of a general factor which explained 19.89% of the total variance. Finally, Rueda-Jaimes *et al.* (2008) further examined the psychometric properties of the BITE in a sample of 261 Colombian university students. In this study They found an internal consistency (Cronbach's alpha) for the *Symptom* subscale of .86 and .52 for the *Severity* subscale. The analysis of its internal structure indicated the presence of two factors which explained 29.80% of the total variance. The first factor was composed of aspects related to diet and the second factor was composed of aspects pertaining to loss of control.

The BITE is also a useful measurement instrument for examining the prevalence rates of bulimic symptomatology, and in particular binge eating, in nonclinical and clinical populations (Rodríguez-Cano, Beato-Fernández, and Belmonte-Llario, 2005). Furthermore, it allows us to deepen our comprehension of the phenomenology of these symptoms across gender, age, or culture of origin. In this sense, when the observed scores on the *Symptom* and *Severity* subscales are compared as a function of gender,

we find that females score higher than males in bulimic symptoms measured with this instrument (le Grange, Telch, and Tibbs, 1998; Miotto, De Coppi, Frezza, Petretto *et al.*, 2003; Preti *et al.*, 2007; Ricciardelli *et al.*, 1999). Very few studies have used the BITE to analyze the role that age plays in the expression of bulimic symptomatology, being age a less frequently studied variable than gender. In general terms, the studies which have employed the BITE in different samples, have not found statistically significant differences in the BITE scores by age of the participants analyzed (Preti *et al.*, 2007; Ricca *et al.*, 2000). However, when mean scores are used to compare groups (*e.g.,* male/ female; youths/ adults) it is important that the scores have the same meaning in each group; that is, the assessment is invariant across groups. In a classic study, Horn and McArdle (1992) defined measurement invariance as: «whether or not, under different conditions of observing and studying phenomena, measurement operations yield measure of the same attribute» (p. 117). When comparisons between groups are made, it is typically assumed that both the measurement instrument and the psychological construct underlying said instrument behave in the same manner and have the same significance across the groups being compared. If measurement invariance does not hold, the validity of the inferences and interpretations extracted from the data may be erroneous (Byrne, 2008). Therefore, it is crucial to examine measurement invariance of the assessment tool so that findings based on comparisons of the groups can be valid.

Within this field of research, the main purpose of this instrumental study (Carretero-Dios and Pérez, 2007; Montero and León, 2007) was to examine the dimensional structure and measurement invariance of the BITE across gender and age in a community sample of nonclinical adolescents. The present investigation is relevant for various reasons as it allows us to: a) understand and examine the dimensional structure (number and content) of bulimic symptomatology at an age of special risk for the development of eating disorders; b) test whether bulimic symptomatology holds invariant across gender and age without the confounding effects of medication and stigmatization frequently associated to clinical samples; c) determine the psychometric properties of a measurement instrument for screening purposes and for its use in detection and early intervention programs for participants at risk; and d) provide epidemiological data to better understand the nature and phenomenological expression of this psychological phenomenon in community adolescent samples.

Method

Participants

One thousand seven hundred and ninety-four adolescents enrolled in ten different Secondary Education Centers in the Principality of Asturias, a northern region in Spain, participated in the study. The schools were selected to ensure the heterogeneity of the sample with participants recruited from both urban and rural areas as well as from different socioeconomic statuses. The age of the participants ranged from 12 to 19 (M = 14.67; SD = 1.72), 50.2% males (n = 900) and 49.8% females (n = 894). The age distribution of the sample was the following: 12 years (n = 185), 13 years (n = 347), 14 years (n = 362), 15 years (n = 285), 16 years (n = 315), 17 years (n = 212), 18 years (n

= 74) and 19 years (n = 14). With the aim of conducting the pertinent statistical analyses, a cross-validation study was performed where the total sample was then randomly split into two subsamples of 897 participants. The first sample consisted of 457 boys and 440 girls with a mean age of 14.66 years (SD = 1.72) and the second consisted of 443 boys and 454 girls with a mean age of 14.68 years (SD = 1.71). Neither age (t = -.193; p > .05) nor sex rates (χ^2 = .43; p > .05) differed across subsamples.

Measurement instrument

The BITE (Henderson and Freeman, 1987) is a self-report questionnaire used to evaluate the presence and severity of bulimic symptomatology, and cognitive and emotional signs and symptoms associated with binge eating. In addition, it can be used as a screening instrument in epidemiological research or as a measure of treatment results in follow-up studies. It is composed of 33 items divided into two different subscales: a 30-item *Symptom* subscale (for example: «*Are you worried about not being able to control how much you eat?*») and a 3-item *Severity* subscale («frequency of fasting», «methods for losing weight», and «frequency of binge eating»). The items in the *Symptom* subscale are formulated in a dichotomous format (*Yes/No*), whereas the items in the *Severity* subscale are formulated in a Likert-type response format (with 5 or 7 options depending on the item). The minimum score on the *Symptom* subscale is 0 and the maximum possible score is 30, there again, the maximum score on the *Severity* subscale is 39. Item 7 in the *Severity* subscale has four sub-items. In addition, the authors propose a total score based on the sum of the scores on both subscales which can range from 0 to 69 points. Henderson and Freeman (1987) consider a BITE score under 10 points as indicative of no problem with eating behavior, a score between 10 and 20 points as indicative of abnormal eating patterns (from 15 to 20 points warns us of the presence of a possible sub-threshold BN) and a score higher than 20 points constitutes altered eating patterns with a possible BN. The cut-off points for the Severity subscale are: 5-9 clinically significant severity; 10 or more points indicates a highly severe problem. Regarding the total score, scores of 25 or more suggest the presence of a severely altered eating behavior pattern. Nevertheless, neither the scores on the subscales nor the total scores on the BITE can be used for diagnostic purposes. The Spanish adaptation has been analyzed by Rivas *et al.* (2004) in a sample of 1,122 nonclinical adolescents. They found an internal consistency (Cronbach's alpha) for the *Symptom* subscale of .82 and .63 for the *Severity* subscale. This version has been employed in BN Spanish patients (Fernández-Aranda *et al.,* 2009) and in relation to other psychological variables (*e. g.,* family meal patterns or coping strategies) (Peñas-Lledó, Loeb, Puerto, Hildebrandt, and Adrián Llerena, 2008; Sierra-Baigrie and Lemos-Giráldez, 2008).

Procedure

The study took place during the school schedule with participants completing the questionnaires in their classrooms or school laboratories in groups of 15 to 25 students under the supervision of the researchers. Professional child psychologists gave the instructions on how to answer the test and helped them during the session. Permission

from the schools' principals and consent from the adolescents' families were obtained for the study. The study was completely anonymous and voluntary and no incentive was offered for participation.

Data analyses

First, we calculated the descriptive statistics of the items and of the total score for the two subscales of the BITE. Second, in order to study the dimensional structure of the *Symptom* subscale of the BITE by means of cross-validation, the total sample was divided into two subsamples. An exploratory factor analysis was performed in the first subsample using the Unweighted Least Squares method. The tetrachoric correlation matrix was used. The procedure for determining the number of factors was Minimum Average Partial. A Confirmatory Factor Analysis (CFA) was conducted on the second subsample testing the model obtained in the exploratory factor analysis. The following goodness-of-fit indices were used: Satorra-Bentler scaled chi-square test (S-B χ^2), General Fit Index (GFI), Root Mean Square Error of Approximation (RMSEA) (and its confidence interval) and Standardized Root Mean Square Residual (SRMR). S-B χ^2 permits the correction of χ^2 when the distributional assumptions are violated. Hu and Blentler (1999) suggested RMSEA should be less or equal to .06, CFI values superior or equal to .95, and SRMR values inferior to .08, being indicative of a well-fitting model. Third, with the aim of studying measurement invariance (MI), successive multi-group CFA's were conducted. MI is frequently tested by multigroup comparisons using structural equation modeling within the framework of a CFA model (Byrne and van de Vijver, 2010). Basically, a hierarchical set of steps are followed when invariance is tested, typically starting with the determination of a well-fitting multigroup baseline model and continuing with the establishment of successive equivalence constraints in the model parameters across groups (Byrne, 2008; Byrne and Stewart, 2006; Fonseca-Pedrero *et al.*, 2010). The basal model is called the configural model, which is the first and least restrictive model to be tested and is important because it represents the baseline model against which all subsequent specified invariance models are compared. First of all, the configural model is established by specifying and testing the model for each group separately. Once the theoretical model has been validated in both groups, configural invariance is examined requiring that the same pattern of fixed and freely estimated parameters being equivalent across groups, and therefore, that no equality constraints are imposed. When configural invariance is met, it suggests that the factor structure is similar, but not equivalent across groups. Moreover, metric or weak invariance is established, where the equivalence of the factorial loadings across groups is tested. Factor loadings are freely estimated for the first group only, and in the remaining groups, these parameter estimates are constrained equal to those of the first group. When the metric invariance is met, it suggests that the same unit of measurement is being used for the item across the groups and that the participants interpret and respond to the measure in a similar manner. Finally, strong or scalar invariance is tested, where the item intercepts and the factor loadings are equally constrained across groups. The confirmation of the invariance of the intercepts permits comparison of the latent means in both groups. The analyzed models can be seen as nested models to which constraints are progressively added. For

the comparison of the nested models, we have proposed criteria such as the «CFI or chi-square difference tests ($\Delta\chi^2$) (Byrne and Stewart, 2006; Cheung and Rensvold, 2002). Both criteria have been extensively used in the literature, however, when they are used in conjunction they are clearly in disagreement causing researchers to reach completely contradictory conclusions (Rusticus, Hubley, and Zumbo, 2008). Due to the limitations of the χ^2 regarding its sensitivity to sample size, Cheung and Rensvold (2002) have proposed a more practical criterion, the ΔCFI, to determine if the compared models are equivalent. In this sense, when there is a change greater than .01 in the CFI between two nested models, the least constrained model is accepted and the other rejected, that is, the most restrictive model does not hold. If the change in CFI is inferior to .01, it is considered that all specified equal constraints are tenable, and, therefore, we can continue with the next step in the analysis of MI. SPSS 15, FACTOR (Lorenzo-Seva and Ferrando, 2006), LISREL 8.73 (Jöreskorg and Sörbom, 1993) were used for all data analyses.

Results

Descriptive statistics

The mean score on the *Symptom* subscale of the BITE for the total sample was 5.50 (*SD* = 4.37) ranging the scores from 0 to 26. For the *Severity* subscale the mean score was 4.77 (*SD* = 3.57) with a score range of 2-28. In the current study, 226 adolescents (12.6%) obtained a score between 10 and 20 points on the BITE. There were only 30 cases (1.7%) with a score of 20 points or greater. Most of the adolescents had less than 10 points on the BITE (*n* = 1,538). With respect to the *Severity* subscale, a total of 81 participants (4.5%) obtained a score between 5 and 9 whereas a total of 27 adolescents (1.4%) obtained a score over 10. Table 1 displays the descriptive statistics of the items in the BITE for the total sample and for males and females.

TABLE 1. Descriptive statistics for the items in the Bulimic Investigatory Test, Edinburgh for the total sample and for males and females.

	Total sample (N = 1,794)		*Males (n = 900)*		*Females (n = 894)*	
Items	*M*	*SD*	*M*	*SD*	*M*	*SD*
1. Regular eating patterns	.36	.48	.35	.48	.37	.48
2. Strict dieter	.08	.27	.06	.24	.10	.30
3. Feel a failure if break diet once	.18	.38	.14	.35	.22	.41
4. Count calories, even when not on a diet	.07	.26	.05	.22	.10	.30
5. Fast for a whole day	.26	.44	.21	.40	.30	.46
8. Eating disrupts life	.07	.26	.05	.22	.10	.30
9. Food dominates life	.10	.30	.084	.28	.11	.32
10. Eat and eat until stopped by physical discomfort	.24	.43	.22	.41	.27	.45
11. All you can think about is food	.26	.44	.26	.44	.26	.44

TABLE 1. Descriptive statistics for the items in the Bulimic Investigatory Test, Edinburgh for the total sample and for males and females. (Cont.).

	Total sample (N = 1,794)		*Males (n = 900)*		*Females (n = 894)*	
Items	*M*	*SD*	*M*	*SD*	*M*	*SD*
12. Eat sensibly in front of others and make up in private	.09	.29	.08	.27	.11	.31
13. Stop eating when want to	.12	.32	.10	.30	.14	.34
14. Experience urges to eat and eat	.20	.40	.17	.38	.23	.42
15. Eat a lot when feeling anxious	.25	.43	.16	.36	.33	.47
16. Thought of becoming fat terrifying	.47	.50	.35	.48	.59	.49
17. Eat food rapidly	.37	.48	.39	.48	.36	.48
18. Ashamed of eating habits	.10	.30	.09	.28	.12	.32
19. Worry that you have no control over eating	.35	.48	.29	.45	.40	.49
20. Turn to food for comfort	.06	.24	.04	.21	.08	.27
21. Able to leave food on the plate	.15	.36	.20	.40	.11	.31
22. Deceive people about how much you eat	.09	.28	.06	.24	.11	.31
23. How hungry you feel determines how much you eat	.47	.50	.50	.50	.45	.50
24. Binge on large amounts	.36	.48	.40	.49	.31	.46
25. Binges leave you miserable	.07	.25	.04	.21	.09	.29
26. Binge when you are alone	.05	.23	.039	.19	.07	.26
28. Go to great lengths to satisfy an urge to binge	.06	.24	.06	.25	.06	.23
29. Feel guilty after overeating	.16	.38	.11	.31	.24	.43
30. Eat in secret	.17	.37	.16	.37	.17	.37
31. Eating habits normal	.15	.36	.15	.36	.14	.35
32. Compulsive eater	.06	.23	.05	.22	.07	.25
33. Weight fluctuates more than five pounds in a week	.04	.20	.047	.21	.04	.20

Note. Item 6 («*frequency of fasting*»), item 7 («*methods for losing weight*»), and item 27 («*frequency of binge eating*») make up the *Severity* subscale.

Internal consistency of BITE scores

Cronbach's alpha coefficient for the items comprising the *Symptom* subscale of the BITE was .95, whereas for the *Severity* subscale items it was .70. All the discrimination indices for the items in the *Symptom* subscale were superior to .20 with the exception of items 1, 21 and 23. Regarding the *Severity* subscale the discrimination indices were superior to .30.

Exploratory factor analysis of BITE items

An exploratory factor analysis was conducted with the first subsample using the tetrachoric correlation matrix. The measure of sample adequacy (Bartlett's statistic) was 13723.2 ($p < .001$), with a Kaiser-Meyer-Olkin index of .97. The advised number of dimensions for Minimum Average Partial was one. The Scree Plot analysis, the Kaiser

criterion and the interpretation of the factors and the number of suggested factors are in accordance with an essentially one-factor solution. This first factor explained 19.64% of the total variance with an eigenvalue of 11.97 and it was denominated *Bulimic symptomatology*. Table 2 shows the factor loadings and the communalities for the first factor obtained.

TABLE 2. Exploratory and confirmatory factor analyses of the Bulimic Investigatory Test, Edinburgh.

	Exploratory factor analysis Sample 1		*Confirmatory factor analysis Sample 2*	
Items	*Loadings*	*Communalities*	λ_x	R^2
1. Regular eating patterns	.16	.03	.05	.00
2. Strict dieter	.44	.19	.30	.01
3. Feel a failure if break diet once	.57	.33	.55	.33
4. Count calories, even when not on a diet	.51	.26	.43	.18
5. Fast for a whole day	.41	.17	.32	.10
8. Eating disrupts life	.77	.59	.73	.53
9. Food dominates life	.72	.51	.70	.49
10. Eat and eat until stopped by physical discomfort	.57	.32	.59	.34
11. All you can think about is food	.51	.26	.48	.23
12. Eat sensibly in front of others and make up in private	.73	.53	.66	.44
13. Stop eating when want to	.54	.29	.50	.25
14. Experience urges to eat and eat	.58	.33	.58	.34
15. Eat a lot when feeling anxious	.54	.29	.62	.38
16. Thought of becoming fat terrifying	.51	.25	.54	.29
17. Eat food rapidly	.50	.25	.42	.17
18. Ashamed of eating habits	.82	.68	.80	.64
19. Worry that you have no control over eating	.49	.24	.57	.33
20. Turn to food for comfort	.68	.46	.80	.64
21. Able to leave food on the plate	.20	.04	.27	.07
22. Deceive people about how much you eat	.70	.49	.66	.43
23. How hungry you feel determines how much you eat	.24	.06	.19	.03
24. Binge on large amounts	.49	.24	.41	.17
25. Binges leave you miserable	.87	.76	.86	.74
26. Binge when you are alone	.75	.56	.67	.44
28. Go to great lengths to satisfy an urge to binge	.44	.20	.63	.40
29. Feel guilty after overeating	.68	.47	.70	.48
30. Eat in secret	.59	.34	.49	.24
31. Eating habits normal	.65	.42	.67	.46
32. Compulsive eater	.80	.65	.81	.65
33. Weight fluctuates more than five pounds in a week	.46	.21	.58	.34

Note. κ_x: standardized coefficients; R^2: proportion of explained variance. Item 6 ("*frequency of fasting*"), item 7 ("*methods for losing weight*"), and item 27 ("*frequency of binge eating*") make up the *Severity* subscale.

Measurement invariance of the BITE across gender and age

Next, the model obtained in the exploratory factor analysis was validated using the second subsample of participants. The CFA tested the essentially one-factor model where all the items saturated in a general bulimic symptomatology factor. The fit indices corresponding to the one-factor model were: S-B χ^2 = 1337.3, *df* = 405, $p < .001$; CFI = .98; GFI = .92; RMSEA = .051 (90% C.I: .048-.054); SRMR = .11. The standardized coefficients and the squared multiple correlations are also presented in Table 2.

Once we had confirmed that the one-factor model presented an adequate fit to the data, measurement invariance of the BITE was tested, first across gender and then across age. To examine measurement invariance across age, the sample was divided into two subgroups (12-15 year-olds and 16-19 year-olds) according to the stages of the Spanish educational system (obligatory/ post-obligatory). Prior to the analysis of measurement invariance across gender and age, we tested whether the one-factor model showed a reasonable good fit in each group. Next, configural, metric and strong invariance across gender and age of participants was examined; the results are shown in Table 3. As can be observed, when the equivalence of the factorial loadings and intercept values were incorporated, the difference in the ΔCFI between the configural and the constrained models did not exceed. Therefore, the results support configural, metric and strong invariance ob the BITE across gender and age.

TABLE 3. Goodness-of-fit indices and measurement invariance for the theoretical model proposed.

Model	*S-B* χ^2	*df*	*RMSEA*	*RMSEA 90 % CI*	*SRMR*	*AIC*	*CFI*	*ΔCFI*
One-dimensional	1337.3	405	.051	.048-.054	.11	1457.2	.981	
Sex								
Men (*n* = 443)	716.1	405	.042	.037-.047	.13	836.1	.990	
Women (*n* = 454)	1016.9	405	.058	.053-.062	.13	1136.9	.980	
Multigroup comparisons								
Configural invariance	1700.7	810	.050	.046-.053	.13	1950.7	.981	
Metric invariance	1770.7	839	.050	.047-.053	.14	1952.7	.980	-.01
Strong invariance	1903.1	868	.052	.048-.055	.14	2147.1	.978	-.01
Age								
12-15 years (*n* = 592)	881.9	405	.045	.041-.049	.12	1001.9	.985	
16-19 years (*n* = 305)	889.1	405	.063	.057-.068	.14	1009.4	.976	
Multigroup comparisons								
Configural invariance	1770.1	810	.051	.048-0.55	.15	2010.7	.980	
Metric invariance	1822.9	839	.051	.048-.054	.16	2004.9	.979	-.01
Strong invariance	2001.6	868	.054	.051-.057	.16	2245.6	.976	-.01

Note. S-B χ^2: Satorra-Bentler Scaled chi-square test; RMSEA: Root Mean Square Error of Approximation; CI: Confidence Interval; SRMR: Standardized Root Mean Square Residual; AIC: Akaike Information Criterion; CFI: Comparative Fit Index.

Next, latent mean differences across groups were estimated fixing the latent mean values to zero in males and, next, in the 12-15 year-old groups. Comparisons among groups were based on statistical significance of the difference evaluated by *z* statistic. The comparison of the gender groups on the latent means, indicated that, on average, women scored .148 units above males in bulimic symptomatology and that this difference was statistically significant (.148; $p < .01$). The comparison of the age groups on the latent means, indicates that, on average, the 16-19 years-old-adolescents score .060 units above the 12-15-year-old adolescents on bulimic symptomatology, being this difference statistically significant (.060; $p < .01$).

Discussion and conclusions

The main purpose of this instrumental study was to examine the factorial structure and measurement invariance of the BITE across gender and age in a community sample of nonclinical adolescents. The results show that: a) the BITE is an adequate measurement instrument for the assessment of bulimic symptomatology in nonclinical adolescent populations; b) the analysis of the dimensional structure of the BITE shows the presence of a solution specified in one general factor; c) bulimic symptomatology, measured by the BITE, holds invariant across gender and age of participants; and d) there are statistically significant differences in the severity of bulimic symptomatology when participants are compared in the latent means according to gender and age.

Consistent with previous literature, the BITE is a measurement instrument which presents adequate psychometric characteristics (Orlandi *et al*., 2005; Ricca *et al.*, 2000; Ricciardelli *et al.*, 1999; Rivas *et al.*, 2004; Rueda-Jaimes *et al.*, 2008; Waller, 1992) for the assessment of bulimic symptomatology and can be used in a rapid and easy manner as a tool for screening or epidemiological purposes, not only in clinical populations but also in adult and adolescent nonclinical populations. When the dimensional structure of the BITE is analyzed the results are in accordance with an essentially one-factor structure (Orlandi *et al.*, 2005; Ricciardelli *et al.*, 1999; Rivas *et al.*, 2004); however, it is true that some studies have found two factors (Ricciardelli *et al.*, 1999; Rueda-Jaimes *et al.*, 2008). The results obtained in our Spanish population, using CFA, show that the unidimensional model had a reasonably good fit to the data, not only for the total sample but also as a function of the gender and age of the adolescents, thus, contributing data supporting the replicability as well as the consistency of the one-factor model across the different groups.

Similarly, when the raw scores on the BITE of the participants (total or *Symptom* subscale) are compared, other studies have found, like in the current study, that females score higher than males on bulimic symptoms (le Grange *et al.*, 1998; Miotto, De Coppi, Frezza, Petretto *et al.*, 2003; Preti *et al.*, 2007; Ricciardelli *et al.,* 1999) however, regarding age, contrary to what has been reported in previous studies (Preti *et al.*, 2007; Ricca *et al*., 2000), no significant differences were found with slightly higher scores as age increased. Nevertheless, it is worth mentioning that the strict comparison between studies is hindered not only by the heterogeneity of the samples but also by the statistical analyses employed. In this study, once measurement invariance was tenable,

the differences in the latent variable means are compared and not in the observed scores. For example, Ricca *et al*. (2000), in a sample of obese patients failed to find statistically significant differences between the different age groups in the BITE total score. Similarly, Preti *et al.* (2007) using a sample of 1,324 Italian adolescents did not find a relationship between the BITE score and age. However, a wide range of studies do not analyze the role that age plays in the BITE score (Ricciardelli *et al.*, 1999; Rivas *et al.*, 2004; Rueda-Jaimes *et al.*, 2008). In general terms, bulimic symptomatology measured through the BITE seems to be a unidimensional structure whose phenotypical expression varies as a function of participants' gender and age.

The study of the presence of bulimic symptomatology in nonclinical populations, such as adolescents who have not yet developed a full-blown eating disorder, is important to further our understanding of this phenomenon and improve our assessment methods for detecting individuals at high risk for BN and, consequently, prevent them from developing this disorder; however, the results of the study should be interpreted in the light of some important limitations. Firstly, the age range, type and size of the sample are relevant factors which should be acknowledged. Adolescence is a developmental period where a series of different affective, social and biological changes take place, and these factors could play an important role in the obtained results of the study. Secondly, the administration of self-reports to assess anxious-depressive symptomatology would have been interesting, given that these symptoms are frequently present in this age group. Thirdly, there are problems inherent to the application of any self-report which hinder the interpretation and comprehension of some items; therefore, the use of a hetero-method, by means of external informants such as parents or teachers, would have been interesting, although this would have been very costly. Lastly, ethnic and cultural differences should be taken into account when making comparisons with other studies.

There are many lines of future research that can be pursued in the field of bulimic symptomatology: on the one hand, the incorporation of the advances in psychological and educational measurement, with the Item Response Theory and Computerized Adaptive Testing (Abad, Olea, Aguado, Ponsoda, and Barrada, 2009) and, on the other hand, the longitudinal follow-up of participants with high scores on these types of self-reports with a view to the implementation of early detection and prevention programs (Shaw, Stice, and Becker, 2009). It could be also an interesting future line of research the implementation of detection and early intervention programs in participants at risk, as in other research areas (Fonseca-Pedrero *et al.*, 2008; Fonseca-Pedrero *et al.*, 2009) identified through their high scores on these self-reports or in combination with other self-reports (Ortet *et al.*, 2010) or constructs (Cunha, Relvas, and Soares, 2009; del Barrio *et al.*, 2009; Gasco, Briñol, and Horcajo, 2010) with the aim of reducing or mitigating the possible impact the disorder could have on their physical, psychological and social wellbeing.

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