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Artigo Original

Factor analysis of the 9-item Psychological Stress Measure in a French Canadian non-clinical student sample.

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ABSTRACT

The aim of this study is to test the unidimensional 9-items factorial model, about psychological stress, with a non-clinical sample of Canadian students, evaluated by the metric principals of factorial analysis and internal consistency. A sample of 546 university students (Women = 79.6%, Men = 20.4%, Mean age = 23.2, Standard Deviation = 7.3) were used. The results of the exploratory factorial analysis (explaining about 55.3% of the total variance of the construct) and confirmatory (GFI = 0.994, AGFI = 0.991, CMIN / DF = 3.77, RMSEA = 0.071, CFI = 0.985) satisfactorily confirmed its unidimensionality. The results of the internal consistency study, obtained by Cronbach's Alpha, McDonald's Omega, Greatest Lower Bound coefficient, and also the EAP scores, ensure the accuracy of the tested model. New studies should explore and test other important metric qualities of this instrument (content validity and test-retest reliability, among others).

Keywords: Validity; Reliability; University Students; Psychological Stress; Psychometric Instrument.

RESUMO

O objetivo deste estudo é testar o modelo fatorial, unidimensional, a 9-itens sobre Estresse psicológico de uma amostra não clínica de estudantes canadenses, avaliado pela Escala de Estresse Psicológico (EEP-9), de Louise Lemyre (1988), através dos princípios métricos das análises fatoriais e consistência interna. Foi utilizada uma amostra de 546 universitários (Mulheres = 79,6%, Homens = 20,4%; Idade média = 23,2; Desvio-Padrão = 7,3). Os resultados das análises fatoriais exploratória (explicando cerca de 55,3% da variância total do construto) e confirmatória (GFI = 0,994; AGFI = 0,991; CMIN/DF = 3.77; RMSEA = 0,071; CFI = 0,985) permitem concluir que o modelo testado confirmou satisfatoriamente sua unidimensionalidade. Os resultados do estudo da consistência interna, obtidos pelos cálculos Alpha de Cronbach, Ômega de McDonald, o maior coeficiente de limite inferior, e, também, o escore EAP, asseguram a precisão do modelo testado. Novos estudos devem explorar/testar outras importantes qualidades métricas deste instrumento (validade de conteúdo e fidedignidade teste-reteste, entre outras).

Palavras-chave: Validade; Fidedignidade; Universitários; Estresse Psicológico; Instrumento Psicométrico.

INTRODUCTION

According to Statistics Canada (2014)[1], in 2013, 23 % of Canadians over 15 years old have declared that their whole day was stressful or very stressful. Moreover, women declared more frequently than men to have very stressful days. The concept of stress has been studied thoroughly in

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the last years. The contribution of Selye's work (1956)[2] has made the concept of stress becomes more familiar, as it is a state of tension, preoccupation and activation experienced by almost everyone (Lemyre and Tessier, 2003)[3]. Throughout time, the concept of stress has evolved. In the early decades of stress research, the physiological view inspired a large part of the studies. Then the psychosocial model brought a counterpart to this type of reasoning. The building of most stress evaluation tools is based on either one or the other view. In the present paper, we aim to provide more validation evidence about the 9-item version of the *Psychological Stress Measure* (PSM-9 – Lemyre & Tessier, 2003)[3], which is the short version of the original 53-item test (PSM-53 – Lemyre & Tessier, 1988)[4]. More information will be provided about these different versions later on. The main reason for validating this instrument is to have a tool to screen high stress levels in non-clinical populations, particularly in workplaces or schools where time is a constraint.

The physiological model brought the idea that the brain, neuroanatomy and biochemicals are key actors in health or illness and is mostly symptom-based (Deacon, 2013)[5]. It underlies that bodily changes signify that homeostasis has been disturbed by noxious conditions of living (Lazarus, 1990)[6]. This model exposes that the person is not responsible for what happens. In their study, Mazé and Verlhiac (2013)[7] indicate that in France, 36,2% of the students admit to having difficulties to handle their stress and specifies risks in one of three students for somatic (pain, digestive disorders) and emotional troubles (anxiety, depression, obsessive symptoms, etc.). Other studies suggest that students are also at risk for negative stress impacts (Dumont, Leclerc and Deslandes, 2003)[8]. A high level of stress can also lead to many problems such as low satisfaction rate in life, cardiac diseases, cerebrovascular stroke and hypertension (Lemyre & Lalande-Markon, 2009)[9]. This medical perspective revealed physiological stress correlates such as blood and saliva immunoglobulin (Fillion, Tessier, Tawadros and Mouton, 1989)[10]. Feeling stressed is related to the activation of the sympathetic nervous system, the release of adrenaline, activation of heart pulse, constriction of blood vessels, high blood pressure, and increased breathing (Lemyre and al., 2009)[9]. These symptoms show the impact of stress on health and support the use of the *Psychological Stress Measure* (PSM) as a preventive tool to assess the presence of stress manifestations.

The psychosocial stress refers to a particular kind of relationship between the person and the environment (Lazarus, 1990)[6]. This interaction is like a transaction and the issue depends on the perceived resources of the person and the perceived demands of the environment. If the transaction feels adequate, stress will not interfere with the process. Otherwise, the person may feel overwhelmed and stressed. There are stressors such as life events or crisis that everyone may experience through life. For some individuals, the balance of events may be negative and generate detrimental consequences (Dumont and al., 2003)[8]. The PSM allows a good overview of the global issues of dealing with stressful situations and its outcome.

Even if stress has been considered as physiological or psychological and disturbs the homeostasis, the concept of stress is also influenced by the nature of the stressor. Amongst others, one's personal characteristics in association with the stressor also matters. Throughout time, stress has been considered either as a stimulus or as the result of the action of the stimuli. Stress as a stimulus is considered «input stress» as featured with tests such as Holmes and Rahe's *Schedule of Recent Experiences* (1967)[11]. These types of measures have been used for two decades but correlations between life events and illness are reportedly small; between .20 and .30 (Lazarus, 1990)[6].

Stress as the result of a stimulus is called «output stress» and several tests such as *Perceived Stress Scale* (Cohen, Kamarck and Mermelstein, 1983)[12] or *Subjective Stress Scale* (Kerle and Bialeck, 1958)[13] aim to assess the level of subjective perturbation of an individual. As the result of this scale is unidimensional, there is no distinction between threatening or challenging stress and no indication for the coping level or strategies. What has been found is that we must study the subjective dimension of the stressful events, in the daily life. Some tests built to measure stress are instead assessing depression, anxiety or the consequences of feeling stressed such as health or psychological problems (Lemyre and Tessier, 1988)[4]. The PSM is designed to explore the « state of feeling stressed » and portray an instant picture of the global outcome of faced challenges.

Later, in the eighties, these two ideologies

were merged together inspired by Doctor Georges Libman Engel's work in 1977 (Siksou, 2008)[14]. His commitment to getting rid of the dualism and creating the biopsychosocial model resulted in new cross-disciplinary approach (Siksou, 2008)[14]. The *Psychological Stress Measure* (PSM - Lemyre, Tessier and Filion, 1990)[15] scale is based on the biopsychosocial model of stress, which gathers the environmental parameters and the individual processes of perception and of stress management. Stressors lead to a state of stress and create symptoms or other observable disorders (Lemyre and Tessier, 1988)[4]. Biopsychosocial research has shown that stress is closely related to physiology and pathology (Deacon, 2013)[5].

Early in their work, Lemyre and Tessier (1988)[4] discussed the tricky question of measuring « state of feeling stressed ». According to the authors, the reported state of feeling stressed is a critical predictor of ill health (Lemyre and al., 2009)[9]. This instrument is aimed to reflect affective, cognitive, behavioral and somatic components of the stress. By assessing the state of feeling stressed, this test is a symptomatic measure of a non-clinical and non-pathological state in the general population. It is different from a global measure of distress and from the other stress measures by its specificity and methodological independency from stressors (Fillion and al., 1989)[10]. There is a range of tests aiming to determine levels of anxiety, post-traumatic state, depression and coping as enunciated earlier. All these indicators may be related to stress, but do not measure the «state of feeling stressed». The authors described the score of this self-report test as an observed state rather than an induced state of stress (Lemyre and Tessier, 1998)[4].

OBJECTIVE

This study's main objective is to explore psychometric properties of the PSM-9 and report the unidimensional factor structure in a large non-clinical French Canadian students sample by using exploratory and confirmatory factor analysis. By doing this, we expect to be able to assess the operationalization of the stress as measured by this instrument. To do so, five main research questions will lead our process: 1) How many factors should be retained to explain psychological stress? 2) What is the percentage of explained variance? 3) Should any item be modified or removed from this test? 4) How good is the model fit? 5) How good is the reliability?

METHOD

Participants

The sample comprised 546 undergraduate students (female = 79,6%, male = 20,4%; mean age = 23,2, SD = 7,3) at a public French Canadian university, Université du Québec à Trois-Rivières. The data were collected upon its Research Ethics Committee (REC) approval. Participants were recruited directly in their class, after obtaining teachers acceptance. The testing period took place just before the beginning of the lecture, and students did not receive any compensation or incentive for their participation, and were also free to accept or decline to participate in this research project. Number of participants in each administration session went from 27 to 67 participants. All were students from psychology, medicine, educational sciences or speech language fields.

Measures

Psychological Stress Measure has been developed by Louise Lemyre in 1988[4] at Ottawa University. It is built in French and aims to measure the impact of 'feeling stressed' as well the psychological impact of stress on health (Lemyre, Tessier and Fillion, 1990)[15]. It has been translated into English (1988, 2003), Japanese, Spanish (Tessier, Fillion, Muckle and Gendron, 1990)[16] and fits international comparisons. Many versions of the PSM were created such as 53 items (Lemyre and Tessier, 1988)[4], 49 and 25 items (Lemyre, Tessier and Fillion, 1990)[15] and 9 items (Lemyre and Tessier, 2003)[3]. Nowadays, the usual long version is the 49 items and those of 25 items are used for repeated measures. PSM items were elaborated by using focus groups and discussion that includes affective, cognitive, behavioral and physical issues. The latest French version (PMS-9) is a 9 item self-reported measure that uses an 8-point Likert response scale to assess psychological stress, as developed by Lemyre and Tessier (2003)[3]. It includes items such as: "I feel preoccupied, tormented or worried; I feel confused; My thoughts are muddled; I lack concentration and I cannot focus my atten-

tion; I feel a great weight on my shoulders". On a scale from 1 to 8 (not at all to extremely), participants must indicate how items fit them for the last week (Lemyre and Tessier, 1988)[4]. The creation of the PSM-9 was intended for general surveys of health and well-being in the workplace, large companies such as Hydro-Québec (public utility managing electricity) or Renault (French automobile maker) and in public service and hospitals (Lemyre, 2009)[9]. The 9 items version has also been created to fit the need for academic research and other various applications (Lemyre, Tessier, 2003)[3]. This short version can easily be included in larger test sets (Lemyre and Tessier, 1990)[15].

This convenient version is said to present the same psychometrics as the longer versions (Lemyre and Tessier, 2003)[3], but this statement remains unclear. However, literature about the longer versions of this scale reports reasonable test-retest reliability and good internal consistency. The unifactorial structure of the original version (Lemyre and Tessier, 1988)[4] explains 36% of the variance of the stress, presents a test retest reliability of 0,63 and Cronbach coefficient of 0,96 in a normal distribution. Inter-item correlations are between 0,32 and 0,35 and item-total correlations of between 0,54 and 0.57 for the different versions. Two parallel 25 items version were used for longitudinal follow up and showed Cronbach coefficients of 0,92 and 0,93 (Lemyre and al., 1990)[15]. Good concomitant validity was reported by Tessier, Fillion, Muckle and Gendron (1990)[10] with tests such as State Trait Anxiety Inventory (STAI[4]) (r = .29 and .36) and Beck Depression Inventory (BDI[5]) (r = .18). The PSM is convergent with BDI and STAI showing a strong correlation between depression, anxiety and stress. Also, it has good predictive power (structure coefficient: 0,85) and good discriminative power (between depressive and schizophrenic people) (Lemyre and Tessier, 1988)[4]. As the psychometric properties of the longer versions are significant and the need for further validation of the 9 item version was tackled, this short version was used in the present study for thorough analysis.

[4] Spielberger, C. D. (1989). State-Trait Anxiety Inventory: Bibliography (2nd ed.). Palo Alto, CA: Consulting Psychologists Press.

[5] Gauthier, J. G., Morin, C, Thériault, F., & Lawson, J. S. (1982). Adaptation française d'une mesure d'autoévaluation de l'intensité de la dépression. Revue québécoise de psychologie, 3(2), 13-27.

Data analysis

Two types of analysis were performed to assess the validity of the PMS-9. To begin, a factor analysis using Unweighted Least Squares (ULS) extraction method and Promin rotation method to explore the latent dimension and items saturation was conducted with polychoric correlations on a sample of 288 participants randomly picked from the initial sample. This analysis was run with FACTOR version 10.3.01. Thereafter, a confirmatory factor analysis was performed on an independent sample of 259 remaining participants to evaluate model fit, using Maximum Likelihood Robust (MLR) estimation technique. This analysis was run with Mplus version 7.4.

RESULTS

First, an analysis of the items' means, standard deviations and medians was made in order to check sample's answers behavior. The means are considered adequate, as the values shown are not close to the minimum possible value of answer, neither to the maximum possible value of answer. Moreover, the medians are, in every case, very similar to the means values. Regarding the standard deviations, they are generally adequate, as most of them do not exceed half of the means values. All of these results indicate that the sample's answer behavior is homogenous, which is important for subsequent analyses.

In order to adequately achieve the main objective and answer the five main questions of this research, a calculation of the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy, that is a check of the correlation matrix determinant, and a calculation of the Bartlett Test of Sphericity were initially assessed. The Kaiser–Meyer–Olkin Measure of Sampling Adequacy (KMO = .90), the Determinant of the Correlation Matrix (0.016) and the Bartlett Test of Sphericity ($\chi 2_{B(36)}$ 2234.9; $p <$ 0,01) indicate that correlations between items are sufficient and very adequate to proceed to factor analyses, indicating that the sample is factorable, though the Bartlett Test of Sphericity is almost always significant in a large sample.

Table 1 – Descriptive statistics, polychoric correlations, exploratory factor analysis and internal consistency results of PSM-9's items.

Psychological Stress Measure (PSM-9)																
Item	Partial Description	$\bar{x}$ {\ displaystyle {\ bar {x}}}	SD	$\tilde{x}$	Polychoric Correlations									h^2_u	Factor	h^2_r
					1	2	3	4	5	6	7	8	9			
1	I feel calm.	4.7	1.8	5	-									.572	.756	.896
2	I feel rushed...	5.4	1.9	6	.51	-								.397	.630	.645
3	I suffer from pains...	4.3	2.1	4	.38	.38	-							.301	.549	.442
4	I feel worried...	4.8	1.9	5	.65	.55	.46	-						.779	.883	.936
5	I feel confused...	3.3	2.0	3	.50	.44	.45	.66	-					.550	.741	.685
6	I feel full of energy...	4.1	1.7	4	.60	.40	.48	.59	.54	-				.484	.696	.724
7	I feel my shoulders...	4.2	1.9	4	.54	.49	.35	.63	.54	.47	-			.523	.723	.571
8	I have difficulty...	3.2	1.9	3	.36	.20	.25	.41	.50	.35	.43	-		.256	.506	.571
9	I feel stressed.	5.2	.9	5	.64	.56	.41	.80	.54	.49	.59	.42	-	.664	.815	.814
Cumulative Proportion of Explained Variance															55.3	
Standardized Cronbach's Alpha (Cronbach, 1951)															.896	
McDonald's Omega (McDonald, 1999)															.899	
Greatest Lower Bound (Woodhouse & Jackson, 1977)															.933	
Reliability of EAP Scores (Ferrando & Lorenzo-Seva, 2016)															.972	

NB.: $\bar{x}$: Mean; SD: Standard Deviation; $\tilde{x}$: Median; h^2_u: Unrotated communalities; h^2_r: Communalities after rotation.

Exploratory Factorial Analysis.

A factor analysis was performed using Unweighted least squares (ULS) extraction method to explore the latent dimension of the 9 items of the French version of PMS-9. To determinate how many factors were to be extracted, two criteria were explored: 1) the number of factors with eigenvalues; 2) the parallel analysis. Both criteria assessed only one factor, corroborating Lemyre et al.'s initial conceptualization. Eigenvalues criteria suggests that this single-dimension model explains 55.3% of the total variance of the construct of psychological stress, while parallel analysis suggests 60.6% of total variance explained. Since only one dimension emerged from this factor analysis, no further information was interpretable.

Inter-items correlations reported that two correlations were lower than 0.3 – both involving item 8, while all the other correlations ranged from 0.35 to .80, which globally suggest adequate inter-item correlations. This result summed up to the fact that item 8 showed the lowest mean among all items; presented standard deviation higher than half of the mean; and had communality before rotation lower than 0.3, indicates that its presence in this instrument should be reconsidered. Other studies shall test this hypothesis.

Confirmatory Factorial Analysis

Confirmatory factor analysis (CFA) was used to assess the previously found model in terms of how well it accounts for relationships in data. For the current study, the Robust Unweighted Least Squares (RULS) estimation technique was employed because it is a robust estimator which does not assume normally distributed variables (Brown, 2015)[17]. Confirmatory factor analysis was performed to assess adequacy evidence between observed data and hypothetical modal. Results demonstrate a chi-square ($CMIN_{(27)}$ = 101.767) statistically significant ($p < 0.01$), showing that the observed covariance matrix is different from the estimated covariance matrix. However it is common to find such problems when analyzing large samples. Relation between chi-square (CMIN) and degree of freedom (DF) – normed chi-square – must be lower than 5 (CMIN/DF = 3.77), which is the case in this study. Moreover, results of Goodness of Fit Index (GFI = 0.994) and Adjusted Goodness of Fit Index (AGFI = 0.991) are shown in this study as excellent indices for absolute fit.

Root Mean Square Error of Approximation (RMSEA) aims to prevent problems linked to sample size by analyzing the difference between the

hypothetical model and the observed covariance matrix of the studied population. It fluctuates from 0 to 1. The lower the value, the better the model fit, with a value of 0.10 acting as the cut-off for poor fitting models (MacCallum et al, 1996)[18]. In the current study, RMSEA (RMSEA = 0.071) suggested an acceptable fit, under the cut-off point.

Comparative Fit Index (CFI) analyses the model fit by examining the gap between available data and hypothetical model, while correcting sample size problems inherent to chi-square model fit test. CFI fluctuates from 0 to 1, whereas higher values suggest a better model fit. A value equal or higher than 0,9 suggests an acceptable model fit. In this present study, the results shown an excellent model fit (CFI = 0,985).

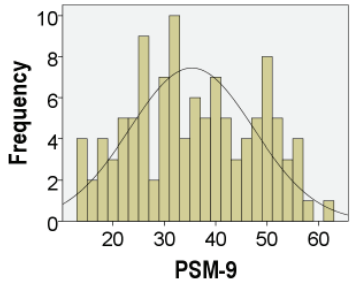
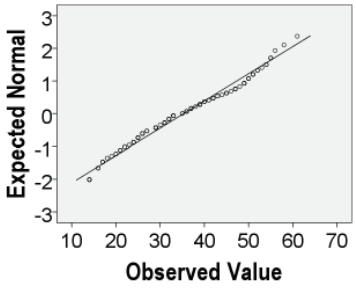
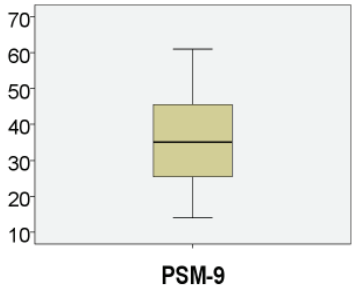
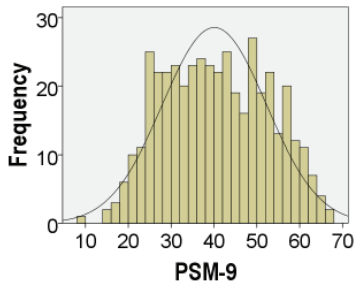
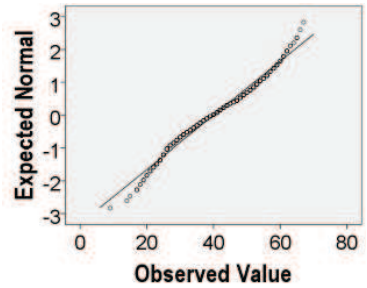
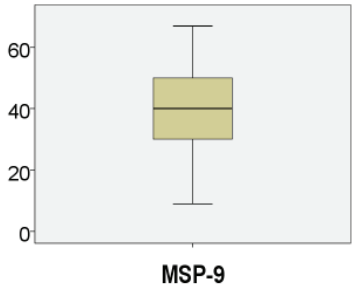
Internal Consistency

There is a variety of coefficients used to assess the precision of dimensions of psychometric instruments, and their combination seems to be a coherent strategy nowadays (Lorenzo-Seva & Ferrando, 2006)[19], justified when taken into consideration advantages and limitations of each of them. All of the results, assessed by Cronbach's alpha, McDonald's Omega, Greatest Lower Bound coefficient and Reliability of EAP Scores, are described in table 1, and ranged from 0.896 to 0.972. These results are satisfactory indicators of the precision of the scale and seem similar to previously observed internal consistency in Lemyre and Tessier (1988)[4].

Additional study

The objective of this additional study is simply to explore the distribution of this test's results according to the sex. As it can be seen by the plots displayed in table 2, the distribution seems normal, observed values are very close to the expected normal line (see Q-Q Plot) and thus, there is no presence of extreme values (outliers) that could cause a distortion on the mean results (see Boxplot). However, when using the normality test Kolmogorov-Smirnov, it was identified that the distribution is normal only for the men group. In fact, for the women group, the histogram indicates a relatively platykurtic distribution in the central portion of the curve, which could explain, at least partially, why these data are not normal. Moreover, it can be speculated that the answering style among men and women is different when using PSM-9. New researches must be conducted in order to explore and explain in detail these phenomena.

Table 2 – Graphic demonstration of the data normality by sex.

Sex	Histogram Plot	Q-Q Plot	Boxplot
Men			
Women			

DISCUSSION

The current study aimed to explore psychometric properties and assess the unidimensional model of the Psychological Stress Measure in 9 items. Overall, our findings suggest a good data fit for this model of a measure of the state of feeling stressed. The internal consistency assessed by Cronbach's Alpha suggested a satisfactory reliability for the short version. These results outline that the 9 items version is similar to the longer versions and support its use in a non-clinical population. Our five initial research questions were answered as follows. Firstly, the factor analysis suggests a single-dimension model which is convergent with the original structure of the PSM-9. This dimension covers a large part of the total variance of the construct of psychological stress, which is significant for a 9 items test. The factor analysis revealed that most items have a good fit in this set of items, therefore no item seems problematic nor should be removed or modified, with the exception of item 8, which could see its presence reconsidered. The results from the confirmatory analysis show overall good model fit and the absolute fit indices are within the requested range. Also, our sample matches the application conditions and allows reliable analyses and conclusions.

Considering the obtained model fit, this short version is indicated for using with multiple populations. Indeed, our sample included a large number of students and produced good fit. Most of the psychometric tests related to stress measure are intended for clinical population and assess pathological stress rather than the feeling of being stressed as the PSM-9 does. It considers the significance related to the perception of the stressful situation rather than the objective potential stress of the event. As stress is considered the disease of the 21st century, this test may be helpful in primary care institutions (Fink, 2016)[20]. It stands out and quickly gives clues about the state of well-being of the non-clinical population. A punctual and quick assessment of stress like the PSM-9 provides a screening tool and could help health investigations in large sample. Inserted in a selection of other psychological tests, this short version is clinic-friendly and may constitute a global psychological stress indicator.

As for the limitations of this study, we did not have previous measures of stress for the students, thus preventing comparative reference. Also, students who may have low motivation might have filled the form reluctantly. As this unidimensional model also is a little simplistic and does not allow to have a full look upon one's stress, it may be considered as an instrument to open up the way for further enquiries.

As these short and longer forms feature good model fit in French and English versions, we

suggest additional translation and validation studies for a Portuguese version and its use in matching services. These results indicate that future research in clinical population seems legitimate and meaningful.

CONCLUSION

Globally, our validation study highlights a good model fit with our sample and explains a large part of the variance for the construct of stress with a single-dimension model. This 9-item version allows assessment of the feeling of being stressed in multiple populations. This short test is a unique measure and has little competition in establishing the level of stress of an individual. As statistics show an increase of stress-related issues in every section of the population, a high score on this screening test can initiate some interventions. Stress will always be a part of life and is an important component of health, although high level of stress may become pathological and generate symptoms that affects the quality of life. The main authors of PSM-9 wanted the assessment of the state of feeling stressed to be a key reference in examining the prior and consequential factors to stress. Future studies should explore the fact that, according to our results, men and women seem to answer differently to this test. To do so, invariance analysis or item response theory (IRT) could be used in an attempt to explain this phenomenon. However that was not the objective of this present study.

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