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Factor Structure, Psychometric Properties, and Measurement Invariance of the Pandemic Experiences and Perceptions Scale Among Italian Hospital Workers

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Abstract

Background: *The COVID-19 pandemic represented substantial risks to hospital workers' physical and mental health. The availability of validated measures on the impact of the pandemic on workplaces is crucial for developing data-driven interventions. The primary purpose of our study was to translate it into Italian and assess factor structure, psychometric properties, and measurement invariance of the Pandemic Experiences and Perceptions Scale (PEPS).* **Methods:** *The survey was completed by 766 workers from an Italian hospital. We examined the internal structure of the PEPS using confirmatory factor analyses (CFA) and exploratory structural equation modeling (ESEM) techniques and testing the invariance for clinical vs. nonclinical workers.* **Results:** *The six-factor ESEM solution showed an excellent fit to the data (CFI=0.956, TLI=0.932, RMSEA=0.050), supporting the superiority of the ESEM solution. The factorial invariance of the PEPS across occupational roles (clinical vs. nonclinical hospital workers) was supported, and the ESEM-based McDonald's omega was good for all factors.* **Conclusions:** *The results from this study provided evidence for the factorial validity, reliability, and measurement invariance across occupational roles of the Italian version of the PEPS. Thus, the Italian version of the PEPS is a reliable and valid tool for assessing pandemic experiences and perceptions among Italian workers.*

1. Introduction

The COVID-19 pandemic has dramatically impacted our lives, causing significant challenges and shaping the future of our societies [1]. The pandemic changed the risk perception process because it has been a global event capable of changing people's behaviors toward risk. In the working context, occupational health and safety measures were crucial in protecting the workforce, especially for those directly engaged in fighting the pandemic, such as healthcare workers (HCWs) [2–4]. In the first year of the pandemic, many studies have been developed to explore how the pandemic impacted individuals' mental health. Recent systematic reviews synthesized the results of those studies, showing that HCWs had to face many challenges, including higher risk of infection and inadequate personal

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protective equipment (PPE) [5, 6], fear of infecting family and loved ones [7], increased workloads, and longer working hours [5, 8], increased work-life imbalance, decreased mental health, and sleep disorders [5, 9, 10].

However, these extreme events and the reactions that HCWs experienced are significant issues that need greater consideration regarding how pandemic-related perceived risks can be assessed. Recently, the World Health Organization (WHO) emphasized that, despite the focus on collecting data to understand the impact of the pandemic on the workforce, most of the studies were conducted adopting no pandemic-specific surveys [2, 11]. Especially at the beginning of the pandemic, most of the newly developed measures focused on assessing COVID-19-related mental health reactions such as fear [12], anxiety [13], and psychological distress in the general population [14]. However, no validated measures on the impact of the pandemic on workplaces were available at the time. In this sense, assessing workers' pandemic experiences based on validated measures would have been crucial for providing policymakers, organizations, managers, and leaders with reliable instruments for dealing with the pandemic context and monitoring working conditions, especially for healthcare workers.

For this purpose, Leiter [15] developed the Pandemic Experiences and Perceptions Scale (PEPS), which measures workers' experiences and perceptions of the pandemic. The PEPS is a self-report measure that consists of 34 items across five domains of pandemic experiences and perceptions: (i) disruption, defined as the extent to which the pandemic disrupted workflow; (ii) resources, defined as the extent to which essential resources were available and sufficient to fulfill job demands; (iii) risk perception, defined as the extent to which workers feel at risk and what accounted for their risk perception in terms of contact, control and potential harm; (iv) impact on work-life areas, defined as employees' perceptions of work factors that are predictive of work engagement and burnout: workload, control, reward, community, fairness, and values congruence [15]. Workload refers to work overload where workers «have to do too much in too little time with too few resources» (p. 95) [16], control refers to the degree to which workers perceive that they can influence decisions about their job, work independently, and have access to job resources [16, 17], reward «addresses the extent to which rewards – monetary, social, and intrinsic – are consistent with expectations» (p. 97) [16], community refers to the quality of the workplace social environment, fairness «is the extent to which decisions at work are perceived as being fair and people are treated with respect» (p. 98) [16], and values congruence refers to the congruence between individual and organizational values; (v) perceptions of leadership, defined as leader(s) and immediate manager(s) expressed hope for success and confidence in staff capacity, identified actions that improved capability.

Although some studies have adopted the PEPS [18–29], the psychometric properties of that instrument have not yet been examined.

Understanding workers' pandemic-related perceptions is fundamental to minimizing workers' health and safety risks, so using validated measures is critical for organizations, researchers, and stakeholders. Hence, this study sought to investigate the psychometric properties of the Italian version of the PEPS among Italian hospital workers in the COVID-19 scenario. It examined the internal structure of the scale using confirmatory factor analyses (CFA) and exploratory structural equation modeling (ESEM) techniques and tested the invariance for clinical vs. nonclinical workers.

2. Methods

2.1 Study Design and Participants

A cross-sectional survey was undertaken during a single time frame between April and November 2021 in an Italian hospital. The Limesurvey (https://www.limesurvey.org/it) was used to collect data. Specifically, the survey's link was shared on the hospital intranet. The survey homepage carried the online informed consent form, a clear description of the purpose of the study, and that participation was voluntary and completely anonymous. No sensitive data were requested, and to ensure total anonymity, we did not ask for sex and age in the survey. The inclusion criteria were: (i) being a hospital worker and (ii) working during the pandemic.

A sample of 1,026 valid questionnaires were collected (response rate 30%). Of those, 253 did not meet the criteria of working during the pandemic and were then deleted. Furthermore, seven were deleted because of missing data in the PEPS items. The final sample comprised 766 hospital workers. Of those, 554 were healthcare workers (i.e., nurses, physicians, and other staff members), and 212 included administrative staff, technicians, and other supporting workers).

2.1.1. Translation and Cultural Adaptation Process

Following the translation/back-translation procedure, we translated the English version of the PEPS into Italian [31, 32]. Initially, two experts independently translated the items into Italian, then back-translated into English by the first author supported by a professional bilingual translator. Finally, a third translator independently compared the original version of the items with the back-translated version to examine and solve any discrepancies.

2.2. Measures

The PEPS is a 35-item self-administered questionnaire divided into six subscales (32 items) and three open-text items measuring sources of help and hope for workers. Precisely, the six subscales measure (i) disruption (3 items; i.e., "To what extent has the pandemic affected the work of your organization?"), (ii) resources (5 items; i.e., "Express your opinion on the adequacy/performance of your protective equipment (e.g., masks, gloves, etc.)"), (iii) risk perception (7 items; i.e., Please indicate how much risk did you perceive to yourself?"), (iv) impact on work-life areas (7 items; i.e., "My work hours were manageable during this period"), and (v) perceptions of leadership concerning the management (5 items; i.e., "The Organizational Management expressed hope for success") and, (vi), direct supervisor (5 items; i.e., "My immediate supervisor expressed hope for success"). PEPS items are scored using a 5-point Likert scale from 1=Not at all/Strongly disagree to 5=Completely/Strongly disagree.

2.3. Statistical Analyses

The factor structure of the Italian version of the PEPS was assessed by comparing five competing models using CFA and ESEM techniques [30]. We considered (i) a unidimensional-CFA model in which all items of the PEPS load on one general factor, (ii) a first-order CFA model where the items of the six dimensions (disruption, resources, risk perception, impact on work-life areas, management leadership, and supervisor leadership) of the PEPS were load on their respective factors, (iii) a second-order CFA where items as the first-order factors accounting for a second-order latent factor, (iv) a model where all items were set to load on their respective factors using ESEM [33], and (v) a second-order ESEM model [33] where a general pandemic experiences and perceptions factor was a function of these six first-order ESEM factors. Our analyses employed a robust maximum-likelihood estimator (MLR) with oblique rotation in Mplus 8.9 [34].

Finally, the final retained measurement model was considered for testing measurement invariance (MI) across occupations (clinical vs nonclinical health care worker). In testing MI, we considered the following steps [35]: configural invariance, metric/weak invariance (invariance of the factor loadings), scalar/strong invariance (loadings and thresholds), strict invariance (loadings, thresholds and uniquenesses), invariance of the latent variances-covariances (loadings, thresholds, uniquenesses and variances-covariances), latent means invariance (loadings, thresholds, uniquenesses, variances-covariances and latent means). The test of configural, metric/weak, scalar/strong, and strict invariances is aimed at assessing measurement biases across the sample, whereas latent variances-covariances and latent means invariances test for meaningful group-based differences at the level of factor variances, covariances, and means.

In assessing model fit, we considered the Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA) [36, 37]. For CFI and TLI, values above 0.900 and 0.950 indicate adequate and excellent model fit, respectively. For RMSEA, values lower than .080 and 0.060 indicate adequate and excellent model fit, respectively. In assessing fit improvement for invariance tests, we used the Mplus DIFFTEST function [38]. We considered the following fit indices [39, 40]: (i) a CFI reduction of 0.010 or less and (ii) an RMSEA increase of 0.015 or less between a model and the preceding model indicates hypothesis rejection for the measurement invariance. Finally, we measured composite reliability for each subscale by calculating ESEM-based McDonald's omega (ω) [41, 42]. As suggested by Morin and colleagues [43], in the ESEM framework, model-based omega coefficients of composite reliability is preferable to the traditional Cronbach's alpha. Values greater than 0.70 are considered to reflect adequate internal reliability.

3. Results

The descriptive statistics of PEPS items are presented in Table 1. As reported in Table 2, the unidimensional-CFA showed an unacceptable level of all goodness-of-fit indices (CFI and TLI≤0.900; RMSEA≥0.080), whereas first-order CFA, H-CFA, and H-ESEM solutions provided an acceptable level of fit according to the CFI (≥0.900) and TLI (≥0.900). The ESEM solution achieved an excellent fit to the data according to the RMSEA (RMSEA≤0.080), supporting the superiority of the six-factor ESEM solution. Parameter estimates associated with these models are reported in Table 3 for the ESEM solution.

3.1. Factor Structure and Reliability

All factors appeared to be globally well-defined overall. Items showed standardized factor loadings (λ=0.10 to 0.97, M=0.71) higher in their *a priori*-defined factor than in the other factors, and low cross-loadings emerged. However, inspecting factor loadings for each factor, one item from the risk perception subdimension showed a low value, item 14 ("Please indicate to what extent did your training, equipment, and support provide you with control over your contact with the virus?"; λ=0.11) and a cross-loading (λ=0.30) on the resources dimension. Concerning factorial intercorrelations and internal consistencies (Table 4), the ESEM-based McDonald's omega (ω) was good for all factors: disruption=0.92, resources=0.86, risk perception=0.83, AWL=0.85, managerial leadership=0.89, direct supervisor leadership=0.94.

Finally, factorial invariance tests across occupational roles (clinical vs. nonclinical hospital workers) were conducted using the six-factor ESEM solution (Table 4).

Table 1. Mean and Standard Deviation (SD) of the PEPS items (N=766).

	Mean	SD
PEPS1	4.18	0.92
PEPS2	4.04	0.98
PEPS3	3.94	1.00
PEPS4	3.22	1.12
PEPS5	3.13	1.05
PEPS6	2.76	1.21
PEPS7	3.13	1.05
PEPS8	2.51	1.14
PEPS9	3.17	0.64
PEPS10	3.11	0.70
PEPS11	3.11	0.67
PEPS12	3.16	0.63
PEPS13	2.47	1.12
PEPS14	3.61	0.84
PEPS15	3.33	1.01
PEPS16	3.37	1.05
PEPS17	3.63	0.94
PEPS18	3.13	0.98
PEPS19	2.99	1.11
PEPS20	3.37	1.02
PEPS21	3.09	1.06
PEPS22	3.44	1.01
PEPS23	2.91	1.05
PEPS24	2.82	1.01
PEPS25	2.90	1.02
PEPS26	2.70	1.09
PEPS27	2.87	1.11
PEPS28	3.17	1.04
PEPS29	3.01	1.11
PEPS30	3.08	1.09
PEPS31	2.90	1.13
PEPS32	3.13	1.13

Table 2. Goodness-of-fit statistics for the estimated models.

Model	χ2	df	CFI	TLI	RMSEA	[90% CI]
M1. Unidimensional-CFA	6759.92	464	0.541	0.509	0.133	[0.130-0.136]
M2. First-order CFA (6 factors)	1497.07	449	0.924	0.916	0.055	[0.052-0.058]
M3. H-CFA	1610.86	457	0.916	0.909	0.057	[0.054-0.060]
M4. Six-factor ESEM	922.04	319	0.956	0.932	0.050	[0.046-0.053]
M5. H-ESEM	1021.05	328	0.949	0.924	0.053	[0.049-0.056]

Note: CFA=confirmatory factor analysis; ESEM=exploratory structural equation modeling; χ2=scaled chi-square test of exact fit; df=degrees of freedom; CFI=comparative fit index; TLI=Tucker-Lewis index; RMSEA=root mean square error of approximation; 90% CI = 90% confidence interval of the RMSEA.

Table 3. Standardized parameter estimates from ESEM.

	Disruption	Resources	Risk Perception	AWL	Management	Supervisor	
	λ1	λ2	λ3	λ4	λ5	λ6	δ
PEPS1	**0.84**	0.02	0.04	0.08	-0.04	-0.03	0.29
PEPS2	**0.97**	-0.02	-0.03	0.00	0.00	-0.04	0.07
PEPS3	**0.83**	-0.03	0.06	-0.03	-0.01	-0.02	0.26
PEPS4	0.08	**0.77**	-0.03	-0.09	-0.02	0.08	0.42
PEPS5	-0.02	**0.85**	-0.02	-0.08	-0.06	0.06	0.35
PEPS6	-0.07	**0.71**	0.07	0.12	0.02	-0.09	0.44
PEPS7	-0.02	**0.68**	-0.02	0.07	-0.06	0.05	0.48
PEPS8	-0.02	**0.51**	-0.05	0.08	0.30	0.00	0.37
PEPS9	-0.02	0.08	**0.91**	-0.01	-0.04	0.03	0.19
PEPS10	-0.02	-0.04	**0.77**	0.08	0.01	-0.04	0.42
PEPS11	-0.06	-0.01	**0.75**	0.05	-0.02	-0.05	0.47
PEPS12	-0.01	0.03	**0.93**	0.04	-0.01	-0.02	0.16
PEPS13	0.22	0.05	**0.27**	-0.22	0.03	0.08	0.77
PEPS14	0.09	0.30	**0.11**	0.14	0.11	-0.03	0.76
PEPS15	0.12	-0.09	**0.45**	-0.12	0.12	0.08	0.71
PEPS16	-0.16	0.05	0.02	**0.49**	0.02	-0.16	0.75
PEPS17	0.03	0.02	-0.08	**0.58**	0.02	-0.08	0.66
PEPS18	0.02	0.01	-0.03	**0.72**	0.06	0.03	0.38
PEPS19	0.00	-0.06	0.01	**0.78**	0.06	0.10	0.29
PEPS20	0.05	0.00	-0.01	**0.62**	-0.05	0.19	0.48
PEPS21	0.01	0.06	0.01	**0.76**	-0.01	0.09	0.30
PEPS22	0.06	0.07	0.00	**0.52**	0.08	0.10	0.53
PEPS23	0.01	0.02	-0.02	-0.10	**0.73**	0.09	0.44
PEPS24	-0.05	0.04	0.04	-0.08	**0.84**	0.03	0.32
PEPS25	0.02	-0.01	0.01	0.04	**0.80**	0.02	0.31
PEPS26	-0.01	0.06	-0.07	0.16	**0.70**	-0.03	0.28

Table 3 (*Continues*)

	Disruption	Resources	Risk Perception	AWL	Management	Supervisor	
	λ1	λ2	λ3	λ4	λ5	λ6	δ
PEPS27	-0.01	-0.03	-0.01	0.09	**0.71**	0.02	0.40
PEPS28	-0.05	0.06	0.01	0.01	0.01	**0.82**	0.26
PEPS29	-0.02	-0.01	0.03	0.00	0.04	**0.89**	0.19
PEPS30	-0.02	0.02	-0.01	0.00	0.04	**0.86**	0.20
PEPS31	-0.01	0.05	-0.05	0.10	0.05	**0.75**	0.20
PEPS32	0.02	-0.01	0.00	0.11	-0.02	**0.81**	0.26

Note: ESEM=exploratory structural equation model; AWL=areas of worklife; λ=standardized factor loading; δ=standardized item uniqueness.

Table 4. Factor correlations and internal consistencies (in diagonal) of the actors for the ESEM solution.

	1	2	3	4	5	6
1. Disruption	(0.92)					
2. Resources	-0.06	(0.86)				
3. Risk Perception	0.37**	-0.26**	(0.83)			
4. Areas of worklife	-0.20**	0.58**	-0.32**	(0.85)		
5. Managerial leadership	-0.09*	0.61**	-0.26**	0.63**	(0.89)	
6. Direct supervisor leadership	0.02	0.49**	-0.17**	0.64**	0.66**	(0.94)

*Note: * $p < 0.05$; ** 0.01.*

Table 5. Tests of measurement invariance of PEPS across occupational roles.

Model	χ2	df	CFI	TLI	RMSEA	[90% CI]	CM	Δχ2	Δdf	ΔCFI	ΔTLI	ΔRMSEA
Measurement invariance												
M6. Configural invariance	1391.82	638	0.947	0.918	0.056	[0.052-0.060]						
M7. Weak invariance	1548.77	794	0.947	0.934	0.050	[0.046-0.053]	1	170.88	156	0.000	0.016	-0.006
M8. Strong invariance	1597.78	820	0.945	0.934	0.050	[0.046-0.053]	2	48.83	26	-0.002	0.000	0.000
M9. Strict invariance	1608.83	852	0.947	0.938	0.048	[0.045-0.052]	3	28.45	32	0.002	0.004	-0.002
M10. Var-Cov invariance	1656.36	873	0.945	0.937	0.048	[0.045-0.052]	4	47.62	21	-0.002	-0.001	0.000
M11. Latent means invariance	1685.22	879	0.943	0.936	0.049	[0.045-0.052]	5	30.33	6	-0.002	-0.001	0.001

Note: χ2 = scaled chi-square test of exact fit; df = degrees of freedom; CFI = comparative fit index; TLI = Tucker-Lewis index; RMSEA = root mean square error of approximation; 90% CI = 90% confidence interval of the RMSEA; VarCov = variance-covariance; CM = comparison model; Δ = change in fit information relative to the CM.

□ $p < 0.01$.

The configural invariance model adequately fitted the data (CFI=0.947, TLI=0.918, RMSEA=0.056). Then, progressively invariance constraints were added. The weak invariance model (M7; factor loadings constrained equally across groups) fitted the data well (CFI=0.947, TLI=0.934, RMSEA=0.050). The comparison of this model with the configural invariance model (M6) suggested improvement for RMSEA and TLI, revealing equal factor loadings across groups. Then, we tested for the strong invariance model (M8), constraining factor loadings and thresholds to be equal across groups. This model fitted the data well (CFI=0.945, TLI=0.934, RMSEA=0.050), showing the slight change in model fit indices (CFI), then support for the strong measurement invariance. Then, we tested for the strict invariance model (M9), constraining residual variances to be constant across groups. This model fitted the data well (CFI=0.947, TLI=0.938, RMSEA=0.048), showing improved goodness of fit compared with the previous less constrained model (M8).

These results supported the strict invariance of the model. Then, we constrained variances and covariances of all factors to be equal across groups. This model (M10) fitted the data well (CFI=0.945, TLI=0.937, RMSEA=0.048), thus supporting the invariance of the model. Finally, when we tested for the invariance of the latent means across groups, the model (M11) fitted the data well (CFI=0.943, TLI=0.936, RMSEA=0.048), thus supporting the invariance of the model.

4. Discussion

The main aim of our study was to explore the psychometric characteristics of the PEPS in an Italian sample of hospital workers. Specifically, we tested for its factorial structure, internal consistency, and measurement invariance. First, we assessed the factorial validity of the PEPS by contrasting CFA and ESEM solutions. To our knowledge, this study was the first cultural adaptation/validation of the PEPS. In general, our study confirmed the PEPS's multidimensional structure, as Leiter postulated [15] and in line with the literature. For example, in their research, Bailey et al. [21] considered a measurement model in which the PEPS showed an excellent fit to the data. Findings from our study were partially in line with those from Bailey et al. [21], as we showed the superiority of ESEM over traditional restrictive CFA, providing a satisfactory and parsimonious representation of the structure of the PEPS. However, the hypothesized six-factor CFA [15] showed an acceptable fit to the data, suggesting that all the subdimensions of the PEPS are well defined and separated. In this sense, the PEPS is formed by six distinct subdimensions: disruption, resources, risk perception, impact on areas of work life, management leadership, and direct supervisor leadership. Another confirmation of the good psychometric properties of the PEPS is that results from ESEM showed that most of the cross-loadings were below the threshold of 0.30. Only item 14, "Please indicate to what extent did your training, equipment, and support provide you with control over your contact with the virus?" showed moderate cross-loading with the resources subdimension. This may suggest that hospital workers considered training, equipment, and support received as organizational resources. Furthermore, it is possible that workers answered this item considering their adequacy in increasing the control over the virus.

All subscales were good in terms of measure reliability. These results align with previous research, where reliabilities, calculated using Cronbach's alfa, were higher than 0.70 for all PEPS subscales [25, 27].

Finally, an essential contribution of our study was examining measurement invariance models. Measurement invariance tests "the extent to which the content of each [survey] item is being perceived and interpreted in the same way across samples" [44]. In our study, results from the measurement and latent mean invariance tests showed that the ESEM solution was factorially invariant across occupational roles, proving that clinical and nonclinical hospital workers were not different regarding scores of the Italian PEPS constructs. This suggests that the items of the PEPS subscales have the same meanings for clinical and nonclinical hospital workers. This is a significant result, as the PEPS can be reliably used for comparison across professions directly exposed to the pandemic (such as nurses, physicians, etc.)

and those non-directly exposed (such as administrative, technicians, etc.). To the best of our knowledge, this is the first study to investigate the measurement invariance of the PEPS.

4.1. Limitations and Directions for Future Research

The current study has some limitations that need to be acknowledged. First, we employed a cross-sectional research design that precludes any assessment of the test-retest reliability of the PEPS over time. Second, we considered a convenience sample of Italian hospital professionals, limiting the generalizability of our results. Future studies should consider other health professionals working in non-hospital contexts, such as general practitioners, nursing homes, and private hospitals. Third, our results should be interpreted with caution due to a possible selection bias. The 70% of participants who did not respond might have different demographic characteristics, attitudes or experiences with the pandemic. This could lead to nonresponse bias, where the results are influenced by the characteristics of the participants, who may not be representative of the entire population. Finally, we did not assess both convergent and discriminant validity of the PEPS. Future studies should determine the relationship of PEPS with other variables, such as anxiety, stress, etc.

5. Conclusion

Our study explored the structure of the Italian version of the PEPS adopting an ESEM framework, providing evidence of its factorial validity, reliability, and measurement invariance across occupational roles. Despite the limitations highlighted above, the Italian version of the PEPS is a reliable and valid tool for assessing pandemic experiences and perceptions among Italian workers.

Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the local Independent Ethics Committee (N° Prot PG/2021/5436).

Informed Consent Statement: Participation was voluntary and anonymous. Participants could withdraw from participation in any moment. No sensitive data were requested, and, to ensure total anonymity, we did not ask for sex and age in the survey. Online informed consent was obtained.

Declaration of Interest: The authors declare that they have no competing interests.

Author Contribution Statement: All authors contributed to the study's conception and design. All authors performed material preparation, data collection, and analysis. IP, MG, and MPL wrote the first draft of the manuscript, and all authors commented on previous versions. All authors read and approved the final manuscript.

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