

## Psychometric properties and factorial invariance of bias scale trait version in engineering and health sciences university students

Propiedades psicométricas e invarianza factorial de la escala bias versión rasgo en universitarios de ciencias de la salud e ingeniería

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### Abstract

Beauty and thinness standards of come from a cultural idea that even today is considered esthetic; being physically perfect has become one of the main objectives in developed societies, a goal imposed by new models of life, in which the aspect of body image is associated with wellbeing and seems to be the only valid synonym of success and happiness. However, negative body image has serious consequences for health behaviors and is associated with low self-esteem, depression, social anxiety and contributes to the development and maintenance of body dysmorphic disorder and eating disorders. In this context, the present instrumental study aimed to analyze the psychometric properties of BIAS (Body Image Anxiety Scale) testing, trait version, in engineering and health sciences students, evaluating in the students anxiety about body parts that correspond, on the one hand with physical beauty, for example: lips, forehead, chin; and on the other hand, those related to body weight, such as: abdomen, thighs, hips, among others. The total sample consisted of 1081 participants; 568 engineering students (142 women and 426 man) and 513 health sciences students (201 women and 311 man), with a mean age of 18.16 years (SD = 0.73) and 18.21 years (SD = 0.72) respectively, the sample was obtained through convenience sampling. The instrument was applied through a computerized application using the instrument administrator module of scales editor, version 2.0 in a session of approximately 25 minutes in the computer labs corresponding to each participating academic unit. The confirmatory factorial analysis showed that a bi-factorial structure is feasible and convenient for both populations (engineering and health sciences) according to the established psychometric requirements when the informants were the same students. Furthermore, the factorial structure, factorial loads and the intercepts are considered invariant in the engineering and health sciences areas; however, there are differences in the mean of both factors among the two populations.

**Key words:** Anxiety, factorial structure, invariance of measure, confirmatory multi-sample factorial analysis.

## Resumen

Los estándares de belleza y delgadez provienen de una idea cultural que aún hoy en día se considera estética; ser físicamente perfecto se ha convertido en uno de los principales objetivos de las sociedades desarrolladas, meta impuesta por nuevos modelos de vida, en los que el aspecto de la imagen corporal se asocia al bienestar y parece ser el único sinónimo válido de éxito y felicidad. Sin embargo, la imagen corporal negativa tiene graves consecuencias para los comportamientos de salud y se asocia con baja autoestima, depresión, ansiedad social y contribuye al mantenimiento y desarrollo del trastorno dismórfico corporal y los trastornos alimentarios. En este contexto, el presente estudio instrumental, tuvo como objetivo analizar las propiedades psicométricas del test BIAS (Body Image Anxiety Scale), versión rasgo, en estudiantes de ingeniería y ciencias de la salud, evaluando en los estudiantes la ansiedad sobre las partes del cuerpo que guardan correspondencia, por un lado con la belleza física, por ejemplo: labios, frente, mentón; y por otro, aquellas relacionadas con el peso corporal, como lo son: abdomen, muslos, caderas, entre otras. La muestra total estuvo conformada por 1081 participantes; 568 estudiantes de ingeniería (142 mujeres y 426 hombres) y 513 estudiantes de ciencias de la salud (201 mujeres y 311 hombres), con una edad media de 18,16 años (DE = 0,73) y 18,21 años (DE = 0,72) respectivamente, la muestra se obtuvo mediante un muestreo por conveniencia. El instrumento se aplicó a través de una aplicación informatizada, utilizando el módulo administrador de instrumentos del editor de escalas, versión 2.0 en una sesión de aproximadamente 25 minutos en los laboratorios de informática correspondientes a cada unidad académica participante. El análisis factorial confirmatorio mostró que una estructura bifactorial es factible y conveniente para ambas poblaciones (ingeniería y ciencias de la salud) de acuerdo con los requisitos psicométricos establecidos cuando los informantes son los mismos estudiantes. Además, la estructura factorial, las cargas factoriales y los interceptos se consideran invariantes en las áreas de ingeniería y ciencias de la salud; sin embargo, existen diferencias en la media de ambos factores entre las dos poblaciones.

**Palabras claves:** Ansiedad, estructura factorial, invariancia de medida, análisis factorial confirmatorio multimuestra.

## INTRODUCTION

Currently there is a great interest in body appearance, not only in adult and young women, but also in young men and older people, and this interest may be associated with healthy or risky behaviors (MacNeill et al., 2017; Ramírez et al., 2015), since being physically perfect has become one of the main objectives in developed societies, a goal imposed by new models of life, in which the aspect of body image is associated with wellbeing (Swami et al., 2018) or seems to be the only valid synonym of success, happiness and health (Ortega, 2010).

In this consumer society, which glorifies beauty, youth and health; the cult of the body and its aesthetic value leads to the obsession for a perfect body, which has led especially to groups of young people, to a tyranny of beauty, making this difficult in some cases, and hindering in others, the coexistence of values of greater urgency and need in human formation. To have an attractive physique has become vital, since it implies prestige, security and superiority; although sometimes, it is achieved at the expense of the sacrifice of other more humanizing values. In conclusion, never before has the body influenced so much the self-concept like today (Gervilla, 2002; Raich, 2004).

In this sense, the models of beauty that most represent women today, is a body with extreme thinness (Wang et al., 2020) and men a muscular body (Thornborrow et al., 2020). Since the person's own valuation of his or her body image can condition the ideal of beauty through different behaviors that can ultimately be transformed into eating disorders, which is

why young university students that are submitted to the inherent changes in this stage of life and university transition, are a particularly vulnerable population group (Castillo et al., 2019; Soto et al., 2015), who show greater susceptibility when acquiring inappropriate habits during their formation, which could be settled throughout their life (Radwan et al., 2019; Valdes-Badilla et al., 2015).

All of the above justifies that the study of this subject is increasingly relevant in healthy population, as it is the university population, since, as Raich (2004) comments, traditionally most of the investigations in the area of the body image had been centered on the overestimation of body size in individuals with eating disorders, however, it has been confirmed that people without eating disorders also present alterations in body image, externalized as body dissatisfaction, in general or in specific areas of the body, to which college students are not outside of the situation; many times influenced by social media (Dougherty & Krawczyk, 2018).

In relation to the study of the Body Image, there are numerous terms currently used in this field, which are conceptually close, similar or even treated as synonyms, but which have not been submitted to consensus by the scientific community, such examples are: Body Scheme, Body Satisfaction, Body Esteem, Appearance, Body Appearance, among others. Therefore, the use of one expression or another depends more on the scientific orientation of the researcher, or on the specific aspect to be investigated or even on the available evaluation technique (Ortega, 2010).

In this work the concept of body image is used, since as the author mentioned above, this is a theoretical construct widely used in the field of Physical Education, Psychology, Psychiatry, Medicine in general, or even Sociology. In addition, it is considered crucial to explain important aspects of personality such as self-esteem or self-concept and behavior, among others.

Schilder (1950), precursor of the multidimensional analysis of the body image concept, explains it as the figure that we form of our own body in our mind, that is, the way in which our body represents us to ourselves.

For Arroyo et al. (2008), the body image can be defined as the mental representation and the experience that each individual has of his own body. According to Cash (2012), the body image includes cognitive, behavioral, and emotional importance that individuals place on their own physical appearance, and its evaluation consists in cognitive and affective appraisals of their own physical appearance such as: body satisfaction or dissatisfaction.

Therefore, a negative body image can cause interpersonal anxiety, if the person is not able to accept herself, he will believe that others can not do so and as a result of this is not surprising that the person feels uncomfortable or inadequate in their social interactions, and this can happen with people of the same sex and sometimes with their counterparts (Raich, 2004).

Coinciding with Spielberger (1966, as cited in Ries et al., 2012), that for the proper study of anxiety it is necessary to take into account the differentiation between anxiety as an emotional state and anxiety as a personality trait, proposing the Anxiety Theory State-Trait.

The first of these, according to Spielberger, is an immediate "emotional state", modifiable in time, characterized by a unique combination of feelings of tension, apprehension and nervousness; annoying thoughts and worries, along with physiological changes. The second refers to the individual differences of relatively stable anxiety, these being a disposition or tendency. Contrary to state anxiety, anxiety-trait is not directly manifested in behavior and should be inferred by the frequency with which an individual experiences increases in his anxiety state.

Consequently, subjects with a high level of anxiety-trait may perceive a greater range

of circumstances as threatening and are more predisposed to suffer anxiety-state more frequently or more intensely (Ries et al., 2012).

The present study analyzes the factorial invariance of the Body Image Anxiety Scale (BIAS), in its trait version, in university students of health sciences and engineering, evaluating in the students anxiety about body parts that correspond, for one side with physical beauty, such as: lips, forehead, chin; and on the other, those related to body weight, such as: abdomen, thighs, hips, among others.

The main interest of this study is not only the factorial instrument, but also the psychometrical equivalence of it in different groups; since in the context of inter-groupal comparison is crucial to consider the need of adapting an instrument of a psychological measure that contains all the equivalence criteria, but all above is consider if the same factorial structure is applicable to different groups of subjects or in a more generic form to different types of population (Abalo et al., 2006; Blanco et al., 2011; Castañeda et al., 2010) with the purpose of counting on valuable information for tutoring and the personal development systems in our universities; offering evidences and data that promotes Educational Intervention into a perspective of attention to diversity inside the classroom.

## MATERIALS AND METHODS

### Participants

The sample consisted of 1081 participants, 568 (52.5%) engineering students and 513 (47.5%) health sciences students. This was achieved from a convenience sampling trying to cover a representative sample from both areas (engineering and health sciences) offered at the Autonomous University of Chihuahua.

The students sample from engineering area was composed of 568 participants; 142 (25%) women and 426 (75%) man. The age was ranging from 17 and 20 years old, with a mean of 18.16 and a standard deviation of 0.73 years old.

The students sample from health sciences was composed of 513 participants; 201 (39.4%) women and 311 (60.6%) man. The age was ranging from 17 and 20 years old, with a mean of 18.21 and a standard deviation of 0.72 years old.

### Instrument

Body Image Anxiety Scale (BIAS) in its original version, is a 15 items questionnaire which evaluates anxiety-trait related to weight (8 items related to Weight Factor) and with body parts not related to weight (7 items related to No-Weight Factor), where the respondent in a scale from 0 to 4 answered how anxious, tense, or nervous feels toward specific body parts. According to Raich (2000) the BIAS has a good internal consistency, good temporal stability and validity; which is consistent with internal consistency and validity reported by Ornelas et al. (2011) with Cronbach's alpha and congruent superior coefficients to .90. This type of survey was selected for its easy application (Raviolo et al., 2010); in addition of providing a good base for a first individuals organization in the characteristic been measured. Three adaptations to the original version were made for this study:

First adaptation. In the original scale it is scored with five answers, for this study, the subject chooses among eleven possible answers. The original was combined with this new version as follows, nothing (0), slightly (1, 2 and 3), moderately (4, 5 and 6), a lot (7, 8, 9) and too much (10). This first adaptation is justified because the subjects are familiar to the scale from 0 to 10. They have been evaluated this way by Mexico's Educational System. Viciano et al. (2007) report a similar change in the validation scale with very similar characteristics,

working with spanish subjects and Ornelas et al. (2011) with mexican university students.

Second adaptation. In this version, only 12 items were used according to the results reported by Ornelas et al. (2014).

Third and last adaptation consisted in applying the instrument through a computer. This with the aim to store the data collected without previous codification stages, with more accurate precision and speed.

### **Procedure**

Students from the first year at the engineering and health sciences areas at the Autonomous University of Chihuahua were invited to participate; the ones who accepted the invitation signed a consent letter. Then, the instrument explained above was applied through a computerized application using the instrument administrator module of scales editor, version 2.0 (Blanco et al., 2013) in a session of about 25 minutes in the computer labs correspondent to each participating academic unit. At the beginning of each session, students were given a brief introduction on the importance of the study and the protocol of how to access to the instrument was explained; instructions of how to answer were on the first computer screens, before the first instrument item. At the end of the session, students were thanked for their contribution to the study.

Once the instrument was applied, data was collected by the results generator module of scales editor, version 2.0 (Blanco et al., 2013).

### **Data Analysis**

A psychometrical analysis was applied in two stages: 1) Factorial Confirmatory Analysis and 2) Invariance Factorial Analysis; so that it could obtain evidence that presents the best properties for the scores confirmation of body image anxiety of engineering and health sciences university students.

A confirmatory factor analysis was conducted for each sample using the software AMOS 21 (Arbuckle, 2012). The error variances were specified as free parameters. In each latent variable (factor) one of the structural coefficients associated was fixed to the value of one in order to make its scale equal to one of the observed variables (items). The maximum likelihood estimation method, following Thompson's (2004) recommendations, was conducted to compare the fit indices of several alternative models to select the best one.

In the fit model assessment, the chi-squared test, the adjusted goodness of fit index (GFI), and the root mean square error of approximation (RMSEA) were used as absolute fit indices. The adjusted goodness-of-fit index (AGFI), the Tucker-Lewis index (TLI) and the comparative fit index (CFI) were used as incremental fit indices. Chi-squared divided by degrees of freedom (CMIN/df), and the Akaike information criterion (AIC) were used as parsimony fit indices (Byrne, 2010; Gelabert et al., 2011).

Lastly, a factor invariance analysis of the body image anxiety scale (BIAS) among engineering and health sciences students was conducted following the recommendations of Abalo et al. (2006), the reliability of each of the dimensions was calculated using the Cronbach's alpha and the omega coefficient (Revelle & Zinbarg, 2009; Sijtsma, 2009).

## **RESULTS**

### **Confirmatory Factorial Analysis**

According to the results of Table 1, the confirmatory factor analysis of 12 items grouped

into two factors in the sample of health sciences students is optimal (GFI .986 and RMSEA .050) and according to the incremental fit measures and parsimony significantly higher than the independent model and very similar to the saturated model.

On the other hand, the confirmatory factor analysis in the sample of engineering students (Table 1) again indicates that the two-factor measurement model is optimal (GFI .963 and RMSEA .056) and according to the incremental adjustment measures and parsimony significantly higher than the independent model and very similar to the saturated model.

Table 1. Absolute, incremental and parsimony fit indexes for the generated models. Confirmatory factor analysis for students of health sciences and engineering.

Model	Absolute Fit Indices			Incremental Fit Indices			Incremental Fit Indices	
	$\chi^2$	GFI	RMSEA	AGFI	TLI	CFI	CMIN/DF	AIC
Factorial solution for students in health sciences								
Two-factors 12 items	109.884*	.965	.050	.943	.980	.986	2.289	169.884
Saturated	0.000	1.000				1.000		156.000
Independent	4373.063*	.250	.357	.114	.000	.000	66.259	4397.063
Factor solution for engineering students								
Two-factors 12 items	132.013*	.963	.056	.940	.974	.981	2.750	192.013
Saturated	0.000	1.000				1.000		156.000
Independent	4437.861*	.272	.342	.140	.000	.000	67.240	4461.861

Note: \*  $p < .05$ ; GFI = goodness-of-fit index; RMSEA = root mean square error of approximation; AGFI = adjusted goodness-of-fit index; TLI = Tucker-Lewis index; CFI = comparative fit index; CMIN/df = chi-squared fit index divided by degrees of freedom; AIC = Akaike information criterion

Figure 1 shows the measuring model of the first confirmatory factorial analysis (health sciences students) for the 12 items grouped in two factors, including standardized regression coefficients among items and factors and the standardized factorial saturations (commonalities) of each item.

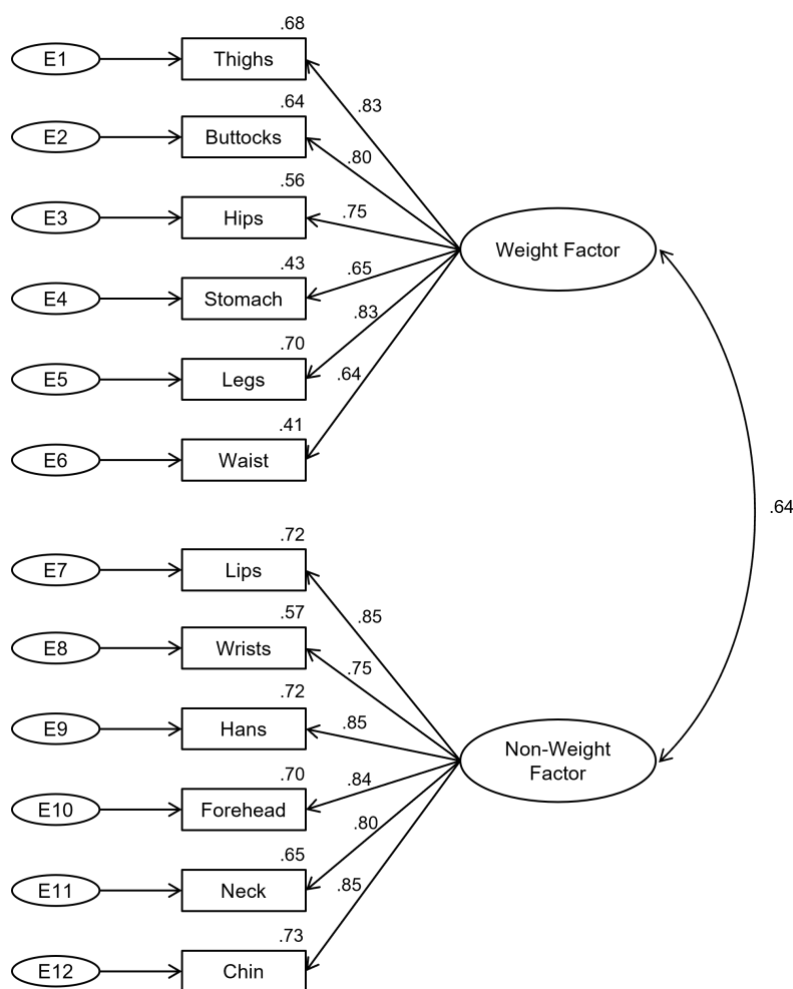


Figure 1: Measuring model for the scale. Confirmatory factorial analysis of health sciences students.

Both factors: anxiety “weight” trait and anxiety “no weight” trait present high standardized factorial saturations (higher than .60) therefore all the items result well explained from these factors.

The estimation of the correlation among the two factors of the scale is .64 shows that as it increases the level of anxiety in one of the factors, the other increases as well.

Figure 2 presents the measuring model of the second confirmatory factorial analysis (engineering students) for the 12 items grouped in two factors, including standardized regression coefficients among items and factors and the standardized factorial saturations (commonalities) of each item.

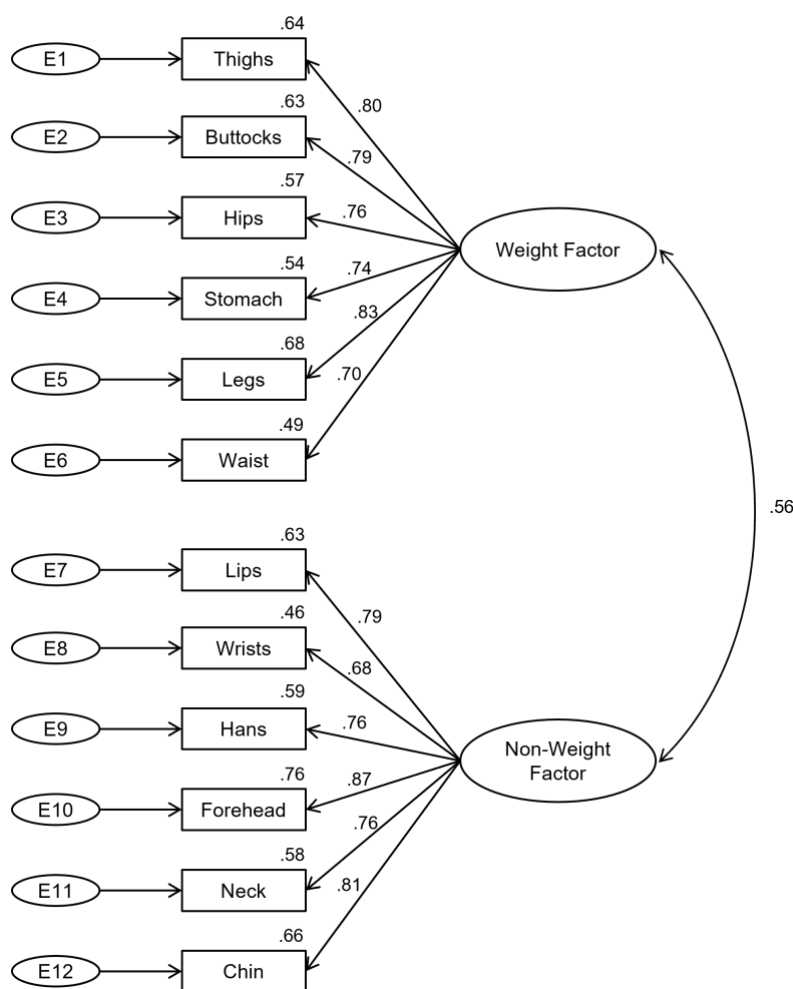


Figure 2: Measuring model for the scale. Confirmatory factorial analysis of engineering students.

Both factors: anxiety “weight” trait and anxiety “no weight” trait present high standardized factorial saturations (higher than .65) therefore all the items result well explained from these factors.

The estimation of the correlation among the two factors of the scale is .56 shows that as it increases the level of anxiety in one of the factors, the other increases as well.

Factor structure invariance between health science students and engineering students

The adjustment indexes obtained (Table 2) allow to accept the equivalence of the basic measurement models between the two samples. Although the Chi-square value exceeds that required to accept the invariance hypothesis, the indices GFI = .964, CFI = .983, RMSEA = .038 and AIC = 361,895 contradict this conclusion, which allows us to accept the base model of the Invariance (unrestricted model).

Adding to the base model constraints on factor loads we characterize the metric invariance. The values shown in Table 2 allow us to accept this level of invariance. The goodness of fit index (GFI .962) and the root mean square error of approximation (RMSEA .036) continue to provide convergent information in this direction. Also, the Akaike information criterion (AIC 352.034) and the Bentler comparative fit index (CFI .983) do not suffer large variations from the previous model. Using the criterion for the evaluation of nested models



proposed by Cheung & Rensvold (2002), who suggest that if the calculation of the difference of the CFI of both nested models decreases by .01 or less, the restricted model is taken for granted, and therefore the fulfillment of factorial invariance; the difference between CFIs obtained allows to accept the metric invariance model. We can conclude up to this point that factorial loads are equivalent in the two samples.

Once the metric invariance between the samples was demonstrated, we proceed to evaluate the equivalence between intercepts (strong factor invariance). The indexes (Table 2) show an optimum fit of this model, evaluated independently as well as analyzed with respect to its nesting with the metric invariance model. The difference between Bentler's comparative indexes is .002; The general fit index is .959 and the root mean square error of approximation is .037. Accepting the strong invariance, the two models evaluated are equivalent with respect to the factor coefficients and to the intercepts.

Table 2. Goodness of fit indexes of each of the models tested in the factorial invariance.

Model	Fit indices						
	$\chi^2$	df	GFI	NFI	CFI	RMSEA	AIC
Model without restrictions	241.895*	96	.964	.973	.983	.038	361.895
Metric Invariance	252.034*	106	.962	.971	.983	.036	352.034
Strong factor invariance	273.810*	109	.959	.969	.981	.037	367.810

Nota: \*  $p < .05$ ; GFI = comparative fit index; NFI = normed fit index; CFI = comparative fit index; RMSEA = root mean square error of approximation; AIC = Akaike information criterion

The factors obtained in the confirmatory factorial analyzes reached, in most cases, values of internal consistency above .75 in both samples (engineering and health sciences students); showing an adequate internal consistency for this type of subscales, particularly considering the reduced number of items (Table 3).

Table 3. Omega and Alpha coefficients of each of the obtained factors.

Factor	Health Sciences students		Engineering students	
	$\Omega$	$\alpha$	$\Omega$	$\alpha$
1. Weight	.887	.899	.897	.906
2. No weight	.855	.927	.819	.904

### Contrasts of Means Factors between Health Science Students and Engineering Students

Once the factorial invariance was verified, the differences between the means of the factors of the two groups were estimated taking as reference the sample of students of the health sciences, setting at 0 the value of the means for this sample and freely estimating the value of the means for the sample of engineering students. The restrictions on the regression coefficients and intercepts required for the contrasts between the means were automatically performed using the AMOS 21 software (Arbuckle, 2012).

The results of the comparisons indicated that the means of the factors, weight factor and non-weight factor were significantly lower -.610,  $p < .001$  and -.450,  $p < .001$  respectively in engineering students.

## DISCUSSION

From the results, analysis and discussion shown, and taking in consideration the main objective of this study which was to examine the factorial structure and the measure of the invariance of this structure in engineering and health sciences students, we can conclude the following:

1) The Confirmatory Factorial Analysis indicated that the adjustment of the data to the theoretical model of the 12 grouped items in two factors is acceptable. At the same time that the two factors obtained present in general adequate standardized factorial saturations. Meanwhile factors correlate among themselves in a positive way and statistically significant, show that, as anxiety perceived increases in one of the factors, the other factor increases as well.

2) Factorial Invariance Analysis among samples shows a high congruency among the two pair of factors. This suggests the existence of strong validity evidences crossed with the mean and so the stability of the structure, until there is evidence to the contrary.

3) Comparisons among groups showed meaningful differences, in favor of engineering students in both factors means. This suggests that students from engineering show less levels of anxiety than students from health sciences in relation with their body.

## CONCLUSIONS

In synthesis, the analysis of the psychometric properties has shown that a bi-factorial structure is feasible and appropriate according to the established psychometric requirements when the informants were the same students. The structure of the two factors, based on statistical and substantive criteria have demonstrated adequate adjustment indicators or reliability and validity; which is consistent with the results found by Ornelas et al. (2011) and Ornelas et al. (2014). However, we consider that more studies are necessary to corroborate or refute data obtained in this present study.

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