Received: 23 October 2020 | Revised: 4 February 2021 | Accepted: 5 February 2021

DOI: 10.1002/eat.23488

ORIGINAL ARTICLE

International Journal of EATING DISORDERS WILEY

Confirmatory factor and measurement invariance analyses of the Eating Disorder Examination Questionnaire in sexual minority men and women

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Funding information
National Institutes of Health, Grant/Award Number: 5R25GM058906-16

Action Editor: Ruth Weissman

Abstract

Objective: The present study aimed to investigate the factor structure of the Eating Disorder Examination Questionnaire (EDE-Q) in a large sample of cisgender sexual minority men and women, and subsequently, to evaluate measurement invariance by gender.

Method: The sample consisted of 962 sexual minority adult men (*n* = 479) and women (*n* = 483) who completed online self-report surveys. Confirmatory factor analysis was conducted using two previously supported factor structures (Friborg et al.'s four-factor model and Grilo et al.'s brief three-factor model) as well as the original four-factor structure of the EDE-Q.

Results: Results indicated that the best fitting models were Friborg et al.'s four-factor model (CFI = .974, RMSEA = .098, SRMR = .0 70) and Grilo et al.'s brief three-factor model (CFI = .999, RMSEA = .049, SRMR = .017). The model fit of both factor structures were nearly identical when examined separately for men and women. The original four-factor structure could not be supported in this sample. Measurement invariance analyses further indicated that the best fitting models were invariant by gender in sexual minority individuals. Internal consistency was adequate for all subscales of Friborg et al.'s and Grilo et al.'s models.

Discussion: The present study provides support for the use of the EDE-Q in sexual minority men and women. Additionally, findings demonstrate that the EDE-Q performs similarly in sexual minority men and women. Future research is needed to further evaluate measurement invariance of the EDE-Q by sexual orientation, gender identity, and race.

KEYWORDS
bisexual, Eating Disorder Examination-Questionnaire, eating disorders, factor analysis, gay, lesbian, psychometrics, sexual minorities, symptom assessment

1 | INTRODUCTION

Sexual minority individuals (i.e., individuals who identify as gay, lesbian, bisexual, or any identity other than heterosexual, and/or that are attracted to and/or engage in sexual behavior with others of the same or multiple genders; Institute of Medicine, 2011) are at greater risk for developing eating disorders and disordered eating behavior as compared to their heterosexual peers (Calzo, Blashill, Brown, &

Argenal, 2017). Although studies examining the prevalence of diagnosable eating disorders in sexual minority populations are rare, a recent, nationally representative study of United States adults found elevated rates of eating disorder diagnoses in sexual minority individuals as compared to heterosexual men and women (Kamody, Grilo, & Udo, 2020); however, this study did not examine differences in eating disorder diagnoses among sexual minority individuals by gender. Previous studies that have examined disparities by gender have found higher rates of eating disorders in sexual minority men as compared to heterosexual men, but no differences in women by sexual orientation (Diemer, Grant, Munn-Chernoff, Patterson, & Duncan, 2015; Feldman & Meyer, 2007; Matthews-Ewald, Zullig, & Ward, 2014). Additionally, most studies conclude that sexual minority individuals have higher rates of unhealthy weight control behaviors, including dieting, fasting, purging, laxative use, and diet pill use to lose weight as compared to heterosexual individuals (Austin, Nelson, Birkett, Calzo, & Everett, 2013; Laska et al., 2015; Matthews-Ewald et al., 2014; Watson, Adjei, Saewyc, Homma, & Goodenow, 2017). Overall, sexual minority individuals have demonstrated higher risk for eating disorder diagnoses and behaviors as compared to heterosexual individuals. Therefore, appropriate measurement and assessment of eating disorder symptoms in this population is of paramount importance so that clinicians and researchers can reliably detect eating disorders within sexual minority individuals and link them with care.

One of the most widely used measures of eating pathology is the Eating Disorder Examination-Questionnaire (EDE-Q; Fairburn & Beglin, 1994). Originally developed and validated in women of unknown sexual orientation, the EDE-Q contains 28 items, 22 of which are used to create four theoretical subscales: Weight Concern, Shape Concern, Eating Concern, and Dietary Restraint (Fairburn & Beglin, 2008). However, this factor structure has rarely been replicated in psychometric analyses, and differing factor structures have often been found (see Rand-Giovannetti, Cicero, Mond, & Latner, 2020 for review). Therefore, the most appropriate factor structure of the EDE-Q remains unknown.

Psychometric examinations of the EDE-Q within sexual minority individuals are rare. Previous researchers have presented norms for the EDE-Q using the original four theoretical subscales for cisgender sexual minority men and women (Nagata, Capriotti, et al., 2020; Nagata, Compte, et al., 2020; Nagata, Murray, et al., 2020). Only one known study has examined measurement invariance of the EDE-Q between sexual minority and heterosexual men (Scharmer, Donahue, Heiss, & Anderson, 2020), which found support for a brief three-factor structure that utilized seven items of the EDE-Q and three subscales: Dietary Restraint, Weight/Shape Overvaluation, and Body Dissatisfaction (Grilo, Reas, Hopwood, & Crosby, 2015). To our knowledge, no previous research has examined the factor structure of the EDE-Q scores among sexual minority women.

Moreover, examinations of measurement invariance by gender are also relatively rare. Rand-Giovannetti et al. (2020) found support for metric invariance in men and women of unknown sexual orientation, and scalar invariance for all but two EDE-Q items of a modified four-factor structure that used all 22 items of the EDE-Q and four subscales: Dietary Restraint, Preoccupation and Restriction, Weight and Shape Concern, and Eating Shame (Friborg, Reas, Rosenvinge, & Rø, 2013). In addition, Jenkins and Davey (2020) also found support for the measurement invariance of the aforementioned brief three-factor structure with seven items among men and women. Therefore, at least among individuals of unknown sexual orientation, it appears that the EDE-Q scores are invariant by gender utilizing both Friborg et al.'s (2013) four-factor structure and Grilo et al.'s (2015) brief three-factor structure. Evaluation of measurement invariance of the EDE-Q is useful in supporting examinations of group (e.g., gender) differences in eating disorder symptoms.

The current study aimed to test the factor structure of the EDE-Q in cisgender sexual minority men and women as well as measurement invariance by gender. No known studies to date have examined the factor structure of the EDE-Q scores among sexual minority women, and there has been limited research among sexual minority men. Based on prior research, it was hypothesized that Fairburn and Beglin's (1994) original four-factor model would not be supported. It was also hypothesized that Grilo et al.'s (2015) model would fit well as it did in prior samples of both college men and women (Rand-Giovannetti et al., 2020) as well as sexual minority men (Scharmer et al., 2020). No directional hypothesis was made about the fit of Friborg et al.'s (2013) model due to mixed findings in the literature (e.g., Rand-Giovannetti et al., 2020; Scharmer et al., 2020). Additionally, both of these models have also demonstrated measurement invariance by gender in samples of unknown sexual orientation, therefore, measurement invariance of the EDE-Q was hypothesized in the present sample of sexual minority men and women. Despite no a priori reason to predict lack of invariance by gender, confirming invariance in the current study will bolster future researchers' confidence in examining group differences on the EDE-Q between sexual minority men and women.

2 | METHOD

2.1 | Participants and procedures

Participants were recruited from across the United States via Qualtrics Panels, which is an online survey-based platform (https://www.qualtrics.com). Qualtrics Panels recruits individuals through, for example, online advertisements, and individuals who are interested create accounts and participate in surveys that match their Qualtrics demographic profile (e.g., age, gender, sexual orientation, state of residence). The current study was a secondary data analysis from a parent study (Gonzales & Blashill, 2021), which examined racial and ethnic differences in body image disorders, body image concerns, and appearance and performance enhancement drug misuse. Potential participants were sent a deidentified invitation to participate in the parent study if they met the following inclusion criteria based on their Qualtrics profile: (a) cisgender man or woman; (b) gay, lesbian, bisexual, or any other non-heterosexual identity; (c) between the ages of 18–30 years; (d) African American, Non-Hispanic White, Asian

American/Pacific Islander, or Hispanic with any other race; and (e) English speaking. Following the confirmation of eligibility via a prescreener, participants in the parent study took a 15–20 min survey. Each participant received $4 of e-rewards currency for participating in the study, which are administered by Qualtrics. All procedures were reviewed and approved by the San Diego State University Institutional Review Board. The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy/ ethical restrictions.

2.2 | MEASURES

2.2.1 | Demographic characteristics

Participants were asked to provide information such as age, race, ethnicity, sexual identity, and sexual attraction. Sexual identity was assessed by the following question: "How would you describe your sexual identity?" Participants were asked to select *Lesbian/Gay*, *Bisexual*, *Heterosexual*, *Asexual*, *Other*, or *Prefer Not to Answer*. Sexual attraction was assessed by the following question: "How would you describe your sexual attraction?" Participants were asked to select *Male who is only attracted to males*, *Female who is only attracted to females*, *Male who is mostly attracted to males*, *Female who is mostly attracted to females*, *Male who is equally attracted to males and females*, *Female who is equally attracted to males and females*, *Male who is only attracted to females*, or *Female who is only attracted to males*. For statistical analysis purposes, the response options for the sexual attraction variable were recoded to *Only attracted to same gender*, *Mostly attracted to same gender*, and *Equally attracted to men and women*. No participants indicated attraction only to the opposite gender; therefore, this response option was not included in descriptive and group difference analyses.

2.2.2 | Eating disorder symptoms

The Eating Disorder Examination-Questionnaire 6.0 (EDE-Q; Fairburn & Beglin, 1994) was used to assess the frequency and/or severity of eating and shape/weight concerns over the past 28 days. The EDE-Q has 22 items which are scored on frequency and Likert scales ranging from 0 (*no days* or *not at all*) to 6 (*every day* or *markedly*). The original factor structure of the EDE-Q includes four subscales: Dietary Restraint, Eating Concern, Weight Concern, and Shape Concern, and a global score (Fairburn & Beglin, 1994). Rand-Giovannetti et al. (2020) found strongest support for Friborg et al.'s (2013) four-factor model in a sample of 981 undergraduate students (69.9% women) using CFA with a WLSMV estimator. This model has previously demonstrated adequate internal consistency in terms of Cronbach's alpha (Dietary Restraint = .86, Preoccupation and Restriction = .82, Weight and Shape Concern = .93, and Eating Shame = .78) in a community sample of 538 Norwegian women (Friborg et al., 2013). Grilo et al.'s seven-item three-factor model, which demonstrated acceptable fit in a sample of heterosexual and sexual minority adult men (Scharmer et al., 2020), also had adequate internal consistency in terms of Cronbach's alpha (Dietary Restraint = .89, Shape/Weight Overvaluation = .92, body dissatisfaction = .92) in a sample of 801 university students (n = 573 women, n = 228 men; Grilo et al., 2015).

2.3 | Statistical analysis

Descriptive statistics were conducted for demographic characteristics. Means (M) and SD were calculated for continuous variables and frequencies and percentages of total sample for categorical variables. Additionally, differences between men and women on demographic variables were assessed using independent sample t-tests, for the continuous age variable, or Pearson's chi-squared (χ^2) tests for categorical variables.

Confirmatory factor analyses (CFA) of the EDE-Q was conducted using three existing models: Fairburn and Beglin's (1994) original four-factor model, Friborg et al.'s (2013) four-factor model, and Grilo et al.'s (2015) brief three-factor model. The best-fitting model among sexual minority men and women was then used to investigate measurement invariance by gender. Fairburn and Beglin's (1994) model was included because it is the most commonly utilized factor structure despite well-documented lack of support for this model (Rand-Giovannetti et al., 2020). Additionally, Friborg et al.'s (2013) model demonstrated best fit, compared with 12 different 22-item EDE-Q models, in a sample of undergraduate psychology students ranging in age from 16 to 48 years with a mean age of 20.34 (SD = 3.74; Rand-Giovannetti et al., 2020). Moreover, Grilo et al.'s (2015) brief three-factor model was supported in samples of sexual minority and heterosexual men, compared with six other factor structures including Friborg's four-factor model (Scharmer et al., 2020). Grilo et al.'s (2015) brief three-factor model was also supported in undergraduate students (Rand-Giovannetti et al., 2020) and both a clinical and undergraduate nonclinical samples of women from recent investigations of brief EDE-Q models using the Portuguese version of the EDE-Q (Machado, Grilo, Rodriguez, Vaz, & Crosby, 2020). The multitude of other existing EDE-Q models, which have been reviewed by Rand-Giovannetti et al. (2020), were not chosen because of, for example, either the restrictive sample demographics in which they were evaluated (e.g., only women, bariatric samples, or athletes; Darcy, Hardy, Crosby, Lock, & Peebles, 2013; Parker, Mitchell, O'Brien, & Brennan, 2016; Peterson et al., 2007) or, in the case of other brief models, inclusion of only shape or weight concern items (e.g., Wade et al.'s brief one-factor model; Chan & Leung, 2015; Wade, Byrne, & Bryant-Waugh, 2008). The choice of Friborg et al.'s, Grilo et al.'s, and the original Fairburn et al.'s models in the current study was, therefore, based on evidence-based fit with the current study's sample and was the most parsimonious route.

CFA models were conducted for the full sample and then, separately, for men and women, prior to assessing measurement invariance, using a WLSMV estimator. Pairwise deletion processes were implemented for CFA models due to at most 1% missing data on all EDE-Q items (Parent, 2012). Pairwise deletion when using the WLSMV

estimator has been shown to generate unbiased estimates as long as the amount of missing data is not substantial (Asparouhov & Muthén, 2010). Prior research has indicated support for Friborg et al.'s (2013) four-factor model in a sample of men and women of unknown sexual orientation (Rand-Giovannetti et al., 2020), and recent research has supported Grilo et al.'s (2015) brief three-factor model among heterosexual and sexual minority men (Scharmer et al., 2020). Therefore, in the present study, the fit of these models, as well as the ubiquitous, original factor structure (Fairburn & Beglin, 1994) were compared.

Model fit was assessed using the comparative fit index (CFI), root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR). Findings from simulation studies conducted by Hu and Bentler (1999) have indicated the following thresholds suggestive of good model fit: CFI $\geq$ .95, RMSEA < .06, and SRMR $\leq$ .08. The chi-squared test of exact fit was also reported, although the χ^2 statistic should be interpreted with caution, given its sensitivity to sample size (Schermelleh-Engel, Moosbrugger, & Müller, 2003). The best fitting single-factor model was compared with the best fitting two-factor model with a Satorra-Bentler scaled χ^2 difference test (SB $\Delta\chi^2$; Satorra & Bentler, 2001). Standardized and unstandardized factor loadings were reported for the best fitting model.

The best fitting model across both men and women was then used for assessment of measurement invariance by gender, using the marker method (Vandenberg & Lance, 2000). Configural invariance indicates that factor loading patterns are similar between groups. Metric invariance indicates equal factor loadings, and scalar invariance indicates equal loadings and thresholds (i.e., intercepts). Significant differences between configural and metric invariance models were assessed, such that ΔCFI< .010, in conjunction with either ΔRMSEA< .015 or ΔSRMR< .030, would indicate invariance (Chen, 2007). Significant differences between metric and scalar invariance models were assessed using the same thresholds, except that ΔSRMR< .010 would indicate invariance (Chen, 2007). Internal consistency of the EDE-Q was evaluated using Cronbach's alpha (α) and omega (ω; Dunn, Baguley, & Brunsden, 2014) for the full sample, and separately for men and women. However, the recommended reliability coefficient for any two-item subscales is the Spearman-Brown coefficient (ρ), as it is considered less biased than Cronbach's alpha and other reliability coefficients (Eisinga, Te Grotenhuis, & Pelzer, 2013). Additionally, 95% confidence intervals were reported for reliability coefficients of subscales including more than two items. CFA and internal consistency analyses were conducted using the lavaan (Rosseel, 2012) and userfriendlyscience (Peters, 2014) packages in RStudio.

3 | RESULTS

3.1 | Participants

Participants were 962 cisgender sexual minority men (n = 479) and women (n = 483) ranging in age from 18 to 30 years (M_{age} = 23.68, SD = 3.73). Men in the sample demonstrated a mean age of 24.03 years (SD = 3.76) and women demonstrated a mean age of 23.33 years (SD = 3.68). There was a small but statistically significant difference in age between men and women, $t(960) = 2.95$, $p = .003$, $d = .19$. Additionally, there were no statistically significant gender differences in race or ethnicity frequency distributions. However, a statistically significant gender difference was present for sexual identity and sexual attraction frequency distributions. Table 1 summarizes the demographic characteristics of the present sample, including race, ethnicity, and sexual orientation.

3.2 | Confirmatory factor analysis

Results from Mardia's multivariate normality test and frequency histograms, using the MVN package (Korkmaz, Goksuluk, & Zararsiz, 2014) in RStudio (Version 1.2.1335), indicated a nonnormal distribution of EDE-Q items for the full sample (skewness = 2,173.66, p < .001; kurtosis = 25.66, p < .001) as well as, individually, for men (skewness = 6,088.67, p < .001; kurtosis = 47.71, p < .001) and women (skewness = 5,313.26, p < .001; kurtosis = 38.08, p < .001). Therefore, CFA was conducted using the robust weighted least squares mean and variance adjusted estimator (WLSMV) and entering the EDE-Q items as ordinal variables.

The model fit indices of all models that converged, for the full sample and, separately, for men and women, are summarized in Table 2. Table 2 does not include Fairburn and Beglin's (1994) original four-factor structure because a review of factor correlations, factor loadings, and variances indicated that this was a problematic model, with correlations between the Shape Concern and Weight Concern factors exceeding 1, even with the removal of the redundant item 8 ("Has thinking about shape or weight made it very difficult to concentrate on things you are interested in [for example, working, following a conversation, or reading?]"), and negative factor loadings and variances. Based on descriptive fit indices in the full sample, both Friborg et al.'s (2013) four-factor model and Grilo et al.'s (2015) brief three-factor model demonstrated appropriate model fit. When we examined the factor structure separately for men and women, the results were nearly identical to the full sample. Because full-item models cannot be directly compared with reduced-item models due to differing numbers of variables (Rand-Giovannetti et al., 2020), both models were considered the best fitting models.

A second-order CFA was also conducted using Friborg et al.'s (2013) model, in which the four factors loaded onto a single higher order factor. The SB $\Delta\chi^2$ test indicated that the higher order model fit significantly worse than the first-order model in the full sample (SB $\Delta\chi^2[2] = 23.57$, p < .001), as well as, separately, in men (SB $\Delta\chi^2[2] = 8.90$, $p = .01$) and women (SB $\Delta\chi^2[2] = 13.86$, p < .001). Tables 3 and 4 illustrate the standardized and unstandardized factor loadings, with 95% confidence intervals, for Friborg et al.'s (2013) four-factor model and Grilo et al.'s brief three-factor model, respectively, demonstrating significant factor loadings on all factors, among men and women. The interfactor correlations in Friborg et al.'s (2013) model were statistically significant (p < .001) and very large among the full sample (rs range: .691–.839), and separately, in men (rs range: .728–.842) and women (rs range: .653–.841). The interfactor correlations in Grilo et al.'s (2015) model were also statistically significant (p < .001) and very large among the full sample (rs range: .574–.891), and separately, in men (rs range: .633–.872) and women (rs range: .511–.906).

TABLE 1 Demographic characteristics of the sexual minority sample

Variable	Men *n* (%)	Women *n* (%)	Total sample *n* (%)	χ^2	*p*
Race[a]					
White	184 (38.6%)	187(38.7%)	371 (38.6%)	$\chi^2[3] = 0.45$	.93
Black/African American	146 (30.5%)	148 (30.6%)	294 (30.6%)		
Asian/Pacific islander	134 (28.1%)	138 (28.6%)	272 (28.3%)		
Native American/American Indian	13 (2.7%)	10 (2.1%)	23 (2.4%)		
Ethnicity					
Hispanic/Latino/a	120 (25.1%)	114 (23.6%)	234 (24.3%)	$\chi^2[1] = 0.28$	.60
Sexual identity					
Lesbian/gay	239 (49.9%)	97 (20.1%)	336 (34.9%)	$\chi^2[3] = 101.82$	<.001
Bisexual	206 (43.0%)	358 (74.1%)	564 (58.6%)		
Asexual	10 (2.1%)	10 (2.1%)	20 (2.1%)		
Other[b]	24 (5%)	18 (3.7%)	42 (4.4%)		
Sexual attraction					
Only attracted to same gender	203 (42.4%)	92 (19.0%)	295(30.7%)	$\chi^2[2] = 94.31$	<.001
Mostly attracted to same gender	89 (18.6%)	53 (11.0%)	142 (14.8%)		
Equally attracted to same gender	187 (39.0%)	338 (70.0%)	525 (54.5%)		

[a]Missing race data for two men.
[b]Other sexual identities included, but were not limited to Pansexual, Demisexual, or Queer.

TABLE 2 Model fit comparisons of factor structures of the Eating Disorder Examination Questionnaire

Model	χ^2	*df*	*p*	CFI	RMSEA	SRMR
Friborg et al.'s (2013) four-factor model						
Men	963.02	203	<.001	.974	.089	.069
Women	1,120.73	203	<.001	.975	.097	.077
Full sample	2084.76	203	<.001	.974	.098	.070
Friborg et al.'s (2013) second-order model						
Men	951.47	205	<.001	.975	.087	.070
Women	1,116.16	205	<.001	.975	.096	.079
Full sample	2065.42	205	< .001	.974	.097	.071
Grilo et al.'s (2015) brief three-factor model						
Men	19.03	11	.06	.999	.039	.018
Women	21.83	11	.03	.999	.045	.018
Full sample	36.38	11	<.001	.999	.049	.017

Abbreviations: CFI, comparative fit index; RMSEA, root mean square error of approximation; SRMR, standardized root mean square residual.

3.3 | Measurement invariance by gender of the best fitting models

Measurement invariance analyses were conducted using both Friborg et al.'s (2013) four-factor model and Grilo et al.'s (2015) brief three-factor model. The results of measurement invariance analyses are summarized in Table 5. The configural invariance model demonstrated good fit based on two of three descriptive fit indices for Friborg et al.'s four-factor model (CFI = .974, RMSEA = .093, SRMR = .073) and based on all three descriptive fit indices for Grilo et al.'s brief three-factor model. Constraining factor loadings to be equal across groups led to ΔCFI, ΔRMSEA, and ΔSRMR within recommended thresholds, indicating metric invariance (Chen, 2007). Constraining item intercepts to also be equal across groups led to ΔCFI, ΔRMSEA, and ΔSRMR within recommended thresholds, indicating scalar invariance.

3.4 | Scale reliability of the best fitting models

Internal consistency was adequate for Friborg et al.'s (2013) four-factor model, including the Dietary Restraint (α = .88, 95% CI [.87, .89]; ω = .88, 95% CI [.87, .89]), Preoccupation and Restriction

TABLE 3 Factor loadings of Friborg et al.'s model of the Eating Disorder Examination Questionnaire

	Factor loadings					
	Men		Women		Full sample	
Item	Unstandardized [95% CI]	Standardized [95% CI]	Unstandardized [95% CI]	Standardized [95% CI]	Unstandardized [95% CI]	Standardized [95% CI]
Factor 1: Dietary Restraint						
1. Restraint over eating	1.04 [0.98,1.10]	0.85 [0.82,0.88]	1.00 [0.94,1.05]	0.87 [0.84,0.90]	1.02 [0.98,1.06]	0.86 [0.84,0.88]
3. Food avoidance	0.96 [0.90,1.02]	0.81 [0.78,0.81]	1.00 [0.95,1.06]	0.87 [0.84,0.90]	0.98 [0.94,1.02]	0.85 [0.82,0.87]
4. Dietary rules	0.99 [0.93,1.06]	0.84 [0.80,0.87]	0.93 [0.87,0.99]	0.81 [0.77,0.85]	0.96 [0.91,1.00]	0.82 [0.80,0.85]
Factor 2: Preoccupation & Restriction						
2. Avoidance of eating	0.94 [0.89,0.99]	0.78 [0.74,0.82]	0.96 [0.90,1.02]	0.78 [0.74,0.82]	0.95 [0.91,0.99]	0.78 [0.76,0.81]
5. Empty stomach	1.07 [1.01,1.12]	0.84 [0.80,0.87]	1.04 [0.98,1.10]	0.82 [0.78,0.85]	1.05 [1.01,1.10]	0.83 [0.80,0.85]
7. Preoccupation with food, eating, calories	1.05 [0.99,1.11]	0.82 [0.79,0.86]	1.09 [1.03,1.15]	0.85 [0.83,0.88]	1.07 [1.02,1.11]	0.84 [0.81,0.86]
8. Preoccupation with shape and weight	1.09 [1.03,1.15]	0.85 [0.83,0.88]	1.12 [1.06,1.18]	0.87 [0.85,0.90]	1.10 [1.05,1.14]	0.86 [0.84,0.88]
9. Fear of losing control over eating	1.12 [1.06,1.19]	0.88 [0.85,0.91]	1.09 [1.02,1.16]	0.85 [0.82,0.88]	1.11 [1.06,1.15]	0.87 [0.85,0.89]
Factor 3: Weight & Shape Concern						
6. Flat stomach	0.87 [0.81,0.92]	0.74 [0.70,0.79]	0.85 [0.79,0.91]	0.73 [0.69,0.78]	0.87 [0.83,0.90]	0.74 [0.71,0.77]
10. Fear of weight gain	1.16 [1.09,1.23]	0.86 [0.83,0.88]	1.18 [1.10,1.25]	0.86 [0.84,0.89]	1.15 [1.10,1.20]	0.86 [0.84,0.87]
11. Feelings of fatness	1.15 [1.09,1.23]	0.86 [0.83,0.88]	1.19 [1.12,1.26]	0.87 [0.85,0.89]	1.18 [1.13,1.23]	0.87 [0.86,0.89]
12. Desire to lose weight	1.17 [1.10,1.24]	0.87 [0.84,0.90]	1.24 [1.16,1.31]	0.91 [0.89,0.92]	1.21 [1.16,1.26]	0.90 [0.88,0.91]
22. Importance of weight	1.19 [1.12,1.26]	0.90 [0.86,0.91]	1.19 [1.12,1.26]	0.87 [0.85,0.89]	1.20 [1.15,1.25]	0.89 [0.88,0.90]
23. Importance of shape	1.19 [1.12,1.26]	0.89 [0.87,0.91]	1.19 [1.11,1.26]	0.87 [0.84,0.90]	1.20 [1.15,1.25]	0.89 [0.87,0.90]
24. Reaction to prescribed weighing	0.99 [0.91,1.08]	0.74 [0.68,0.79]	0.92 [0.83,1.01]	0.67 [0.62,0.73]	0.94 [0.88,1.00]	0.70 [0.66,0.73]
25. Dissatisfaction with weight	1.16 [1.09,1.22]	0.86 [0.84,0.88]	1.18 [1.11,1.25]	0.86 [0.84,0.88]	1.16 [1.11,1.21]	0.86 [0.85,0.88]
26. Dissatisfaction with shape	1.15 [1.07,1.22]	0.85 [0.83,0.88]	1.17 [1.10,1.24]	0.86 [0.84,0.88]	1.15 [1.10,1.21]	0.85 [0.84,0.87]
27. Discomfort seeing body	1.12 [1.05,1.19]	0.83 [0.80,0.86]	1.17 [1.10,1.24]	0.86 [0.84,0.88]	1.15 [1.10,1.19]	0.85 [0.83,0.86]
28. Discomfort exposing body	1.11 [1.04,1.18]	0.83 [0.80,0.85]	1.15 [1.07,1.22]	0.84 [0.81,0.87]	1.13 [1.08,1.12]	0.84 [0.82,0.85]
Factor 4: Eating Shame						
19. Eating in secret	0.75 [0.65,0.85]	0.69 [0.60,0.77]	0.75 [0.65,0.86]	0.66 [0.57,0.75]	0.74 [0.67,0.82]	0.67 [0.60,0.73]
20. Guilt after eating	1.33 [1.16,1.51]	0.92 [0.88,0.96]	1.33 [1.14,1.51]	0.88 [0.85,0.90]	1.35 [1.22,1.48]	0.90 [0.87,0.93]
21. Social eating	1.22 [1.07,1.36]	0.84 [0.80,0.88]	1.17 [1.01,1.34]	0.77 [0.72,0.82]	1.21 [1.09,1.32]	0.80 [0.77,0.84]

Note: All *p*-values are <.001; Standardized and unstandardized factor loadings from a confirmatory factor analysis are presented for a four-factor model, originally supported in "Core pathology of eating disorders as measured by the Eating Disorder Examination Questionnaire (EDE-Q): The predictive role of a nested general (g) and primary factors," by Friborg et al. (2013).

TABLE 4 Factor loadings of Grilo et al.'s model of the Eating Disorder Examination Questionnaire

Item	Factor loadings					
	Men		Women		Full sample	
	Unstandardized (95% CI)	Standardized (95% CI)	Unstandardized (95% CI)	Standardized (95% CI)	Unstandardized (95% CI)	Standardized (95% CI)
Factor 1: Dietary Restraint						
1. Restraint over eating	1.02 (0.96, 1.07)	0.84 (0.81, 0.87)	0.97 (0.92, 1.01)	0.85 (0.83, 0.88)	0.99 (0.95, 1.03)	0.85 (0.83, 0.86)
3. Food avoidance	0.99 (0.93, 1.04)	0.83 (0.80, 0.86)	1.04 (0.98, 1.09)	0.88 (0.86, 0.91)	1.01 (0.97, 1.05)	0.86 (0.84, 0.88)
4. Dietary rules	0.99 (0.94, 1.05)	0.84 (0.80, 0.87)	0.96 (0.91, 1.01)	0.82 (0.79, 0.85)	0.97 (0.94, 1.01)	0.83 (0.80, 0.85)
Factor 2: Shape/Weight Overvaluation						
22. Importance of weight	0.98 (0.94, 1.02)	0.92 (0.90, 0.94)	1.01 (0.98, 1.05)	0.94 (0.92, 0.95)	1.00 (0.97, 1.02)	0.93 (0.92, 0.94)
23. Importance of shape	1.02 (0.98, 1.06)	0.94 (0.92, 0.96)	0.99 (0.95, 1.02)	0.93 (0.90, 0.95)	1.00 (0.76, 1.03)	0.93 (0.92, 0.95)
Factor 3: Body Dissatisfaction						
25. Dissatisfaction with weight	1.02 (0.97, 1.06)	0.92 (0.89, 0.94)	1.01 (0.98, 1.05)	0.91 (0.89, 0.93)	1.01 (0.98, 1.04)	0.91 (0.90, 0.93)
26. Dissatisfaction with shape	0.98 (0.94, 1.03)	0.90 (0.88, 0.93)	0.99 (0.96, 1.02)	0.90 (0.88, 0.92)	0.99 (0.96, 1.02)	0.90 (0.89, 0.92)

Note: All *p*-values are <.001; Standardized and unstandardized factor loadings from a confirmatory factor analysis are presented for a brief three-factor model of the EDE-Q, originally supported in "Factor structure and construct validity of the Eating Disorder Examination-Questionnaire in college students: Further support for a modified brief version," by Grilo et al. (2015).

TABLE 5 Measurement invariance by gender: Model fit indices

Model	χ^2	*df*	*p*	CFI	RMSEA	SRMR	$\Delta\chi^2$	ΔCFI	ΔRMSEA	ΔSRMR
Friborg et al.'s (2013) four-factor model:										
Configural model	2079.406	406	<.001	.974	.093	.073	—	—	—	—
Metric invariance: Factor loadings equal across groups	1971.283	424	<.001	.976	.087	.073	−108.123	.002	−.006	0
Scalar invariance: Factor Loadings & Intercepts Equal across Groups	2,210.552	530	<.001	.974	.081	.073	239.269	−.002	−.006	0
Grilo et al.'s (2015) brief three factor model:										
Configural model	41.046	22	.008	.999	.042	.018	—	—	—	—
Metric invariance: Factor loadings equal across groups	46.675	26	.008	.999	.041	.019	5.629	0	.001	.001
Scalar invariance: Factor Loadings & Intercepts Equal across Groups	105.336	58	<.001	.998	.041	.018	58.661	−.001	0	−.001

Abbreviations: CFI, comparative fit index; RMSEA, root mean square error of approximation; SRMR, standardized root mean square residual.

(α = .91, 95% CI [.90, .92]; ω = .91, 95% CI [.90, .92]), Weight and Shape Concern (α = .95, 95% CI [.95, .96]; ω = .96, 95% CI [.95, .96]), and Eating Shame (α = .85, 95% CI [.83, .86]; ω = .85, 95% CI [.83, .87]) subscales. Additionally, internal consistency was adequate for Grilo et al.'s model factors, including Dietary Restraint (α = .88, 95% CI [.87, .89]; ω = .88, 95% CI [.87, .89]), Weight/Shape Overvaluation (ρ = .90), and Body Dissatisfaction (ρ = .87).

4 | DISCUSSION

The current study used CFA to test the factor structure of the EDE-Q in a large sample of cisgender sexual minority men and women in the United States. To our knowledge, this study is the first to explore the factor structure of the EDE-Q in sexual minority women, and this research adds to the paucity of research examining the factor

structure of EDE-Q among sexual minority men. Analyses compared three models of the EDE-Q factor structure: Fairburn and Beglin's (1994) original four-factor model, Friborg et al.'s (2013) four-factor model, and Grilo et al.'s (2015) brief three-factor model. The best fitting models were then further assessed for evidence of measurement invariance by gender.

Consistent with much of the existing research on the factor structure of the EDE-Q (see Rand-Giovannetti et al., 2020 for review), no support was found for Fairburn and Beglin's (1994) original theoretically derived four-factor model. This finding suggests that Fairburn and Beglin's (1994) original factor structure may have limited use with sexual minority men and women, and future studies should explore whether similar results are found in other samples of sexual minority individuals. However, Fairburn and Beglin's model converged with warnings of negative factor loadings and variances in the current sample, which may not generalize to other samples. Among the models compared in the CFA, both Friborg et al.'s (2013) four-factor model and Grilo et al.'s (2015) three-factor model demonstrated adequate fit. Results were nearly identical when we examined the factor structure in the full sample and separately for men and women. Supplemental analyses, using Friborg et al.'s (2013) four-factor model, examining a higher order model with the four factors loaded onto a single factor, consistent with the EDE-Q global score, fit statistically significantly worse than the first-order model. These findings are consistent with Rand-Giovannetti et al.'s (2020) review of EDE-Q factor structures in undergraduate men and women of unknown sexual orientation, who indicated that the lack of a higher order factor may suggest that a global EDE-Q score may not capture the multidimensional nature of eating pathology. However, Rand-Giovannetti et al. (2020) also cautioned that the chi-squared difference test for nested model comparison may be sensitive to small differences in model fit, which indicates that the higher order model may be statistically but not practically significantly different from the four-factor model. The present findings indicate support for the calculation of EDE-Q subscale scores, using Friborg et al.'s four-factor structure and Grilo et al.'s brief three-factor structure in samples of sexual minority men and women. Furthermore, although the higher order model demonstrated significantly worse statistical fit than Friborg et al.'s four-factor structure, it did demonstrate adequate descriptive fit. Thus, future research is needed to further test the model fit and utility of a higher order factor structure of the EDE-Q.

Measurement invariance analyses of the EDE-Q by gender using both Friborg et al.'s (2013) and Grilo et al.'s (2015) models found evidence for configural, metric, and scalar invariance in this sample. These results are consistent with findings from previous studies of gender-related measurement invariance of the EDE-Q in samples of unreported sexual orientation (Grilo et al., 2015; Jenkins & Davey, 2020; Penelo, Negrete, Portell, & Raich, 2013), suggesting that the EDE-Q has the same factor analytic properties for men and women. Inconsistent with Rand-Giovannetti et al.'s (2020) findings, which indicated a lack of measurement invariance on two Weight and Shape Concern factor items, in the present study, Friborg et al.'s (2013) four-factor model demonstrated scalar invariance across all factors, suggesting that Weight and Shape Concern subscale scores may represent similar levels of eating pathology in sexual minority men and women. Given mixed findings across studies, future research should seek to further elucidate whether differences in the Weight and Shape Concern factor exist between heterosexual and sexual minority men and women.

The findings of this study should be interpreted in the context of several limitations. First, data were collected using online Qualtrics panels which may reveal different psychometric properties to data collected via conventional in-person sampling methods. However, findings from a large meta-analytic review indicate that the psychometric properties of data collected from online panel sources are not meaningfully different to data based on conventional samples and are, therefore, comparable (Walter, Seibert, Goering, & O'Boyle, 2019). Further, our findings are based on data provided by young cisgender sexual minority men and women in the United States who volunteered to participate in research. Findings from this sample may not generalize to other sexual minority samples, eating disorder patients or other clinical samples, heterosexual or gender minority individuals, different age groups, or individuals outside of the United States. Future research should attempt to replicate this factor structure of the EDE-Q among these other groups. Additionally, this study could not test measurement invariance by sexual orientation because there was no heterosexual comparison group and, within the sexual minority sample, low sample sizes across sexual minority subgroups (i.e., gay, lesbian, and bisexual individuals). It would also be important for researchers to investigate structural invariance of the EDE-Q across different racial and ethnic groups in the sexual minority population, to determine whether use of the EDE-Q across racial groups among sexual minority individuals is appropriate. Future studies should be conducted to address this, specifically by assessing for structural invariance between heterosexual and sexual minority groups, sexual minority subgroups, and different racial and ethnic groups to ensure that mean EDE-Q scores can appropriately be compared. Despite these limitations, the study's findings are strengthened by the large sample size and the sample's racial and ethnic diversity.

Although the present study supports the use of both Friborg et al.'s (2013) and Grilo et al.'s (2015) models of the EDE-Q, there are few methodological and theoretical concerns to be considered with the use of Grilo et al.'s brief-three factor model. Grilo et al.'s brief three-factor model includes three items assessing dietary restraint, and four items (across two factors) assessing shape and weight concerns. Unlike Friborg et al.'s (2013) model, Grilo et al.'s (2015) model did not address eating behaviors outside of dietary restraint, such as binge eating or purging, and other eating concerns such as shame around eating—a factor associated with the thoughts and behaviors shown to maintain disordered eating (Goss & Allan, 2009). Although shape and weight concerns are considered core pathology in eating disorders, for researchers and clinicians interested in evaluating eating concerns and behavior other than dietary restraint, this model has limitations because it does not assess eating-related cognitive and interpersonal factors which are core to many theoretical models of disordered eating (Cooper, Todd, & Wells, 2009; Fairburn, 2008).

Additionally, Hair Jr., Black, Babin, and Anderson (2014) have indicated that latent factors should have a minimum of three items per factor to avoid under-identification of a model and to reliably measure a construct and increase its generalizability. Thus, although Grilo et al.'s (2015) model may have benefits as a brief clinical assessment, researchers and clinicians should be cautious of the aforementioned limitations when choosing to utilize it.

Overall, the current research provides a meaningful contribution to the existing literature on the factor structure of the EDE-Q and adds to the scarcity of existing research on the EDE-Q among sexual minority men and women. Most notably, these results add to the growing literature suggesting that researchers and clinicians should take caution in utilizing Fairburn and Beglin's (1994) original theoretically derived factor structure for the EDE-Q. Future researchers are encouraged to consider multiple factor structures in their analyses to further evaluate the utility of the original factor structure. Instead, this research provides further support for the factor structure posited in Friborg et al.'s (2013) four-factor model and Grilo et al.'s (2015) brief three-factor model. Additionally, these findings provide evidence that the EDE-Q, as conceptualized in Friborg et al.'s (2013) and Grilo et al.'s (2015) models for sexual minority men and women, is invariant across genders, suggesting that comparison of scores by gender is appropriate. However, given the paucity of research examining measurement invariance of the EDE-Q, further research is needed.

ACKNOWLEDGMENTS

This work was partially supported by 5R25GM058906-16, awarded to Mr. Gonzales. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

CONFLICT OF INTEREST

The authors declare no potential conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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How to cite this article: Klimek P, Convertino AD, Pennesi J-L, et al. Confirmatory factor and measurement invariance analyses of the Eating Disorder Examination Questionnaire in sexual minority men and women. *Int J Eat Disord*. 2021;54:745–754. https://doi.org/10.1002/eat.23488