Psicothema (2023) 35(1) 98-108

Psicothema

www.psicothema.com • ISSN 0214-9915

Colegio Oficial de Psicólogos del Principado de Asturias

Article

Spanish Validation of the Technostress Creators Scale

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ARTICLE INFO

Received: April 21, 2022
Accepted: July 29, 2022

Keywords:
Technostress
Technostress creators
Management of ICTs
Confirmatory factor analysis
Validation

ABSTRACT

Background: The COVID-19 pandemic has changed the way organizations operate, forcing many of them to opt for remote-working as an alternative to the face-to-face mode. This global phenomenon has increased the importance of studying the psychosocial risks linked to the use of Information and Communication Technologies (ICTs), such as technostress. This study aims to provide validity evidence for the Technostress Creators Scale in Spain and to test its measurement invariance in terms of gender. **Method:** We analyzed the psychometric properties of the scale, its factor solution, and gender invariance in a sample of 931 employees from Spain. **Results:** The Exploratory Factor Analysis (EFA) showed that the Spanish version maintained the five factors from the original version: techno-overload, techno-invasion, techno-complexity, techno-insecurity, and techno-uncertainty. The instrument demonstrated adequate reliability. The results of the Confirmatory Factor Analysis (CFA) also replicated the five-factor structure of the English version. Additionally, measurement invariance tests indicated differences between genders. **Conclusions:** The resulting Spanish scale has 18 items, which is shorter than the original version. The implications and limitations of the Spanish version of the instrument are detailed in the discussion.

Validación Española de la Escala de Creadores de Tecnoestrés

Palabras clave:
Tecnoestrés
Productores de tecnoestrés
Dominio de TIC
Análisis factorial confirmatorio
Validación

RESUMEN

Antecedentes: La pandemia por COVID-19 ha cambiado la forma en que funcionan las organizaciones, obligando a optar por el teletrabajo como alternativa a la modalidad presencial. Este fenómeno ha mostrado la importancia de estudiar los riesgos psicosociales vinculados al uso de las Tecnologías de la Información y la Comunicación (TIC), como el tecnoestrés. Este estudio tiene como objetivo proporcionar evidencia de validez de la Technostress Creators Scale en España y analizar su invariancia en términos de género. **Método:** Analizamos propiedades psicométricas de la escala, solución factorial e invariancia de género en una muestra de 931 empleados de España. **Resultados:** El Análisis Factorial Exploratorio (AFE) de la versión en español mantuvo los cinco factores de la versión original: tecno-sobrecarga, tecno-invasión, tecno-complejidad, tecno-inseguridad y tecno-incertidumbre. Asimismo, las dimensiones demostraron una adecuada fiabilidad. En cuanto a los resultados del Análisis Factorial Confirmatorio (AFC), la estructura de cinco factores de la versión en inglés fue replicada. Por otra parte, el análisis de la invarianza de género arrojó diferencias entre los grupos. **Conclusiones:** La escala resultante cuenta con 18 ítems, siendo más corta que la versión original. En la discusión se detallan las implicaciones y limitaciones de la validación en español de este instrumento.

Cite as: Arenas, A., Sanclemente, F. J., Terán-Tinedo, V., & Di Marco, D. (2023). Spanish Validation of the Technostress Creators Scale. *Psicothema, 35*(1), 98-108. https://doi.org/10.7334/psicothema2022.198
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Technology continues to advance every day, changing not only the way we interact with others but the entire dynamic of work and how organizations function (Cascio & Montealegre, 2016). Due to the COVID-19 pandemic, this topic has become more important. The health crisis caused by the virus has forced several companies to reinvent their way of working, many of them introducing remote working for the first time to guarantee the safety of their workforce and preserve their economic activity (Pulido-Martos et al., 2021). In 2019, around 11% of the EU-27 employees were working from home at least some of the time (Sostero et al., 2020), while in July 2020, a survey by Eurofound (2020) reported that 48% of the respondents were remote-working at least part of their working schedule, of which 34% were working exclusively from home. Furthermore, among those who worked remotely, 46% had no previous experience with remote work.

In this sense, information and communication technologies (ICTs) have shown many advantages for organizations, such as productivity improvements and the opportunity to work from remote locations (Cousins & Robey, 2015; Ninaus et al., 2015); nonetheless, some studies suggest that excessive use of ICTs can have a significant impact on mental health, causing anxiety, depression, and sleep disorders, among others (Buomprisco et al., 2021).

Furthermore, the fact that ICTs allow the establishment of connections anywhere and anytime can be misinterpreted as being constantly available, affecting employees' nonworking hours, and invading their personal lives (Eurofound and International Labour Office, 2017). Moreover, research has shown that remote working may perpetuate gender roles, since women carrying out a professional activity are also the ones assuming the roles of care and home maintenance, therefore increasing their workload (Hartig et al., 2007).

Psychosocial risks linked to technologies have increased during the COVID-19 pandemic, mainly due to the increase of job demands against personal resources, workload, and changes in schedule (Barriga-Medina et al., 2021). Additionally, gender inequalities have become sharper in the lockdown context, making it especially difficult for women to reconcile care and work (Eyzaguirre, 2020; Soubelet-Fagoaga et al., 2021; Pacheco et al., 2022). It is reasonable to suppose that this extraordinary circumstance will trigger an accelerated process of digitalization of work (López-Peláez et al., 2021), which is why it is important to evaluate and address how to cope with connected risks.

Previous research related to psychosocial risks as a consequence of inadequate use of ICTs has resulted in the study of a phenomenon known as technostress. Craig Brod (1984), who coined this term, described it as a modern disease caused by the inability to cope with technology adequately. Nowadays, it is also related to the work context, being conceived as an inability to adapt to technological changes in an organization (Jena, 2015).

Ragu-Nathan et al. (2008) developed the first instrument to measure technostress creators and inhibitors in organizations. Based on the transactional-based model of stress (Lazarus, 1966; Lazarus & Folkman, 1984), the Technostress Creators Scale (TCS) identifies five factors: techno-overload, related to increased workload; techno-invasion, referred to work-home conflict; techno-complexity, describing the feeling of inadequacy due to the complexity of ICTs and spending time and effort to learn and understand them; techno-insecurity, as feeling threatened to lose a job either by being replaced by technology or by others with better skills; and techno-uncertainty, due to constant changes associated to technologies.

The TCS has been widely referenced by the scientific community interested in studying this phenomenon and has been validated in other countries like Italy (Molino et al., 2020), China (Zhao et al., 2021) and Brazil (Carvalho & d'Angelo, 2021). Although this scale has been one of the most frequently applied instruments to measure technostress due to its reliability (Fischer et al., 2019), to our knowledge, it has only been adapted in Spanish in a sample of workers from Chile (Salazar Concha, 2019) and Peru (Torres, 2021).

Other instruments have been developed to measure anxiety caused by the use of technology, such as the *Computer Anxiety Rating Scale* (CARS; Heinssen et al., 1987), or to assess mindsets towards computing, like the *Attitudes Toward Computers Scale* (ATCS; Rosen et al., 1987). The *Computer Hassles Scale* (Hudiburg, 1989) was specifically designed to measure technostress, conceiving 'hassles' as frustrations provoked by human-computer interactions. However, since these instruments are from the past century, they may not be sensitive to new and constantly changing technologies, therefore, to the most recent conceptions of technostress.

The Spanish RED-TIC developed by Salanova et al. (2013) considers personal resources, experiences, and demands of the work environment, and focuses on psychological experiences derived from technostress, such as techno-addiction and techno-strain. Furthermore, some inventories have been developed to measure technostress among teachers, such as the technostress questionnaire by Wang & Li (2009) and the *Technostress Scale of Teacher Educators* by Thiyagu (2021).

Day et al. (2012) developed the *ICT demands scale*, defining ICT demands as any external event that has the potential to cause stress in employees. However, in terms of the sample considered for its validation, a high percentage had university or professional degrees, resulting in an instrument that may be more sensitive to the technostress of white-collar workers with a higher socioeconomic position (Borle et al., 2021).

In this sense, the TCS by Ragu-Nathan et al. (2008) considered education as a variable that influences ICTs-related stress, and its validation showed that, indeed, technostress decreased as education increased. Hence, TCS is a short and easy-to-understand instrument applicable to any profession. The proposal of five dimensions based on the high learning demand due to constant changes in technologies, the technical errors that may occur, the requirement to do multiple tasks in response to increase workload, the feelings of uncertainty and the blurry boundaries between workspace and personal domain, allows to analyze and comprehend what creates the technostress. Therefore, the TCS is a tool that may facilitate the development of strategies that help ICTs users and organizations to cope adequately to demands related with technologies.

Technostress causes muscle cramps, headaches, and insomnia (Çoklar & Şahin, 2011), inability to concentrate and increased irritability (Raja Zirwatul Aida et al., 2007), mental fatigue (Champion, 1988, as cited in Çoklar & Şahin, 2011), increased blood pressure (Johansson & Aronsson, 1984), burnout (Khedhaouria &

Cucchi, 2019), among others. To address these effects on ICT users' well-being, this research aims to adapt and provide validity evidence for the Spanish version of the TCS by Ragu-Nathan et al. (2008), and to test the measurement invariance across gender, that, to our knowledge, has not been addressed previously.

To provide additional evidence of its validity, an analysis of the TCS scores with respect to the General Health Questionnaire (GHQ-12; Sánchez-López & Dresch, 2008) scores will be carried out, expecting to get negative correlations between each of the technostress factors and the Successful coping and Self-esteem factors of GHQ-12, and a positive correlation of each TCS factor with the Stress factor of GHQ-12.

Method

Participants

The main sample comprised 931 employees from Spain (75.6% were female) aged between 21 and 67 years (M = 47.89; SD = 8.34). Participants carried out a wide range of job activities. The job sectors more represented were education (49.9%), health services (26.5%), and administrative services (4.3%). Other less represented sectors were industry, construction, commerce, and other service activities.

A convenience sampling system was used among invited organizations which agreed to participate in the study, achieving around 30% of response rate. Employees completed an online questionnaire, and the participation was completely voluntary and anonymous. At the beginning of the online questionnaire, participants received instructions on how to complete the questionnaire and information about the anonymity of their answers.

Instruments

Technostress Creators. Technostress creators include those factors that create technostress in the organization. It was measured using a Spanish translated version of the Ragu-Nathan et al.'s (2008) TCS. The English version scale is composed by 23 items whose response options range from 1 (strongly disagree) to 5 (strongly agree). The original version of the TCS shows a five-factor structure: Techno-overload (TC1, α= .82), Techno-invasion (TC2, α = .80), Techno-complexity (TC3, α = .77), Techno-insecurity (TC4, α = .78), Techno-uncertainty (TC5, α = .83).

Psychological Health. The 12-item version of the General Health Questionnaire (GHQ-12; Goldberg & Williams, 1988) validated in the Spanish (Sánchez-López & Dresch, 2008) was used to assess psychological health. Sánchez-López and Dresch (2008) found a three-factor structure of GHQ-12 in the Spanish population: Factor 1 "Successful coping" (value 0 to 18), Factor 2 "Self-esteem" (value 0 to 9) and Factor 3 "Stress" (value 0 to 9). The Cronbach's alpha found by Sánchez-López and Dresch (2008) for the entire instrument was .76. The GHQ-12 assesses the severity of a mental problem over the past few weeks. The items scored on a four-point Likert-type scale from 0 (never) to 3 (always). The items scores were summed to create an overall psychological health score for each participant, ranging from 0 to 36. In order to calculate the general score, negative items were inverted, thus, higher scores indicated better psychological wellbeing. For the entire instrument GHQ-12 the Cronbach's alpha in the sample (N = 931) was .92 and McDonald's omega was .94.

Sociodemographic data. Gender, age and job sector were included in the survey.

Procedure

Following the Brislin (1970) procedure, the English version of the Ragu-Nathan et al.'s (2008) TCS was translated into Spanish by a Spanish-speaking translator. Then, a back-translation into English language was carried out by two independent English-speaking translators. After this step, they discussed incongruences in order to reach consensus and assure the equivalence of the two versions. Table 1 shows the Spanish version of the TCS.

The validation of the scale was conducted in four steps. Firstly, we performed an exploratory factor analysis (EFA) to determine factorial loadings on each item. In the second step and after the elimination of those items showing inadequacy, a confirmatory factor analysis (CFA) was conducted to determine factor loading on the final Spanish version. In the third step, a gender invariance analysis was performed to probe the invariant structure of the final Spanish scale. Finally, a test of concurrent validity with the GHQ-12 was carried out.

Data analysis

The data in this study were analyzed in four phases, following the methodology for validation from Worthington and Whittaker (2006). Afterwards, our sample (N = 931) was randomly divided in two homogeneous independent subsamples ($n1A$ = 466) and ($n1B$ = 465). Regarding to adequacy of our samples, sample sizes of at least 300 participants are generally sufficient in most cases (Worthington & Whittaker, 2006). The first subsample (n1A) was used to perform an exploratory factor analysis (EFA) in order to determine adequacy of factorial loadings on each item of the Spanish TCS. A preliminary analysis of skewness and kurtosis was conducted on each item to determine normality. Additionally, adequacy of the matrix to perform the EFA was tested using the Kaiser-Meyer-Olkin (KMO) test and the Barlett's test of sphericity. To carry out the EFA analysis using the maximum likelihood extraction method, oblique rotations (direct oblimin) were performed. The EFA analysis was conducted to extract on a freeway the factorial structure from the data and was based on Eigenvalues greater than one. The second subsample (n1B) was used to perform a confirmatory factor analysis (CFA) after the elimination of those items not reaching the minimum factor loadings to be considered or loading in more than one factor. The selected indexes to assess the goodness of fit of the CFA were the normal theory weighted least-squares (NTWLS), chi-square test and the non-normed fit index (NNFI), comparative fix index (CFI), root mean square error of approximation (RMSEA) and the standardized root mean square residual (SRMR), which evaluate the adjustment of confirmatory solution (Ferrando, et al., 2022). Additionally, the CFA models evaluated were SEM confirmatory factorial models estimated using mean and covariance matrix and the maximum likelihood procedure as it is implemented in LISREL 8.0 (Jöreskog & Sörbom, 1996).

Table 1.
English and Spanish version of the Technostress Creators Scale.

Dimensions	Item content
Techno-overload [TC1_Tecno-sobrecarga]	1. I am forced by this technology to work much faster [Estas tecnologías me obligan a trabajar mucho más rápido]
	2. I am forced by this technology to do more work than I can handle [Estas tecnologías me obligan a hacer más trabajo del que puedo manejar]
	3. I am forced by this technology to work with very tight time schedules [Estas tecnologías me obligan a tener horarios de trabajo muy ajustados]
	4. I am forced to change my work habits to adapt to new technologies [Estoy obligado a cambiar mis hábitos de trabajo para adaptarme a las nuevas tecnologías*]
	5. I have a higher workload because of increased technology complexity [Tengo una mayor carga de trabajo por el aumento de la complejidad en las tecnologías*]
Techno-invasion [TC2_Tecno-intrusión]	6. I spend less time with my family due to this technology [Paso menos tiempo con mi familia debido al uso de estas tecnologías*]
	7. I have to be in touch with my work even during my vacation due to this technology [Tengo que estar en contacto con mi trabajo, incluso durante mis vacaciones, debido a estas tecnologías]
	8. I have to sacrifice my vacation and weekend time to keep current on new technologies [Tengo que sacrificar mis vacaciones y tiempo de mi fin de semana para mantenerme al día en nuevas tecnologías]
	9. I feel my personal life is being invaded by this technology [Siento que mi vida personal está siendo invadida por estas tecnologías]
Techno-complexity [TC3_Tecno-complejidad]	10. I do not know enough about this technology to handle my job satisfactorily [No sé lo suficiente sobre estas tecnologías para hacer mi trabajo satisfactoriamente]
	11. I need a long time to understand and use new technologies [Necesito mucho tiempo para entender y utilizar nuevas tecnologías]
	12. I do not find enough time to study and upgrade my technology skills [No encuentro tiempo suficiente para estudiar y mejorar mis habilidades tecnológicas]
	13. I find new recruits to this organization know more about computer technology than I do [Creo que el nuevo personal de esta organización sabe más sobre tecnología informática que yo]
	14. I often find it too complex for me to understand and use new technologies [A menudo me parece demasiado complicado entender y usar nuevas tecnologías]
Techno-insecurity [TC4_Tecno-inseguridad]	15. I feel constant threat to my job security due to new technologies [Siento que mi seguridad laboral se ve constantemente amenazada por las nuevas tecnologías*]
	16. I have to constantly update my skills to avoid being replaced [Tengo que actualizar constantemente mis habilidades para evitar ser reemplazado]
	17. I am threatened by coworkers with newer technology skills [Me siento amenazado por compañeros de trabajo con habilidades tecnológicas más actualizadas]
	18. I do not share my knowledge with my coworkers for fear of being replaced [No comparto mi conocimiento con mis compañeros de trabajo por miedo a ser reemplazado]
	19. I feel there is less sharing of knowledge among coworkers for fear of being replaced [Siento que hay menos intercambio de conocimiento entre compañeros de trabajo por miedo a ser reemplazados]
Techno-uncertainty [TC5_Tecno-incertidumbre]	20. There are always new developments in the technologies we use in our organization [Siempre hay nuevos desarrollos en las tecnologías que utilizamos en nuestra organización*]
	21. There are constant changes in computer software in our organization [Hay cambios constantes en el software de los ordenadores de nuestra organización]
	22. There are constant changes in computer hardware in our organization [Hay cambios constantes en el hardware de los ordenadores de nuestra organización]
	23. There are frequent upgrades in computer networks in our organization [Hay actualizaciones frecuentes en las redes informáticas de nuestra organización]

Note. * signals items deleted after EFA analysis of the Spanish version

In the third phase, a new subsample (*n2* = 465) was randomly extracted from the general sample (*N* = 931), controlling the gender variable and ensuring 50% males and 50% females. Afterwards, an invariance analysis was performed to probe the gender invariant structure of the final Spanish scale. In order to do it, we conducted a multi-group analysis with gender as the analysis criterion, following Putnick and Bornstein (2016). The four-measurement invariance forward steps (sequential constraint imposition) considered were: M1 configural equivalence of model form, M2 metric (weak factorial) equivalence of factor loadings, M3 scalar (strong factorial) equivalence of item intercepts, and M4 residual (strict or invariant uniqueness) equivalence of items' residuals. The fit of the models was tested using the following indexes: the Satorra-Bentler scaled chi-square ($\Delta\chi 2_{A\text{-}B}$), (Satorra & Bentler, 2001), CFI, NNFI (≥ .90 is adequate, ≥ .95 is optimal), RMSEA, and the SRMR (≤ .08 is adequate, ≤ .05 is optimal) (Hu & Bentler, 1999). The condition of measurement invariance appears when a nonsignificant chi-square difference test for the two nested models, ($\Delta\chi 2_{A\text{-}B}$) and changes in NNFI, CFI, RMSEA and SRMR indexes are lower than .01 (Putnick & Bornstein, 2016). Additionally, the scale reliability was tested using Cronbach's alpha coefficient and McDonald's omega coefficient (McDonald, 1999), which measures the overall reliability of a series of heterogeneous yet similar items, showing to be a more sensible index of internal consistency than alpha coefficient (Dunn et al., 2014). The scale reliability values greater than the recommended minimum value of .70 were considered as acceptable (Hair et al., 1998; Nunnally, 1978). Finally, a test of concurrent validity of the Spanish TCS was conducted analyzing correlations with GHQ-12 total score and factors.

Results

Step 1: Exploratory factor analysis using subsample n1A

A preliminary analysis of the data indicates that the items of the Spanish TCS showed a distribution within the limits of normality. According to Finney and DiStefano's (2006) criteria about maximum values for skewness (2) and kurtosis (7), our analysis showed maximum values of 1.01 for skewness and of -1.18 for kurtosis (see Table 2). Likewise, the Barlett sphericity test was $\chi^2 = 6712.36$ (*df* = 253; $p < .001$) and the KMO's was .925 showing data adequacy for factor analysis.

Exploratory factor analysis conducted on subsample (n1A = 466) showed in Table 2 yielded a five-factor structure freely extracted without restrictions for the initial Spanish TCS consisting of 23 items, coinciding with the original factorial structure of the Ragu-Nathan et al.'s (2008) scale. The suitability of the EFA factor solution was reached for five factors, explaining 61.71% of the total cumulative variance (Factor 1: 37,88%; Factor 2: 28%; Factor 3: 6.66%; Factor 4: 4.44%; Factor 5: 2.5%). Regarding the Cronbach's alpha and McDonald's omega reliability test, for TC1 (Techno-overload) α = .85 Ω = .89, TC2 (Techno-invasion) α = .88 Ω = .91, TC3 (Techno-complexity) α = .91 Ω= .93, TC4 (Techno-insecurity) α = .82 Ω = .87, and TC5 (Techno-uncertainty) α = .82 Ω = .88. The total instrument Cronbach's alpha was α = .93 and McDonald's omega was Ω = 93.

Regarding the EFA results, items 4, 5, 6, 15 and 20 were removed following Worthington and Whittaker (2006) recommendations related to deleting items showing factor loadings less than .32 and items showing absolute loadings higher than .32 on two or more factors. Therefore, the final Spanish TCS was reduced from 23 to 18 items.

Step 2: Confirmatory factor analysis using subsample n1B

After deletion of aforementioned items, a confirmatory factor analysis (CFA) of the final Spanish TCS accounting 18 items was conducted on the subsample (*n1B* = 465) in two steps, in order to specify the resulting factor solution in the SEM confirmatory procedure (Worthington & Whittaker, 2006). Firstly, we conducted a first order CFA analysis (Figure 1). Results examining the factor structure showed that the five-factor solution fitted the data adequately ($\chi2$ = 508.16, *df* = 125, *p* = .000, RMSEA = .081[90% CI = .074, .089], *CFI* = .96, *NNFI* = .95, *SRMR* = .064), and all the factor loadings were > .32. Secondly, we conducted a second order CFA analysis (Figure 2). Results analyzing the factor structure showed that the first order five-factor solution and the second order one factor solution (Technostress Creators) fitted the data adequately (χ^2 = 581.44, *df* = 130, *p* = .000, RMSEA = .087 [90% CI = .079, .094], CFI = .95, NNFI = .94, SRMR = .083), and all the factor loadings were > .32. The variance explained by the second order CFA model was R^2 = .75 for TC1; R^2 = .69 for TC2; R^2 = .48 for TC3; R^2 = .16 for TC4; and R^2 = .15 for TC5. Additionally, following Worthington and Whittaker (2006) recommendations, item elimination after EFA did not result in meaningful changes to factor structure, factor intercorrelations, item communalities, and factor loadings, consequently the originally established criteria for these outcomes were preserved. Finally, related to the Cronbach's alpha and McDonald's omega reliability indexes of the final scale on sample (n1B), for Techno-overload α= .75 Ω= .86, Techno-invasion α = .86 Ω= .91, Techno-complexity α = .88 Ω= .92, Techno-insecurity α = .79 Ω= .87, and Techno-uncertainty α = .86 Ω= .92. The total instrument Cronbach's alpha in sample (n1B) was α = .89 and McDonald's omega was Ω= .90.

Table 2.
EFA analysis of the first Spanish version of the Technostress Creators Scale showing factor loadings and descriptive statistics.

Subscale	Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	M	SD	Skewness	Kurtosis
TC1	1					.603	3.34	1.11	-.40	-.46
	2		-.623			.839	3.46	1.12	-.24	-.73
	3					.619	3.13	1.16	-.01	-.87
	4	**.530**	**-.663**			**.713**	**3.54**	**1.20**	**-.48**	**-.75**
	5	**.547**	**-.740**			**.780**	**3.57**	**1.21**	**-.42**	**-.87**
TC2	**6**		**-.775**			**.643**	**3.35**	**1.24**	**-.25**	**-1.01**
	7		-.831				3.27	1.36	-.24	-1.20
	8		-.856				3.02	1.32	-.01	-1.18
	9		-.742				3.45	1.19	-.42	-.78
TC3	10	.849					2.93	1.18	.11	-.92
	11	.895					3.02	1.18	.01	-.95
	12	.752					3.32	1.14	-.28	-.77
	13	.724					3.00	1.12	.03	-.70
	14	.887					2.91	1.16	.11	-.93
TC4	**15**	**.649**			**.517**		**2.76**	**1.17**	**.28**	**-.79**
	16				.669		2.70	1.13	.33	-.55
	17				.764		2.32	1.01	.48	-.31
	18				.682		1.76	.81	1.01	.93
	19				.740		2.13	1.06	.81	.04
TC5	**20**			**.486**			**3.39**	**.98**	**-.54**	**-.01**
	21			.859			2.94	1.03	-.03	-.47
	22			.840			2.71	1.01	.08	-.38
	23			.760			3.06	1.02	-.22	-.37

Note. Bold type signals items candidate to be deleted. TC1: Techno-overload; TC2: Techno-invasion; TC3: Techno-complexity; TC4: Techno-insecurity; TC5: Techno-uncertainty. (n1A = 466).

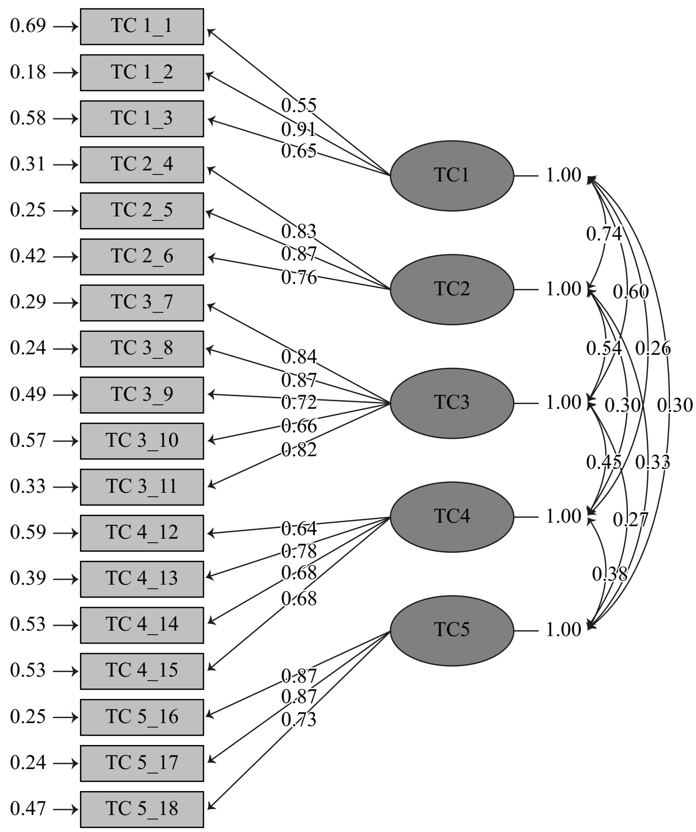

Figure 1.
First order CFA analysis of the final Spanish version of the Technostress Creators Scale.

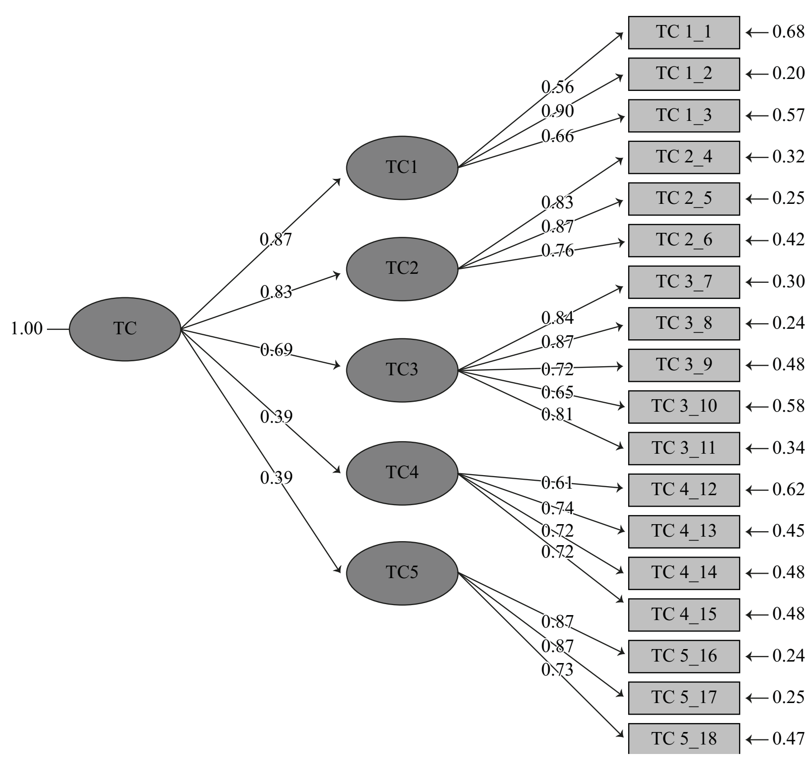

Figure 2.
Second order CFA analysis of the final Spanish version of the Technostress Creators Scale.

Finally, an analysis of descriptive statistics and correlations on the final Spanish TCS was conducted (Table 3). The mean value of each factor was calculated. A total Technostress Creators value (TC) was calculated as the mean of the five mean values TC1 to TC5. TC Total score was significant and positively associated with the five TC subscales, TC1, TC2, TC3, TC4, and TC5. Consistent with our predictions, TC Total score was negatively associated with psychological health (GHQ-12) total score, successful coping (GHQ-12 Factor 1) and self-esteem (GHQ-12 Factor 2). And TC Total score was positively associated with stress (GHQ-12 Factor 3). Finally, gender was positively associated with TC3 (Techno-complexity), signaling differences in this subscale. Additionally, age was significant and positively associated with TC Total score, TC1, TC2, TC3, and TC5, this could suggest that older employees show higher levels of technostress.

Step 3: Test of gender invariance using subsample n2

Finally, the results of invariance analysis to test the gender invariant structure of the final Spanish TCS with subsample (*n2* = 465) are showed in Table 4. The results of the multi-group analyses revealed non-significant differences between genders in the configurational (M1) and metric (M2) invariance tests. Configural invariance model M1 showed an adequate fit to the data with CFI and NNFI values over or equal to .95 and the pattern of loadings of items on the latent factors did not differs in the two groups. Thus, configural invariance or invariance of model form was accepted. Regarding the metric invariance model M2, the chi-square difference ($\Delta\chi2_{A-B}$) was non-significant, and the fit indexes differences (Δ) of the RMSEA, NNFI, CFI and RMR indexes were <.01 of the cut-off score for all comparisons, then metric invariance between the two groups (female/male) was accepted. However, the results of the multi-group analyses revealed significant differences between genders in the scalar (M3) and residual (M4) invariance tests. The chi-square difference ($\Delta\chi2_{A-B}$) were significant and RMSEA was >.080 for scalar and residual invariance. Additionally, the fit indexes differences (Δ) of the RMSEA, NNFI, CFI and RMR indexes were >.01 of the cut-off score for all comparisons on scalar invariance. Then scalar and residual invariances between the two groups (female/male) were rejected.

Step 4: Test of concurrent validity with GHQ-12

Correlations among the TC total score and factors (TC1, TC2, TC3, TC4, TC5) and the GHQ-12 total score and factors (F1, F2, F3), on subsample (n1B) showed in Table 3, indicates that TC total score showed negative correlation with psychological health, successful coping and self-esteem, and positive correlation with stress. Additionally, the highest negative correlations of TC with GHQ-12 values were for Techno-overload, Techno-invasion, Techno-complexity, and the lowest for Techno-insecurity, and Techno-uncertainty. Thus, our results were consistent with our predictions suggesting a negative relationship between TC and Psychological Health, while showing concurrent validity evidence.

Table 3.
Correlations and descriptive statistics for the final Spanish version of the Technostress Creators Scale.

Variable	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12
1 Sex (0 male - 1 female)	--	--	--											
2 Age (years)	47.89	8.34	-.05	--										
3 TC Total	2.90	.65	.02	.18**	--									
4 TC1 (Techno-overload)	3.33	.92	.01	.10*	.72**	--								
5 TC2 (Techno-invasion)	3.28	1.16	-.03	.16**	.75**	.58**	--							
6 TC3 (Techno-complexity)	2.97	.91	.11*	.24**	.80**	.49**	.47**	--						
7 TC4 (Techno-insecurity)	2.19	.78	-.02	-.03	.62**	.22**	.24**	.39**	--					
8 TC5 (Techno-uncertainty)	2.92	.91	-.03	.10*	.55**	.26**	.27**	.24**	.32**	--				
9 Psychological health (GHQ-12)	30.64	7.44	.01	-.13**	-.48**	-.36**	-.54**	-.36**	-.19**	-.19**	--			
10 Successful coping (GHQ-12 F1)	14.81	3.37	.04	-.13**	-.40**	-.32**	-.47**	-.29**	-.13	-.15**	.92**	--		
11 Self-esteem (GHQ-12 F2)	8.88	2.45	-.01	-.08	-.47**	-.33**	-.46**	-.35**	-.27	-.19**	.89**	.73**	--	
12 Stress (GHQ-12 F3)	8.03	2.40	.00	.14**	.45**	.34**	.54**	.33**	.12	.19**	-.88**	-.70**	-.73**	--

Note. *p < .05, **p < .01. (n1B = 465)

Table 4.
Resume of test for measurement gender invariance models.

Model	χ2 (df)	CFI	NNFI	RMSEA (90%CI)	SRMR	Model Comp.	Δχ2 (df)	ΔCFI	ΔNNFI	ΔRMSEA	ΔSRMR	Decision
M1 Configural Invariance	612.96 (250)**	.96	.95	.080 (.072 .088)	.069	-	-	-	-	-	-	Accepted
M2 Metric Invariance	622.21 (263)**	.96	.95	.078 (.070 .086)	.072	M1	9.25 (13)	0	0	.002	.003	Accepted (S&B)
M3 Scalar Invariance	969.04 (281)**	.86	.85	.105 (.100 .110)	.015	M2	346,83 (18)**	.10	.10	.023	.058	Rejected (S&B)
M4 Residual Invariance	1057.61 (299)**	.86	.85	.106 (.100 .110)	.016	M3	88.57 (18)**	0	0	.001	.001	Rejected (S&B)

Note. N = 450; group 1 males n = 225; group 2 females n = 225. S&B = Satorra & Bentler, (2001). * p ≤ .05. ** p ≤ .01.

Discussion

Since the Covid-19 pandemic was declared as a Public Health Emergency of International Concern by the OMS in 2020, our day-to-day interaction, consumption habits, and working practices have been modified. By forcing companies to shift to remote work, the pandemic acted as a catalyst for digitalization (Amankwah-Amoah et al., 2021), increasing the importance of studying the psychosocial risks that ICTs may entail, such as technostress. For this reason, the aim of this study was to provide validity evidence of the TCS by Ragu-Nathan et al. (2008) in a sample of Spanish employees. The TCS is one of the most used instruments to measure technostress, due to its reliability and ease application.

The results of our study show an adequate functioning of the psychometric properties in our sample. The EFA led to a model that explained 61.71% of the total variance, maintaining the five factors of the original English version: techno-overload, techno-invasion, techno-complexity, techno-insecurity, and techno-uncertainty. The five-factor structure has also been maintained in previous validation studies carried out in Chile (Salazar Concha, 2019), China (Zhao et al., 2021), Brazil (Carvalho & d'Angelo, 2021) and Peru (Torres, 2021), although it is frequent that researchers adapt the scale selecting factors or items that are relevant to their studies (D'Arcy et al., 2014; Brooks & Califf, 2017; Molino et al., 2020; Gabr et al., 2021).

For the overall consistency, the Spanish TCS showed high reliability for each dimension, similar to or greater than the original version, with Cronbach's alpha values greater than or equal to .70, and McDonald's Omegas from 0.87 to 0.93 as evidence of good internal consistency.

Five items out of the 23 from the original scale were eliminated after showing inadequacy. By doing so, Techno-overload, Techno-invasion, Techno-insecurity, and Techno-uncertainty factors were finally composed by less than five items. However, previous studies showed that three-item and single-item measures maintain good psychometric properties (Angulo-Brunet et al., 2020; Matthews et al., 2022). Similarly, the Chinese adaptation by Zhao et al. (2021) resulted in 18 items, coinciding with two of the items eliminated in the techno-overload factor of the Spanish version of the scale. In contrast, the adaptations of the scale carried out by Torres (2021) and Salazar Concha (2019) maintained the 23 items of the original scale, while Carvalho and d'Angelo (2021) obtained a 22-item scale. Therefore, this study provides a shorter version that improves its application while maintaining the original factorial structure of the TCS.

Since previous research has found that women experience more work-related stress than men (Gardiner & Tiggemann, 1999; Jenkins & Palmer, 2004; Michael et al., 2009), an analysis of gender invariance was carried out to rule out differences related to the configuration of the instrument between these groups, finding evidence for configural and metric invariance. However, neither the scalar nor the residual invariance models demonstrated a good fit to the data, thus comparisons across genders should be avoided with this version of the scale.

Our study also shows the impact of technostress on workers' health. Our sample scores showed a negative correlation between all TCS factors and GHQ-12 factors Successful coping and Self-esteem. The scores on the validated scale also showed a positive correlation with the Stress factor of GHQ-12, implying that the higher the scores on TCS, the lower the psychological well-being, thus confirming our hypotheses. This outcome shows concurrent validity between GHQ-12 and the Spanish TCS. Other studies have also found a negative relationship between technostress and self-esteem (Korzynski et al., 2020), and suboptimal self-rated health was associated with techno-overload and techno-invasion (Stadin et al., 2016; Stadin et al., 2019).

The present study presents some limitations. First, self-report surveys are linked to method biases related to respondents, such as social desirability, transient mood state, or tendencies to agree or disagree with items independently of their content, which could lead to measurement errors (Podsakoff et al., 2003), therefore, future research should apply a longitudinal approach. Second, since a convenience sampling method was used, it is possible that some of the respondents were more interested in participating due to experiencing higher levels of technostress. We consider that larger samples could counteract this effect. Furthermore, considering the particularities of each sector of work, the type of company could act as an extraneous variable in our study. Similarly, including nontechnical occupations in our samples could have altered the results; therefore, we suggest that they be separated in subsequent studies.

However, this study presents several strengths. The scale was applied to 931 Spanish workers, a large sample that contributes to guarantee more reliable and generalizable results. In addition, the wide variety of work activities of the respondents helps to validate the scale in different work settings. Future research might validate the TCS scale in other Spanish-speaking countries, as well as, the Technostress Inhibitors Scale (Ragu-Nathan et al., 2008) in Spanish, which explore resources or strategies to cope with technostress. Additionally, it would be interesting to compare technostress creators depending on age, occupational variables, or exploring differences between remote and in-office workers. Moreover, future research should explore again gender-related differences in the configuration and measurement of the scale.

The Spanish validation of the TCS is important and necessary for risk prevention, especially in those contexts where it has been little studied (Cuervo-Carabel et al., 2018). Although the benefits of working with ICTs must be acknowledged, we believe that providing an instrument that allows to assess the effects of using them inadequately create more opportunities to increase awareness, to address the problem, and to implement changes. Therefore, this study contributes to the development of a valid, reliable, and easy-to-administer instrument for measuring technostress in Spain. We believe that this scale can be used in future empirical research and/or organizations to explore this risk and develop resources to prevent and decrease its effects on employees' well-being.

Acknowledgments

We acknowledge Affor Health for its collaboration in this research.

Funding

This research has been funded by the Erasmus+ Project entitled "Developing Competences for Stress Resilience @SMEs (DeSTRESS) (Ref. 2019-1-PT01-KA202-060771).

The Ministerio de Universidades/European Union Next Generation reference (MSalas-2022-20053). And the Laboratorio Observatorio de Salud Laboral desde la Perspectiva de Género en Andalucía (LAOGEN) dependent on the Instituto Andaluz de Prevención de Riesgos Laborales (IAPRL)

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