Perceived Stress Scale, a tool to explore psychological stress in Mexican women

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Abstract

Objective. To examine the factor structure of the 4- and 10-item Perceived Stress Scale (PSS) among 1 310 Mexican women participating in a prospective cancer cohort study. **Materials and methods.** We performed exploratory and confirmatory factor analyses in two sub-samples of the Mexican Teachers' Cohort. We evaluated internal consistency, estimated the correlation between PSS-4 and PSS-10, and assessed their correlation with a depressive symptoms scale. **Results.** Two-factor models were the solutions with the best fit to the data for both PSS-4 and -10, exhibiting strong factor loadings (0.39 to 0.75) and high internal consistency (Cronbach's alpha 0.72 and 0.83). The correlation between PSS-4 and PSS-10 was r=0.91 and the correlations of these two scales with a depressive symptoms scale were r=0.41 and r=0.46, respectively. **Conclusions.** PSS might be an adequate scale to assess perceived stress in this prospective cancer cohort study. PSS-4 may be advantageous due to its simplicity, low cost, and short application time in multicountry studies on stress and cancer.

Keywords: perceived stress; cancer; women; factor analysis

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Resumen

Objetivo. Evaluar la estructura factorial de la Escala de Estrés Percibido (PSS, por sus siglas en inglés) de 4 y 10 ítems en 1 310 mujeres mexicanas que participan en un estudio de cohorte sobre cáncer. **Material y métodos.** Se realizó análisis factorial exploratorio y confirmatorio en dos submuestras distintas del estudio ESMaestras. También se evaluó la consistencia interna, la correlación entre la PSS-4 y la PSS-10, y la correlación de estas escalas con una escala de síntomas depresivos. **Resultados.** El modelo de dos factores fue la solución con los mejores índices para ambas escalas, exhibiendo cargas factoriales fuertes (0.39-0.75), y alta consistencia interna (alfa de Cronbach=0.72 y 0.83). La correlación entre la PSS-4 y la PSS-10 fue r=0.91 y la correlación de estas escalas con la escala de síntomas depresivos fue r=0.41 y 0.46. **Conclusiones.** La PSS es una escala adecuada para evaluar el estrés percibido en este estudio de cohorte sobre cáncer. La PSS-4 puede ser ventajosa por su simplicidad, bajo costo y corto tiempo de aplicación en estudios multipaís sobre estrés y cáncer.

Palabras clave: estrés percibido; cáncer; mujeres; análisis factorial

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Stress, defined as the relationship between the person and the environment that is regarded as personally significant and as taxing or exceeding one's resources for coping,[1] affects people worldwide and represents a considerable health burden.[2,3] Stress has been associated with the development of unhealthy behaviors (e.g., alcohol consumption and cigarette smoking),[4,5] mental and physical health conditions,[6,7] and higher mortality risk.[8]

It is proposed that a sustained body response to stress can trigger inflammation processes that increase the risk of developing different health conditions including some types of cancer.[9] This stress-induced response leads to increased norepinephrine levels which results in tumor inflammation and aberrant arachidonic acid metabolism. In addition, stress responses occurring via the autonomic nervous system affect the number and function of immune cells.[10] Consequently, a number of studies have emerged in recent years evaluating the relationship between perceived stress and cancer.[11-13] Depending on the population, the type of cancer and the instrument used to measure it, the prevalence of perceived stress varies between 22 and 69%.[14,15]

The Perceived Stress Scale (PSS) is one of the most widely used measures of self-reported stress.[16] The scale originally included 14 items, but 10- and 4- item versions have also been developed.[17] To date, PSS has been translated into several languages, including Spanish. The PSS offers a method to assess stress among cancer patients because it can provide clinical information about the extent to which patients consider their lives as stressful.[18,19] When utilized in stress models, the scale can possibly distinguish the role of perceived stress in important cancer outcomes; for instance, patients' quality of life and adherence to treatment.[14,20,21] Due to the increased burden of cancer in Mexico and similar countries,[22] understanding its association with perceived stress is of paramount importance. However, almost no studies have been performed to validate the use of the PSS among cancer patients in Mexico or Central American countries. As a first step towards that goal, the factor structure of the PSS requires assessment in this population.

To the best of our knowledge, only one study has assessed the factor structure of the PSS-4 in a Mexican population. This study was conducted among a large sample of men and women from Northern Mexico and supported a two-dimensional structure of the scale. Studies among non-Spanish speakers have reported mixed results.[23,24] Studies exploring the factor structure of Spanish versions of the PSS-10 have favored one-[25] and two-dimensional structures.[26] These studies have been limited to evidence from small samples,[27,28] and conducted predominantly among US-based Latino populations.[26,27] Further validation of this scale is warranted in different populations, such as women living with cancer, as individuals' experiences with stress may vary across different social and cultural contexts.[29]

Therefore, we aimed to examine the factor structure of the Spanish version of the PSS-4 and 10 in a large sample of Mexican women participating in a prospective cancer cohort study.

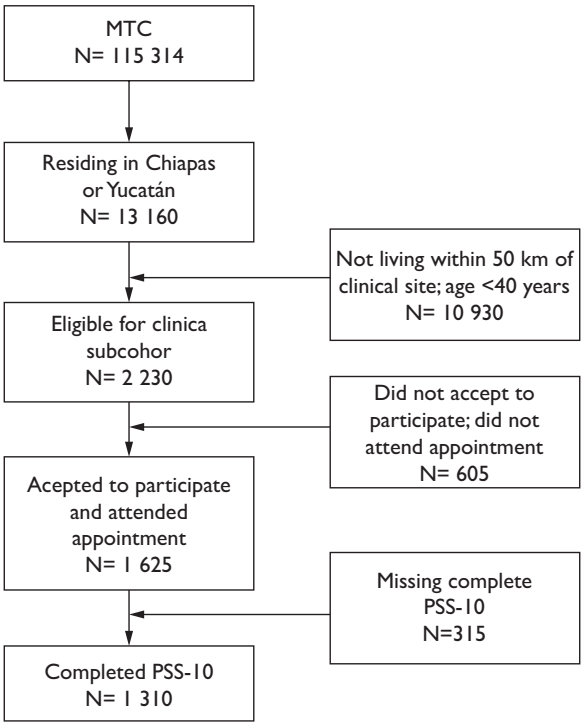
Materials and methods

Study population

Data for this analysis comes from female teachers participating in the Mexican Teacher's Cohort (MTC).[30] The MTC is an ongoing prospective cohort study aimed at assessing the association of lifestyle factors with chronic non-communicable diseases, including cancer. At baseline, 2% of participants reported a cancer diagnosis and 5% had family cancer history. Between September 2012 and November 2013, a subsample of 2 230 women aged ≥40 years were invited to participate in a clinical assessment as part of an ancillary study on cardiovascular risk. The participants lived within 50 kilometers of five clinical sites in two states in Southern Mexico (Chiapas and Yucatán). A total of 1 625 (73%) attended a clinical appointment. Among them, 1 310 (81%) completed the PSS-10 and were included in the current analysis (figure 1). Among the study participants, 902 completed the Patient Health Questionnaire 9 (PHQ-9) in a follow-up between 2012 and 2013. All participants provided written consent. The study was approved by the Institutional Review Board of the National Institute of Public Health (INSP; project number 1221).

Measures

We obtained the participants' age at the time of the clinical appointment and their demographic characteristics at baseline. Participants provided data on education (graduate degree, university or less than university), marital status (married/cohabiting and other, including single, widowed or divorced, in the baseline questionnaire). The baseline questionnaire also asked participants about their ownership (yes/no) of seven household assets —telephone, car, computer, vacuum cleaner, microwave oven, cell phone, and internet access—, from which we constructed an assets index to measure socioeconomic status, categorized into tertiles (low, medium, and high).



MTC: Mexican Teacher's Cohort
PSS: Perceived Stress Scale

FIGURE 1. STUDY FLOWCHART

Perceived Stress Scale

We used the Spanish version of the PSS-10[16] to assess stress, defined as "the degree to which life in the past month has been experienced as unpredictable, uncontrollable and overwhelming" (e.g. "in the last month, how often have you felt nervous and stressed?") on a 5-point response scale (0 = "never", 1 = "almost never", 2 = "sometimes", 3 = "fairly often", 4 = "very often"). As per standard practice[31] PSS-10 scores are obtained by reversing the scores on the four positive items (4, 5, 7 and 8) and summing across all 10 items, with higher scores indicating higher levels of perceived stress (scores range from 0 to 40). We additionally created a PSS-4 score based on questions 2, 4 (reversed), 5 (reversed) and 10 of the original PSS-10 (scores range from 0-16). Since the PSS is not a diagnostic instrument and does not have established cutoff values, we categorized participants' scores using tertiles of the PSS total scores.

Patient Health Questionnaire (PHQ-9)

We previously reported on the factor structure of the PHQ-9 applied in the MTC.[32] This instrument has nine items measuring depression symptoms in the previous two weeks.[33] Items are rated on a 4-point scale, ranging from 0 (not at all) to 3 (nearly every day), and a score is obtained by adding up items and ranges from 0 to 27. Higher scores indicate increased severity of symptoms and increased likelihood of a major depressive disorder.[34]

Statistical analysis

We assessed the factor structure of PSS-4 and PSS-10 using exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). To cross-validate findings from the EFA with CFA, we generated two equally-sized random sub-samples (n=655) from the original sample of participants. We conducted EFA in one sub-sample and CFA in the other. In each sub-sample, we performed descriptive analyses of all covariates and PSS scores. We used chi-square tests for comparison between subsamples. We performed EFA using maximum likelihood estimation with promax rotation and used eigenvalues and their graphic representation (i.e., a scree plot) to determine the number of factors retained.[35] We dropped factors with eigenvalues below one or all additional factors after the one starting the elbow of the scree plot. We fitted one- and two-factor models accordingly. We assessed the reliability of the models by the Tucker and Lewis' Index (TLI), which ranges from zero to one, with larger values indicating better reliability.[36] We performed CFA using maximum likelihood estimation to assess the goodness-of-fit of one- and two-factor solutions of the PSS-4 and PSS-10. We evaluated model fit using: 1) the Root Mean Square Error of Approximation (RMSEA), where good model fit is indicated by an RMSEA value of 0.08 or less;[37] 2) the Comparative Fit Index (CFI), where acceptable model fit is indicated by a CFI value of 0.95 or greater,[38] and 3) the Normed Fit Index (NFI), where values above 0.90 are considered acceptable.[39]

Additionally, we calculated Cronbach's alpha (α) to measure the internal consistency of items in the full scale (for both 4 and 10 item versions) and in each underlying factor. Finally, we explored the correlation between PSS-4 and PSS-10, and between these two scales and PHQ-9 scores by Spearman's correlation. All analyses were conducted using SAS software, version 9.4.

Results

Table I shows the descriptive characteristics of the participants. The mean (SD) age was 48.2 (4.3) years. Most women were non-indigenous, lived in urban areas, had at least a university-level education, were of medium to high socioeconomic level, and were married or living with a partner. The median (IQR) scores of PSS-10,

PSS-4 and PHQ-9 were 14 (9-18), 4 (2-6) and 3 (0-6), respectively. The characteristics of PHQ-9 respondents vs. non-respondent are presented in Supplementary Table I.[40] Briefly, non-respondents were more likely to be indigenous, had a lower education level, were less likely to be married/cohabiting and, and were more likely to be in the highest tertiles of perceived stress.

Overall, there were no differences between the sub-samples used for the EFA and CFA (Supplementary Table II).[40] Results from the EFA are presented in table II and suggested a one-factor solution for PSS-4 and a two-factor solution for PSS-10. The unidimensional model for PSS-4 explained the variance by 49%, and all factor loadings were higher than 0.4. This model displayed a high model fit according to the TLI (0.72) as well as a moderate internal consistency (α= 0.72). For PSS-10. The first factor was defined by six items corresponding to negatively-worded items, and the second factor was defined by four items corresponding to the positively stated items. All items –except for item six– had factor loadings above 0.40, ranging from 0.49 (item 7) to 0.73 (item 3). The first factor accounted for 68.6%, and the second, for 18.7% of the variance. This model displayed a high model fit according to TLI (0.89) and a moderate internal consistency (α= 0.71 and 0.79). Table II also shows the EFA results of a one-factor solution for PSS-10.

Table II shows the fit statistics and standardized factor loadings for the competing CFA models tested in the split sample of 655 women. Results favored the two-factor structure of both PSS-4 and PSS-10. All but one of the factor loadings were above 0.4, and the two-factor solution for PSS-4 had the best fit to the data (RMSEA= 0.00; CFI= 1.00; NFI= 0.99). For PSS-10, the two-factor model showed lower yet adequate fit indices (RMSEA= 0.08; CFI= 0.92; NFI= 0.90). Fit statistics for one-factor models are also shown in table III.

Internal consistency was high for the full scale in both 4- and 10-item versions (α= 0.72 and 0.83, respectively) and slightly lower for each factor of the two-dimensional solutions (ranging from 0.69 to 0.79).

Also, we compared PSS-10 and -4 scores and found that Spearman's correlation was positive and strong (r=0.91, p<0.001), and the agreement between score tertiles was substantial (Kappa=0.66, p<0.001).

We found a positive correlation between PSS and PHQ-9 scores (r=0.41, p<0.001 for PSS-4, and r=0.46, p<0.001 for PSS10). Correlations for each of the factors in the two-factor model and the PHQ-9 score were also positive and significant (PSS-4: r=0.41, p<0.001 for factor 1, and r=0.29, p<0.001 for factor 2; PSS-10: r=0.47, p<0.001 for factor 1, and r=0.32, p<0.001 for factor 2)

Table I
Characteristics of the study participants (n=1 310). Mexico, 2012-2013

Age, years	%
<45	16.5
45-54	70.6
>54	6.9
Indigenous	20.0
Living in rural areas	22.9
Education Level	
Below university level	12.9
University level	58.6
Graduate degree	10.0
Missing	18.5
Socioeconomic status	
Low	25.3
Middle	34.1
High	49.7
Marital Status	
Married/Cohabiting	69.9
Other	28.7
Missing	1.5
PHQ-9 score, median (IQR)*	3 (0-6)
Moderate to severe depressive symptoms (PHQ-9 > 9)*	9.0
PSS-10 score, median (IQR)	14 (9-18)
PSS-4 score, median (IQR)	4 (2-6)

Values are percentages unless otherwise indicated
PSS: Perceived Stress Scale
PHQ-9: Patient Health Questionnaire 9
* Complete PHQ-9 was available only for 902 participants.

Discussion

This study adds to the sparse literature assessing the factor structure of the Spanish version of the PSS-4 and PSS-10 among Mexican women participating in a prospective cancer cohort study. Overall, our results support two-factor solutions for both PSS-4 and PSS-10, with factor loadings similar to those previously reported in the literature.[23,41-43] Interestingly, the two-factor model of PSS-4 not only showed acceptable internal consistency but the highest fit indices and a positive correlation with depressive symptomatology. Furthermore, the correlation between the PSS-4 and 10 scores was high.

The PSS is a tool used to assess perceived stress, and in recent studies has been administered to cancer patients. In the present study, the Spanish versions of the PSS-4 and PSS-10 showed adequate factor properties

Table II
EXPLORATORY FACTOR ANALYSIS AND RELIABILITY OF THE PSS-4 AND PSS-10 AMONG WOMEN FROM THE MEXICAN TEACHERS' COHORT (N=655). MEXICO, 2012-2013

	PSS-4	*PSS-10*		
	One factor	*One factor*	*Two factors*	
Items			*F1*	*F2*
1 Have you been upset because of something that happened unexpectedly?		0.58	0.67	-0.07
2 Are you unable to control the important things in your life?	0.62	0.71	0.66	0.08
3 Have you felt nervous and stressed?		0.72	0.73	0.04
4 Are you confident about your ability to handle your personal problems?	0.61	0.43	0.09	0.50
5 Have you felt that things were going your way?	0.58	0.48	-0.10	0.87
6 Have you found that you could not cope with all the things that you had to do?		0.41	0.39	0.03
7 Have you been able to control irritations in your life?		0.51	0.18	0.49
8 Have you felt that you were on top of things?		0.41	0.06	0.52
9 Have you been angered because of things that were outside of your control?		0.63	0.66	0.00
10 Have you felt difficulties were piling up so high that you could not overcome them?	0.68	0.75	0.66	0.14
Eigenvalue	1.97	5.6	6.86	1.86
Correlation between factors	----	----	0.51	
Cronbach's alpha coefficient	0.72	0.83	0.79	0.71
Tucker and Lewis's Reliability Coefficient	0.68	0.78	0.89	

Scores on the four positively stated items (4,5,7, and 8) were reversed
PSS: Perceived Stress Scale

to evaluate psychological stress and related depressive symptomatology. This suggests that both PSS-4 and PSS-10 might be used to assess stress-related symptoms in Mexican female teachers and could be useful as screening tests in longitudinal studies.

Studies assessing the factor structure of the Spanish version of the PSS-10 are in partial agreement with our study. González-Ramírez and colleagues[25] found a two-factor structure of the PSS-10 in a sample from Northern Mexico with factor loadings and item distributions similar to those reported in our study. Perera and colleagues,[26] on the other hand, reported a bifactor model among a Hispanic/Latino sample residing in the United States. In this bifactor model, all positive items loaded onto a "General perceived stress" factor, and the four-reverse-worded items load onto a "Reverse-worded nuisance" factor. However, Baik and colleagues[27] found a better fit for the bifactor model only for English-speaking participants, but not for Spanish-speaking participants, among 436 Hispanic Americans who answered the PSS-10, in which the data were best explained by the two-factor model. In our study, the two-factor model showed the best fit to the data. Despite the analytical support behind the two-factor solution of the PSS-10, most of the studies conclude that a unidimensional conceptualization of the scale relies on better theoretical support for measuring perceived stress.[23] As suggested by the PSS developers, this is because any distinction between multiple scale factors is irrelevant[16] and only reflects the sentence structure of the scale.

The psychometric properties of PSS-4 have been less explored, and results have also been inconsistent in regard to its factor structure.[23] However, our findings are in line with those of the only other study that assessed the factor structure of the Spanish version of this scale[25] and with those reported in a large sample of cardiac patients in China where a two-factor solution was found to better fit the data.[24] This scale may also be appropriately interpreted as a unidimensional construct, given that the superficial nature of the reversed wording remains.

In Mexico and other Latin American countries, the scarcity of studies focusing on the association between stress and cancer contrasts with the increasing morbidity and mortality rates that have occurred in this region in recent years.[44] Evidence from other studies shows differences in regard to the association between stress and the development of cancer.[13,45] Stress may favor inflammatory processes related to excessive secretion of cortisol, generating alterations of the endocrine and

Table III
Standardized factor loadings and model fit statistics for one-factor and two-factor solutions. Confirmatory factor analysis of the PSS-4 and PSS-10 among women from the Mexican Teacher's Cohort (n=655). Mexico, 2012-2013

	PSS-4			*PSS-10*		
	One factor	*Two factors*		*One factor*	*Two factors*	
Items		*F1*	*F2*		*F1*	*F2*
1 Have you been upset because of something that happened unexpectedly?				0.62	0.66	
2 Are you unable to control the important things in your life?	0.66	0.70		0.66	0.66	
3 Have you felt nervous and stressed?				0.69	0.73	
4 Are you confident about your ability to handle your personal problems?	0.69		0.73	0.45		0.66
5 Have you felt that things were going your way?	0.52		0.71	0.48		0.77
6 Have you found that you could not cope with all the things that you had to do?				0.40	0.39	
7 Have you been able to control irritations in your life?				0.48		0.59
8 Have you felt that you were on top of things?				0.37		0.49
9 Have you been angered because of things that were outside of your control?				0.62	0.64	
10 Have you felt difficulties were piling up so high that you could not overcome them?	0.48	0.77		0.73	0.73	
Cronbach's alpha	0.72	0.70	0.69	0.83	0.79	0.71
Correlation between factors	----	0.62		----	0.54	
RMSEA	0.26	0.00		0.12	0.08	
CFI	0.84	1.00		0.83	0.92	
NFI	0.84	0.99		0.81	0.90	

PSS: Perceived Stress Scale
RMSEA: Root Mean Square Error of Approximation
CFI: Comparative Fit Index
NFI: Normed Fit Index.
RW: Reverse worded
Scores on the four positively stated items (4,5,7, and 8) were reversed.

immune systems, which in turn have been associated with the development of certain types of cancer.[46] The use of PSS-10 and PSS-4 in Latin America may contribute to the understanding of the role of stress in cancer incidence and survival.

We found a positive correlation between perceived stress and depressive symptomatology in the expected direction. This result is consistent with previous studies[23] and with the report by Cohen and colleagues, who state that "there is some overlap between what is measured by depressive symptomatology scales and by the PSS, since the perception of stress may be a symptom of depression".[16] The current literature suggests that stress exposure increases the risk for poor clinical outcomes across a variety of major health conditions, including depression.[47] A strong association between perceived stress and depression was found in a large sample of 229 293 community-dwelling adults from 44 low and middle income countries.[48] Likewise, a high correlation between PSS-10 score and depressive symptoms has been reported among older Vietnamese women.[41] In a case-control study carried out in Poland, women with stress in their daily activities and with depression had a 3.7 times higher risk of developing breast cancer, compared to those who were not exposed to such stress.[49] In a recent study in China, perceived stress measured with the PSS was a predictor for depressive symptoms among oral cancer patients.[50] According to national estimates, in Mexico the prevalence of depressive symptoms is 15%, while detection coverage is 9.9%.[51]

The results of our study should be interpreted in light of its limitations. First, due to the nature of the study, men were not included in our sample. However, previous studies assessing the factor structure of the Spanish version of the PSS-10 have not found differences by gender.[25] Likewise, although this is a population-based study, the generalizability of its findings is limited since the sample only included teachers living in certain

areas of Mexico. Finally, we only performed exploratory analyses evaluating the correlation between stress and depression symptoms. Future studies should consider examining how PSS constructs relate with other risk factors or domains associated with stress such as positive affect or life satisfaction and provide information on the scale's concurrent and discriminant validity.

Despite these limitations, our results present important strengths and implications. First, analyses were performed with robust methods in a large sample with a population-based design. Additionally, the good fit to data and high factor loadings reported here suggest that the Spanish versions of the PSS-4 and PSS-10 are useful measures of perceived stress. We conclude that the Spanish versions of the PSS-4 and PSS-10 maintain psychometric properties suitable to assess perceived stress. For theoretical and practical reasons, their use as unidimensional scales (global score) is recommended. Both the PSS-4 and -10 are valuable research tools for assessing symptoms related to stress and may assist in the assessment of psychological stress in women. The PSS-4 may be more useful for large samples, including multicountry studies on stress and cancer, due to its simpler structure, low cost, and short application time.

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