

## ORIGINAL ARTICLE

# Construct validity and reliability of the public health informatics competency scale for primary health care workers

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### ABSTRACT

**Objective:** Informatics competency is vital for public health care workers to meet the health-related needs of individuals with evidence-based practices through the field of science and engineering. The study was conducted to test the Turkish validity and reliability of the Public Health Informatics Competency for Primary Health Care Worker Scale.

**Methods:** Two hundred thirty one health care workers participated in the study, which was conducted between 25 April and 25 November 2023. The validity and reliability of the scale have been studied by conducting exploratory factor analysis, confirmatory factor analysis, internal consistency coefficients.

**Results:** As a result of the conducted analyses, the factor loadings varied between 0.293 and 0.808, explaining 37.2% of the total variance. Findings revealed that fit index analyses were at an acceptable level. For the scale, the single-factor structure containing 42 items was confirmed. Study found evidence for internal consistency as 0.956.

**Conclusion:** The results showed that the instrument with the uni-dimensional structure meets the validity and reliability criteria. The scale can help clarify the informatics competency of primary health care workers. Within this frame, it could be said that the scale could make significant contributions to the literature.

**Keywords:** Primary Health Care Worker, Informatics Competency, Scale, Validity

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## INTRODUCTION

Health informatics is generally tied to the entire management of information in healthcare<sup>1</sup>. The main focus is the patient and care. Health informatics provides to control the progression in healthcare, obtain medical knowledge and communication among all health-related professions. In addition, it keeps us to be informed about medical developments<sup>1</sup>.

Informatics competency is a crucial element in the rapidly evolving landscape of modern healthcare. It encompasses the knowledge, skills, and attitudes necessary to utilize data, information, and technology effectively to improve patient care, enhance healthcare delivery, and advance clinical research<sup>2</sup>. At its core, informatics competency involves the ability to collect, manage, analyze, and interpret data to inform decision-making. This includes proficiency in using electronic health records (EHRs), clinical decision support systems, and other health information technologies. A healthcare professional with informatics competency understands the principles of data security, privacy, and confidentiality, ensuring that patient information is handled responsibly and ethically. Furthermore, they possess the skills to evaluate the quality and reliability of data, identifying potential biases and errors that could compromise patient safety. The need for informatics competency in healthcare stems from several converging factors<sup>2</sup>. First, the increasing volume and complexity of healthcare data necessitate individuals who can extract meaningful insights from vast datasets. EHRs, medical imaging, genomic data, and patient-generated health data are just a few examples of the information sources that healthcare professionals must navigate. Informatics competency enables them to synthesize this information, identify trends, and develop targeted interventions. Second, informatics competency is essential for improving the quality and safety of patient care. By leveraging data analytics, healthcare providers can identify patterns of adverse events, optimize medication dosages, and personalize treatment plans. Clinical decision support systems, powered by informatics principles, can provide real-time guidance to clinicians, reducing the risk of errors and improving adherence to best

practices. Third, informatics competency is critical for advancing clinical research and innovation. Researchers rely on data mining and statistical analysis to uncover new insights into disease mechanisms, identify potential drug targets, and evaluate the effectiveness of interventions. Informatics-savvy healthcare professionals can contribute to these efforts by providing data, collaborating on research projects, and translating research findings into clinical practice.

Health informatics system is essential for healthcare workers to provide more cost-effective and better care for individuals and vital to meet the demands of the future. Furthermore, it has become a critical need for Primary Health Care (PHC) Workers because of the current trend of Health Informatics (HI) necessity to be performed efficiently<sup>3</sup>. Nowadays PHC professionals may face major challenges, in terms of technological advances, and demographic changes<sup>4</sup>. One of the primary reasons informatics competency is essential is its ability to improve data analysis and interpretation. Public health professionals rely heavily on data to identify trends, assess health needs, and evaluate the effectiveness of interventions<sup>3</sup>. Informatics tools and techniques enable the efficient collection, storage, and analysis of large datasets, providing insights that would be difficult or impossible to obtain through traditional methods. For instance, EHRs and health information exchanges (HIEs) generate vast amounts of data that can be used to monitor disease prevalence, track vaccination rates, and identify populations at risk. Competency in informatics allows professionals to extract meaningful information from these data sources, informing evidence-based policies and practices<sup>2</sup>.

Furthermore, informatics competency plays a critical role in enhancing public health surveillance. Timely and accurate surveillance is essential for detecting and responding to outbreaks, monitoring chronic diseases, and assessing the impact of public health programs. Informatics tools such as syndromic surveillance systems and geographic information systems (GIS) enable real-time monitoring of health events and spatial analysis of disease patterns. Public health professionals with informatics skills can leverage

these technologies to identify emerging health threats, track the spread of diseases, and implement targeted interventions. For example, during a pandemic, informatics tools can facilitate the rapid collection and analysis of data on infection rates, hospitalization rates, and mortality rates, enabling public health agencies to make informed decisions about resource allocation and containment strategies<sup>4</sup>. In addition to data analysis and surveillance, informatics competency is crucial for improving communication and collaboration among healthcare providers and public health agencies. Effective communication is essential for coordinating care, sharing information, and implementing public health initiatives. Informatics tools such as telemedicine platforms, secure messaging systems, and online portals facilitate communication among healthcare providers, patients, and public health officials<sup>5</sup>. These tools enable timely exchange of information, improve care coordination, enhance patient engagement and develop medical decision support system and clinical pathways. Public health professionals with informatics skills can leverage these technologies to improve communication and collaboration, leading to better health outcomes and more effective public health programs.

In the light of these explanations, it is clear that public health informatics competency (PHIC) has become a critical role for PHC workers in health care. Moreover, current trend of health IT adoption needs to have many skills about informatics competency<sup>6,7</sup>. Countries are in differing stages of this competency process all over the world. Prior studies have focused on the competency of e-health devices, applied computer skills, knowledge, perceptions and attitudes of many professionals regarding informatics<sup>8-11</sup>. While there are valid tools to measure the informatics competence of nurses in Türkiye<sup>11,12</sup>, there is no valid scale to measure the informatics competence of public health workers, especially in the field of public health. However, there is no valid scale to measure informatics competence, especially in the field of public health. The informatics competency of PHC workers and evidence in this regard is scarce. As of yet, no studies have measured the competency of health informatics of PHC workers in Türkiye despite the rise of technology. This study

aimed to test the Turkish validity and reliability of the Public Health Informatics Competencies for Primary Health Care Worker Scale (PHIC4PHC-TR). The present study has sections that are usually conducted in the psychometric analysis of scale validity: linguistic validity, content validity, and reliability.

## METHODS

### Study Design, Sample and Data Collection

Two hundred thirty one public healthcare workers were included in this methodological study using a convenience sampling method. Data were collected via an online survey from public health workers in the central and eastern Anatolian region, primarily in Erzurum province. We have an online public health community including nurses, doctors, midwives, and secretaries through which we regularly communicate and transmit information regarding public health issues via personal email addresses. For collecting data from this group, the sample size for this validation study, incorporating Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA), was determined based on established guidelines concerning the ratio of participants to items. Specifically, a minimum ratio of 5:1 participants per item is generally recommended for factor analytic techniques, with some researchers advocating for a ratio as high as 10:1. Given the presence of 42 items within the instrument under investigation, a sample size ranging from 210 (42 items \* 5 participants) to 420 (42 items \* 10 participants) was deemed appropriate. We aimed to achieve a sample size within this range to ensure adequate statistical power and stability of factor solutions.

While aiming for the higher end of the recommended range, practical considerations and resource constraints led to a final achieved sample size of 210 participants, satisfying the lower bound of the established ratio. This decision was made with careful consideration of the trade-off between statistical power and feasibility. 210 participants were needed to include for 42 items within the scope of the research, based on the necessity of reaching 5-10 times the number of items<sup>13-15</sup>. Participants were informed about

the study, and their informed consents were obtained. Data was collected between 25 April-25 October 2023 via online. Eligibility criteria for the study included participants: 1) to be a primary health care worker, 2) working as a public health professional, 3) 18 years of age or older, 4) residents in Türkiye, 5) able to read and write in Turkish, and 6) willing to complete the survey.

### **Public Health Informatics Competencies for Primary Health Care Worker Scale (PHIC4PHC-TR): Drafting the Questionnaire**

PHIC4PHC Scale, which was developed by Rachmani et al.<sup>4</sup>, is intended to measure the informatics competency of PHC workers. It comprises 4 factors and 42 items. Items 11,13,14,15,21,24,25,26,29 and 31 are reverse coded. The title of the factors are cognitive proficiency, technical proficiency, ethical proficiency, and health information literacy. Items in the scale evaluate the health information knowledge (items: 1-8) and health information skills (items 9-11) in cognitive proficiency factor, general computer skills (items: 12-24), office (items: 25-30) and network skills (items: 31,32) in technical proficiency, legal knowledge (item 33) and security knowledge (item 34) in ethical proficiency, and Access (35,36), manage (37,38), integrate (39,40) and evaluate (41,42) in health information literacy factor. Each item is rated on a 5-point Likert scale (SD: strongly disagree to SA: strongly agree). The score results from 42 PHIC4PHC questions will be used to measure the level of digital health literacy competence in the form of the PHIC4PHC Index. The score will follow the questionnaire for positive questions, while for negative questions, The Score will reverse the score. The general calculation for the index is as follows:

$$\text{index} = (\text{mean} - 1) * (50/4)$$

Thus the method of calculation is:  $\text{PHIC4PHC} = (((Q1 + Q2 + Q3 + Q4 + Q5 \dots + Q42)/42) - 1) * 50/4$ . The index value is then categorized as follows:

0-25= “Basic”

>25 to 33= “Literacy”

>33 to 42= “Fluency”

>42 = “Mastery”

### **Steps in Psychometric Analysis of PHIC4PHC Worker Scale**

#### **Linguistic Validity**

We consulted a linguist for back translation. The translator is a social science researcher whose native language is Turkish, who has been living in Canada for 8 years and who has advanced English speaking, comprehension and communication skills. Revisions which recommended were made to the items to ensure linguistic validity. Minor revisions were provided such as item 3: “I know the milestone in the evolution of health information system in my workplace is revised as “I know the development stages of the health information system in my workplace” and “item 28: “I can use a computer as a self-learning tool is revised as “I can use the computer as self-learning tool.” First, the English version was translated into Turkish. The items were sent to ten lecturers (academic nursing professionals, including public health nursing professionals, and academic researchers from medical faculty) who are experts in the field of scale validation studies (statistic specialists). They were asked to check for ambiguous statements and to comment on the items of the scale about the conceptual validity and the formulation of the items. Each expert had a PhD degree and all experts were covered by ethics. Then the items were translated into English again by a linguist well-versed in English and Turkish. To test the intelligibility of the items, a pilot study was conducted with 10 public healthcare workers in a primary care center in Erzurum. This process confirmed the accuracy, readability, and ambiguity of the drafted instrument. The finalized scale was applied to the original sample group, and the applicability of the tool was tested using validity and reliability analyses.

## Validity and Reliability

### Explanatory Factor Analyses

The data were analyzed with IBM SPSS Statistics 22 and Amos 21.0 software to statistically test the validity and reliability of the instrument. The KMO and Bartlett tests, exploratory factor analysis with varimax rotation, descriptive statistics, Cronbach's Alpha, and confirmatory factor analyses were conducted. While a KMO value above 0.90 is considered optimal for exploratory factor analysis, our study's KMO value of 0.759, being above the acceptable threshold of 0.60, suggests that the data is still reasonably suitable for this analysis<sup>16,17</sup>. This indicates a moderate level of common variance within the dataset, and the exploratory factor analysis can still provide valuable insights into the underlying structure of the variables. Though not ideal, our result allows us to proceed with cautious optimism, recognizing the potential for meaningful factor identification and interpretation. Also, Bartlett's test of sphericity was significant:  $\chi^2=10123.512$  ( $p<0.001$ ). These results showed that the data set was large enough for factor analysis and was homogeneous<sup>18,19</sup>. Then, principal components analysis was performed on the scale items.

### Confirmatory Factor Analyses

The single-factor structure of the scale, containing 42 items, was analyzed. The standard regression weights of the scale, which was analyzed with the unweighted least squares (ULS) method<sup>20</sup> was acceptable. While we acknowledge that maximum likelihood (ML) is a widely adopted method due to its default implementation in many software packages and its desirable properties under specific conditions—namely, properly defined models, large sample sizes, normally distributed independent, continuous, and multivariate datasets—our decision to employ ULS method was deliberate and grounded in the specific characteristics of our data. The literature indicates that ML estimation can produce biased results in scenarios involving non-normally distributed data and a limited number of response categories<sup>19,21</sup>. Our dataset exhibits characteristics that deviate from the ideal conditions for ML estimation, such as non-normal distribution. This deviation, if unaccounted for, could

potentially compromise the accuracy and reliability of the parameter estimates, standard errors, chi-square statistics, and goodness-of-fit indices obtained through ML<sup>22</sup>. Our selection of ULS estimation was a conscious decision made to mitigate potential biases associated with ML estimation in the context of our specific dataset. We believe that this approach has allowed us to obtain more reliable and accurate results, thereby strengthening the validity of our findings. The scale fit indices ( $\chi^2$ , df,  $\chi^2$ /df, GFI, AGFI, RFI, NFI, RMR and SRMR) were found to be within accepted limits.

### Reliability

To test the reliability of the PHIC4PHC-TR scale, the Cronbach's alpha coefficient was calculated. It was found to be highly reliable. Findings related to Cronbach's Alpha coefficients indicated that the scale had a well internal consistency and reliability<sup>18</sup>.

## RESULTS

Of the participants in the study, 52.8% were women, 71.4% were married, 49.8% had a bachelor's degree, 53.7% were nurses, 61% had 10 years or more of professional experience, and their average age was  $41.20\pm 6.34$  [minimum-maximum (min-max): 26-55] (Table 1). It was determined that 69.7% of the participants had been using computers for 11 years or more, 52.8% had received computer-related training, and all had been using mobile phones for 10 years or more.

The relationship between items and the scale was evaluated. The item-total correlation values of the scale were found to be in the range of 0.313-0.768. It was identified that the correlation value of each expression was greater than the limit value of 0.30<sup>23</sup>. The results of the item analysis of the scale were found to be sufficient.

The KMO and Bartlett tests were performed to verify the data's suitability for an exploratory factor analysis. The results included for KMO were 0.759; Bartlett test:  $\chi^2= 10123.512$ . First, a 4-factor structure was tested in accordance with the theoretical scope envisaged in the scale's original structure (Table 2).

<b>Table 1.</b> Descriptive characteristics of participants (n=231)		
	$\bar{x}$	SD
Age (min-max: 26-55)	41.20	6.34
	n	%
<b>Sex</b>		
Female	122	52.8
Male	109	47.2
<b>Marital status</b>		
Married	165	71.4
Single	66	28.6
<b>Education</b>		
Associate degree	21	9.1
Bachelor degree	115	49.8
Post graduate	95	41.1
<b>Profession</b>		
Nurse	124	53.7
Doctor	80	34.6
Midwife	16	6.9
Medical secretary	11	4.8
<b>Job experience</b>		
0-1 year	15	6.5
2-5 years	33	14.3
6-10 years	42	18.2
11 years and above	141	61.0
<b>Experience using computer</b>		
0-5 year	22	9.5
6-10 years	48	20.8
11 years and above	161	69.7
<b>Having computer training</b>		
Yes	122	52.8
No	109	47.2
<b>Experience using mobile phone</b>		
10 years and below	-	-
10 years and above	231	100.0

$\bar{x}$ : Mean, SD: Standart deviation, min: Minimum, max: Maximum

According to the results, the 4-factor structure with eigenvalues  $>2$  explained 56% of the total variance. In this structure, some items were included in two

factors at the same time, and the difference between factor loadings was less than 0.10. Additionally, some items were loaded on different factors than the factor in the original scale. For this reason, a single-factor structure was tried without dividing the scale into factors. When the principal components analysis was performed again, a single-factor structure with an eigenvalue of 15.6 and explaining 37.2% of the total variance was determined. In this structure, the factor loading of the items was in the range of 0.293-0.808 (Table 3).

<b>Table 2.</b> Dimensions of the initial PHIC4PHC questionnaire			
No	Factor	Indikator	Items
1	Cognitive proficiency	Health information system knowledge	1-8
		Health information system skill	9-11
2	Technical proficiency	General computer skill	12-24
		Office skills	25-30
		Network skills	31-32
3	Ethical proficiency	Legal knowledge	33
		Security knowledge	34
4	Health information literacy	Access	35,36
		Manage	37,38
		Integrate	39,40
		Evaluate	41,42

<b>Table 3.</b> EFA-factor loadings and CFA-standard regression weights of PHIC4PHC-TR		
Items	EFA factor loading	CFA standard regression weights
Item-1	0.518	0.496
Item-2	0.537	0.535
Item-3	0.507	0.475
Item-4	0.639	0.568
Item-5	0.583	0.513
Item-6	0.648	0.555
Item-7	0.573	0.516

Item-8	0.293	0.256
Item-9	0.717	0.694
Item-10	0.599	0.588
Item-11	0.389	0.439
Item-12	0.564	0.560
Item-13	0.527	0.572
Item-14	0.691	0.764
Item-15	0.514	0.601
Item-16	0.477	0.450
Item-17	0.610	0.575
Item-18	0.627	0.572
Item-19	0.626	0.591
Item-20	0.672	0.638
Item-21	0.391	0.414
Item-22	0.657	0.611
Item-23	0.708	0.713
Item-24	0.296	0.346
Item-25	0.438	0.499
Item-26	0.512	0.555
Item-27	0.392	0.374
Item-28	0.605	0.625
Item-29	0.727	0.832
Item-30	0.444	0.444
Item-31	0.449	0.496
Item-32	0.551	0.500
Item-33	0.771	0.677
Item-34	0.664	0.607
Item-35	0.709	0.614
Item-36	0.808	0.737
Item-37	0.762	0.679
Item-38	0.798	0.709
Item-39	0.720	0.621
Item-40	0.789	0.666
Item-41	0.783	0.680
Item-42	0.704	0.678
Eigenvalue		15.6
Total rate of variance (%)	37.2	
EFA: Explanatory Factor Analysis, CFA: Confirmatory Factor Analysis, PHIC4PHC-TR: Turkish version of Public Health Informatics Competency for Primary Health Care Worker Scale		

scale were between 0.256-0.832. Model fit indices were determined as  $\chi^2= 1167.064$ ,  $df= 819$ ,  $\chi^2/df= 1.424$ ,  $GFI= 0.89$ ,  $AGFI= 0.89$ ,  $RFI= 0.86$ ,  $NFI= 0.86$ ,  $RMR= 0.07$ ,  $SRMR= 0.08$ . The fit indices of the scale were found to be within accepted limits<sup>8,18</sup> and the one-dimensional structure of the scale, consisting of 42 items, was confirmed. The further details of the factor values are presented in Figure 1.

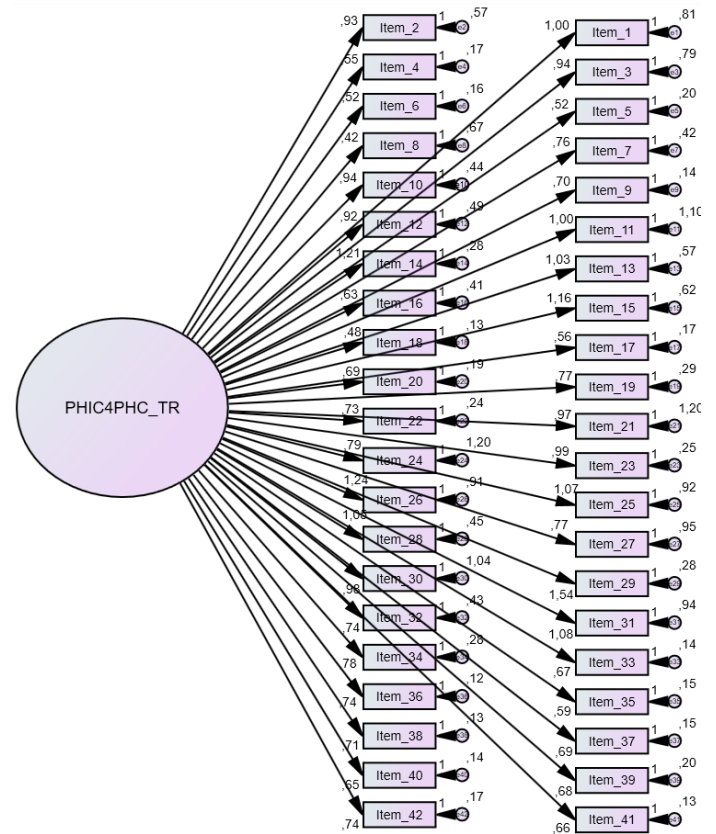


Figure 1. The distribution of factor values

It is seen that the item means of the scale vary between 4.75 (item 18) and 3.23 (item 27) (Table 4). In the item total correlation analysis, the correlation value of the items is 0.272 (item 8) and 0.768 (item 30). Since these values are greater than 0.20, it was not deemed necessary to remove any item from the scale. It is also seen that the Cronbach's Alpha if Item Deleted values of the scale items vary between 0.940-0.943. On the findings of the reliability analyses, the Cronbach's alpha coefficient of the PHIC4PHC-TR scale was 0.956. The reliability was found to be high.

Confirmatory Factor Analysis was the second step of the analyses. The standard regression weights of the

Table 4. PHIC4PHC-TR item-total statistics

	Mean	Std. deviation	Corrected item-total correlation	Cronbach's alpha if item deleted
Item-1	4.05	1.037	0.493	0.941
Item-2	4.26	0.891	0.538	0.941
Item-3	3.93	1.014	0.483	0.941
Item-4	4.55	0.497	0.582	0.941
Item-5	4.63	0.525	0.531	0.941
Item-6	4.63	0.482	0.584	0.941
Item-7	4.28	0.755	0.530	0.941
Item-8	4.43	0.846	0.272	0.943
Item-9	4.54	0.515	0.691	0.940
Item-10	4.45	0.821	0.580	0.940
Item-11	4.00	1.168	0.403	0.942
Item-12	3.79	0.849	0.552	0.940
Item-13	4.04	0.924	0.534	0.941
Item-14	4.32	0.815	0.713	0.939
Item-15	3.73	0.989	0.541	0.941
Item-16	4.27	0.715	0.468	0.941
Item-17	4.67	0.504	0.574	0.941
Item-18	4.75	0.432	0.579	0.941
Item-19	4.45	0.669	0.581	0.940
Item-20	4.58	0.560	0.626	0.940
Item-21	3.48	1.208	0.380	0.943
Item-22	4.46	0.616	0.609	0.940
Item-23	4.27	0.715	0.693	0.940
Item-24	3.79	1.171	0.313	0.943
Item-25	3.90	1.107	0.457	0.942
Item-26	3.61	1.151	0.517	0.941
Item-27	3.23	1.054	0.363	0.942
Item-28	4.08	0.865	0.596	0.940
Item-29	4.05	0.954	0.768	0.939
Item-30	3.94	1.140	0.422	0.942
Item-31	4.04	1.118	0.461	0.942
Item-32	4.47	0.762	0.501	0.941
Item-33	4.62	0.511	0.688	0.940
Item-34	4.46	0.664	0.607	0.940
Item-35	4.54	0.498	0.622	0.941
Item-36	4.46	0.516	0.735	0.940
Item-37	4.49	0.526	0.683	0.940
Item-38	4.47	0.517	0.711	0.940
Item-39	4.50	0.566	0.639	0.940
Item-40	4.52	0.500	0.684	0.940
Item-41	4.49	0.501	0.689	0.940
Item-42	4.39	0.563	0.665	0.940

The ability of PHIC4PHC-TR to distinguish high and low scores was analyzed for each item and scale total. After the scale scores were ranked from high to low, the upper 27% (n=62) and lower 27% (n=62) groups were compared. Accordingly, it was determined that

there was a statistically significant difference between the upper and lower groups at the level of the total scale and items, and the analysis results are given in the Table 5 (p<0.001). Further details (in Turkish version) about the items are given in the Table 6.

**Table 5.** Comparison of 27% lower and upper groups regarding PHIC4PHC-TR

The instrument	Group	n	Mean	SD	Test statistics	p
PHIC4PHC-TR Total	Lower 27%	62	155.17	8.23	<i>t</i> =-37.445	0.000
	Upper 27%	62	200.88	44.99		

**Table 6.** The items of the PHIC4PHC (Turkish version)

Items
1. Kamu sağlık hizmetleri ve hastane yönetim sistemleri gibi sağlık bilgi sistemleri hakkında bilgi sahibiyim
2. İşyerimde mevcut sağlık bilgi sistemi hakkında bilgi sahibiyim
3. Çalıştığım sağlık kuruluşunda sağlık bilgi sistemlerinin değişim aşamalarını biliyorum
4. Günlük görevleri yerine getirmeme yardımcı olabilecek bilgisayar uygulamalarını biliyorum (örneğin; çevre sağlığı, sağlıklı yaşam teşviki vb)
5. Bilgisayarlar, çalışma ve kontrol için bir araç olarak kullanılabilir
6. Verilerin, işim için önemini ve avantajlarını biliyorum
7. Verilerin nasıl toplandığına ve kullanıldığına dikkat ediyorum
8. Sağlık bilgi sistemi, çalıştığınız sağlık kuruluşlarında verimlilik için kullanışlı bir araçtır
9. İşimi tamamlamak için sağlık bilgi sistemini kullanabilirim
10. Çalışma ortamında verileri depolamak, almak ve aktarmak için bir sağlık bilgi sistemi kullanabilirim
11. Tıbbi ve sağlık hizmetlerinde kullanılan bilgisayar ekipmanlarını KULLANAMIYORUM
12. Bilgisayardaki yaygın ve basit sorunları çözebilirim
13. Kişisel ihtiyaçlar için bir bilgisayarı nasıl kullanacağımı BİLMİYORUM
14. Yazıcı, tarayıcı gibi bilgisayarla bağlantılı cihazları KULLANAMIYORUM
15. Aynı anda birçok kullanıcı gibi bilgisayar programının yavaş yanıt vermesinin nedenini BİLMİYORUM
16. Bilgisayar programı etkinlik ve verimlilik için kullanılan bir araçtır
17. Bilgisayardaki dosyalar yedeklenmelidir
18. Bilgisayarın kapatılması ve mouse kullanılması gibi temel kullanımlarını biliyorum
19. Windows gibi bir işletim sisteminin nasıl kullanılacağını biliyorum
20. Dosyaları nasıl yöneteceğimi ve kaydedeceğimi biliyorum
21. Yazıcılar ve tarayıcılar gibi bilgisayar aygıtları için sürücülerin nasıl kurulacağını BİLMİYORUM
22. İşletim sistemlerinin klasör veya dosya oluşturma, kopyalama, taşıma gibi dosya yönetimi işlevlerini biliyorum
23. Günlük işlerdeki belgeleri hazırlamak için kelime işlem yazılımını (Microsoft Word, Google Docs vb.) kullanabilirim
24. Basit veri analizi yapmak için bir elektronik tablo programı (örn. Excel) KULLANAMIYORUM
25. Sunum ve eğitim amaçlı sunum düzenleme yazılımını (Power Point) KULLANAMIYORUM
26. Araştırma ve günlük görevler için istatistik yazılımını KULLANAMIYORUM

Table 6. Continued
27. Günlük işlerimde ihtiyaç duyduğum bir veritabanını oluşturmak için veritabanı yazılımı kullanabilirim
28. Bilgisayarı, bir kendi kendine öğrenme aracı olarak kullanabilirim
29. E-öğrenme, CD ile öğrenme gibi bilgisayarlı kendi kendine öğrenmeyi KULLANAMIYORUM
30. Bir dosyayı Word'den PDF'e gibi farklı uygulama biçimlerine dönüştürebilirim
31. Bilgi aramak için World Wide Web'i (www) KULLANAMIYORUM
32. E-postaları alıp gönderebilir ve ağ üzerinden dosya aktarabilirim
33. Bilgisayar verileri ve tıbbi kayıtların işlenmesinde gizlilik esastır
34. Bilgisayarlarda hasta bilgilerinin korunmasına ilişkin kuralları/yasaları biliyorum
35. İnternette hangi sağlık bilgilerinin mevcut olduğunu biliyorum
36. İnternette faydalı sağlık bilgilerinin nerede bulunacağını biliyorum
37. İnternet sağlık bilgisi kaynağı olarak kullanılabilir
38. İnternette faydalı sağlık bilgilerinin nasıl bulunacağını biliyorum
39. Sağlıkla ilgili soruları yanıtlamak için interneti nasıl kullanacağımı biliyorum
40. İşime yardımcı olmak için bulduğum sağlık bilgilerini nasıl kullanacağımı biliyorum
41. İnternette bulunan sağlık bilgilerini değerlendirebilirim
42. İnternetteki doğru sağlık bilgilerini yanlış sağlık bilgilerinden ayırt edebilirim

## DISCUSSION

Health informatics as well as informatics competency are the crucial elements in modern healthcare, within the role in the acquisition, processing, and interpretation of patient data<sup>24</sup>. It has become vital in the digital era because it is the main resource of healthcare professionals today. The PHIC4PHC-TR scale is the first comprehensive instrument designed to assess the competency of primary healthcare (PHC) workers in areas such as computer skills, ethical considerations, and health literacy. Our study adheres to established methodologies for instrument validation, encompassing linguistic validation, content validation, and reliability analyses, including factor analyses.

The sample's Kaiser-Meyer-Olkin (KMO) value was found to be sufficient for the exploratory factor analysis conducted. In the factor analysis, the items of the scale exhibited a lack of clear delineation among the hypothesized four factors, suggesting a more complex interrelationship than initially anticipated. The original scale, as posited in its initial validation, exhibited a

four-factor structure<sup>4</sup>. Our investigation, employing Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) and utilizing the "PHIC4PHC-TR Scale," comprising 42 items, revealed a single underlying dimension. revealed a contrasting one-dimensional structure. This difference may stem from several methodological and contextual factors. Firstly, the development process differed significantly. The original study utilized a Delphi method, which relies on expert consensus to refine and validate the scale's structure<sup>25,26</sup>. In contrast, our study employed EFA and CFA, statistical techniques that identify latent variables based on patterns of item correlations within a sample population<sup>27,28</sup>. These methods are data-driven and may reflect the specific characteristics of our Turkish sample. In addition, cultural and linguistic nuances could contribute to the observed unidimensionality<sup>28</sup>. The "PHIC4PHC Scale" was adapted for a Turkish-speaking population, and the translation and cultural adaptation process may have altered the perceived relationships between items. Certain constructs that were distinct in the original scale may be understood as facets of a single overarching construct within the Turkish cultural context. The nuances of the Turkish

language could also influence how participants interpret and respond to the items. Moreover, differences in sample characteristics may account for the varying factor structures<sup>29,30</sup>. The demographic composition, experiences, and perspectives of our sample may differ from the original study's sample, leading to variations in item correlations and factor loadings. For instance, specific aspects of healthcare access or cultural beliefs prevalent in Türkiye might have influenced how individuals perceive and respond to the scale items, resulting in a more cohesive, single-factor structure. Besides these reasons, the number of items in the scale (42) could also play a role. While a larger item pool can enhance content validity, it may also lead to increased redundancy and stronger inter-item correlations, potentially contributing to the emergence of a single dominant factor<sup>28</sup>.

The variance (37.2%) in our exploratory factor analysis warrants careful consideration. While the conventional benchmark of 60% explained variance is often cited, it is crucial to acknowledge that the appropriateness of this threshold can vary significantly depending on the specific context of the validation study. Several factors, particularly those inherent to the nature of the construct being measured and the characteristics of the sample, can contribute to lower-than-expected variance explained<sup>31</sup>. Firstly, the complexity and multidimensionality of the construct under investigation play a crucial role. If the phenomenon being measured is inherently multifaceted and influenced by a wide array of underlying factors, it is plausible that the extracted factors, even when psychometrically sound, may only capture a moderate proportion of the total variance<sup>32,33</sup>. In such cases, a lower variance explained does not necessarily indicate a flawed analysis but rather reflects the inherent complexity of the construct itself. Secondly, the sample characteristics can exert a substantial influence. While our sample size might be considered relatively small, it is important to emphasize that the homogeneity or heterogeneity of the sample can also significantly impact the variance explained. A highly heterogeneous sample, characterized by diverse backgrounds, experiences, and perspectives, is likely to exhibit greater variability in responses,

potentially leading to a lower percentage of variance explained by the extracted factors. Conversely, a more homogeneous sample might yield a higher variance explained, but at the expense of generalizability to the broader population. Furthermore, the specific items included in the measurement instrument can also affect the variance explained<sup>31</sup>. If the items tap into nuanced aspects of the construct or capture subtle variations in responses, they may contribute to a more comprehensive understanding of the phenomenon, even if they do not collectively account for a large proportion of the overall variance. In this regard, a lower variance explained might indicate that the instrument is sensitive to a wider range of individual differences, which could be a desirable characteristic in certain contexts. In light of these considerations, we believe that interpreting the explained variance in isolation, without accounting for the specific characteristics of our study, may lead to an overly critical assessment. While we acknowledge the importance of striving for a higher variance explained, we maintain that the 37.2% achieved in our analysis is not necessarily indicative of a fundamental flaw, given the inherent complexity of the construct, the characteristics of our sample, and the specific nature of the measurement instrument. Future research could explore alternative factor extraction methods or consider the inclusion of additional variables to potentially increase the variance explained. However, we believe that the current findings provide valuable insights into the construct under investigation and contribute meaningfully to the existing body of knowledge. Also, while a target of 60% or higher is commonly desired in exploratory factor analysis (EFA), the specific design of the original scale development study may have contributed to this outcome. It is important to note that the original study employed a two-round Delphi panel to develop the current scale<sup>4</sup>. While the Delphi method is valuable for achieving expert consensus, its potential limitations in comprehensively capturing the construct's full breadth should be acknowledged<sup>34-36</sup>. It is plausible that the iterative refinement process in Delphi method, while ensuring content validity based on expert opinion, may have inadvertently narrowed the scope of the scale. This narrowing could result in a reduced capacity to explain the variance observed in

the validation study. Future research could benefit from expanding the scale's items to capture a broader range of facets associated with the construct, potentially leading to a higher percentage of explained variance in subsequent EFA analyses<sup>37,38</sup>.

The 36<sup>th</sup> item, which has the highest factor load and is related to internet usage, revealed that the participants associated IT with the internet or that IT competence is what they do best<sup>26</sup>. In the original study, researchers found that the items providing information using the internet had the highest correlation in the digital health literacy scale they developed. This finding coincides with the original<sup>4</sup>. The current scale showed a well internal consistency with a result equivalent to the original one. Reliability refers to the consistency of a measure. A measure that produces highly consistent scores can be a very good measure of a construct that is supposed to be consistent<sup>18</sup>.

In the current paper, our decision to retain the items which are below 0.5 was based on a multifaceted approach, considering not only statistical criteria but also theoretical relevance and content validity. While a factor loading of 0.5 is often considered a benchmark for item retention, rigidly adhering to this cutoff can lead to the exclusion of items that contribute meaningfully to the construct being measured. Firstly, the magnitude of a factor loading is influenced by sample size<sup>18</sup>. Our study, while adequately powered, may not have been large enough to yield uniformly high factor loadings across all items. Moreover, the complexity of the construct itself can impact factor loadings. If the construct is multi-faceted or nuanced, individual items may capture specific aspects that, while important, do not correlate strongly with the primary factor. We prioritized the content validity of the scale. Several items with lower factor loadings were deemed essential for representing the full breadth of the construct<sup>14,18</sup>. Removing these items would have resulted in a scale that was statistically cleaner but conceptually impoverished, potentially undermining its overall validity and applicability. These items, while not loading strongly on a single factor, exhibited satisfactory item-total correlations and contributed unique variance to the scale. Aslo, we

acknowledge that factor loadings are just one piece of evidence in scale validation. We examined other psychometric properties, such as internal consistency reliability (Cronbach's alpha) and item discrimination indices. The scale as a whole demonstrated acceptable reliability and validity, suggesting that the inclusion of these items, despite their lower factor loadings, did not detract from the scale's overall performance<sup>18,19</sup>. We believe that our approach, which balanced statistical considerations with theoretical and content-related factors, resulted in a scale that is both psychometrically sound and conceptually comprehensive. We hope this explanation addresses readers' concerns and provides a clearer understanding of our decision-making process. The results of the fit indices analyses were acceptable. The chi-square goodness-of-fit index was used as the initial fit index, and the model was well-fitted. Absolute fit indices, GFI and AGFI, are the sample variances explained by the model. In our study, however, the values were found to be acceptable; we acknowledge that some values are at or just below the accepted limit. The NFI value, which is the comparative fit index, was acceptable. As the RMR value, which is the residual-based fit index, approaches zero, the fit of the model increases. In this study, the RMR value was acceptable.

With confirmatory factor analysis, it is clarified that the model of the instrument was acceptable and fitted well. There is no comparison with the original study because of the absence of these analyses in the original instrument<sup>4</sup>. Finally, a 42-item scale with one structure was obtained to measure the informatics competency of primary health care workers. However, it is possible to calculate the discrimination power of each item by applying more advanced analyses such as Item Response Theory (ITT). These analyses show how well an item distinguishes individuals with different skill or knowledge levels and increase the accuracy of the scale. Such an analysis was not conducted in this study because it requires more resources and data. In addition, after the completion of the initial validity and reliability analyses of the scale, advanced analyses can be planned in the next stage.

As a result, the current instrument is essential to being the first instrument to evaluate the informatics competence of PHC workers in Türkiye.

### Limitations

The study participants were restricted to primary health care workers in one province of Türkiye, which may limit the generalisability of the findings. PHIC4PHC is based on self-reported competencies related to informatics rather than observed ones and so responses might be influenced by social desirability bias just as in the original. In our study, the psychometric properties of the scale were analyzed, but item discrimination parameters were not added. The reason for this situation is that this study focused primarily on classical analysis methods to test the validity and reliability of the scale. The preceding analysis, which was conducted in the original paper, while providing valuable insights into the properties of the scale along a four-dimensional space, our analysis is limited by its unidimensional focus.

The addition of item discrimination parameters would allow us to examine the scale's discrimination power between different individuals in more detail and to measure its validity on an item basis more precisely. This is presented as a suggestion for future work.

### CONCLUSION

Our study showed that the Turkish version of PHIC4PHC meets the validity, reliability, and precision criteria. It seems appropriate to measure the informatics competency of PHC workers. Further testing for different samples/professions is recommended.

It is important to note that informatics competency is indispensable for public health professionals. Its ability to enhance data analysis, improve public health surveillance, and facilitate communication and collaboration makes it a critical asset in addressing public health challenges. As healthcare becomes increasingly digital, the need for informatics-savvy public health professionals will only continue to grow.

By investing in informatics training and education, public health agencies can equip their workforce with the skills necessary to improve health outcomes, advance public health initiatives, and protect the health of communities. Investing in informatics training and education is therefore a crucial step towards building a healthcare workforce that is equipped to meet the challenges of the 21<sup>st</sup> century.

This study used an instrument to measure the competency of informatics of PHC workers who work to improve the health and well-being of communities through various roles and specializations with the aim of validating in Turkish as a different language. We can define these professionals as epidemiologists, biostatisticians, health educators, environmental health scientists, and physicians and public health nurses, among others. It is also clear that an instrument measuring the informatics competency specific to primary healthcare professionals is needed in every country.

### Conflict of Interest

The authors declare no conflict of interest.

### Ethics Committee Process

The study protocol was approved by Atatürk University Medical Faculty ethical board (7.09.2023-31). Informed consent forms from participants and consent from Enny Rachmani were received to test the 42-item PHIC4PHC by e-mail on the ResearchGate platform on 23.08.2023.

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