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Turkish Validity and Reliability Study of the Digital Vaccine Literacy Scale

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ABSTRACT

Objectives: This study aimed to assess the validity and reliability of the Turkish version of the Digital Vaccine Literacy (DVL) scale.

Methods: This methodological study was conducted with 236 staff working at a foundation university hospital between September 2023 and April 2024. Data were collected using the Personal Information Form and DVL scale. The linguistic validity, content validity, exploratory factor analysis, and confirmatory factor analysis of the scale were conducted. Reliability was evaluated through item-total correlations, Cronbach's alpha coefficient, and test-retest reliability. Data were analyzed in SPSS 27.0 and AMOS 22.0 package programs.

Results: The study revealed 3 dimensions comprising 7 items, with factor loadings ranging from 0.612 to 0.851, explaining 78.63% of the total variance. The fit measures were acceptable ($\chi 2/df = 3.271$; RMSEA = 0.072; CFI = 0.912; NFI = 0.875; GFI = 0.874; TLI = 0.889; IFI = 0.876; $p < 0.001$) in confirmatory factor analysis. The overall Cronbach's alpha value of the scale was 0.730, while the sub-dimensions were 0.791, 0.891 and 0.781, respectively. The test-retest reliability correlation was positive, very strong and statistically significant ($r=0.962$, $p<0.001$).

Conclusions: It was found that the factor structure of the Turkish version of the DVL is the same as the factor structure of the original version, and it is a valid and reliable tool. Measurement of digital vaccine literacy will play a significant role in developing education strategies, accessing accurate information, preserving public health, supporting vaccine decision-making, and enhancing digital health skills.

Keywords: Digital, Vaccine, Literacy, Validation, Adaptation

ÖZET

Amaç: Bu çalışmanın amacı Dijital Aşı Okuryazarlığı (DAO) ölçeğinin Türkçe versiyonunun geçerlik ve güvenirliğini değerlendirmektir.

Yöntem: Bu metodolojik çalışma Eylül 2023 ve Nisan 2024 tarihleri arasında bir vakıf üniversitesi hastanesinde çalışan 236 personel ile gerçekleştirilmiştir. Veriler Kişisel Bilgi Formu ve DAO ölçeği kullanılarak toplanmıştır. Ölçeğin dil geçerliliği, kapsam geçerliliği, açımlayıcı faktör analizi ve doğrulayıcı faktör analizi yapılmıştır. Güvenirlik, madde-toplam korelasyonları, Cronbach alfa katsayısı ve test-tekrar test güvenirliği ile değerlendirilmiştir. Veriler SPSS 27.0 ve AMOS 22.0 paket programlarında analiz edilmiştir.

Bulgular: Çalışma, faktör yükleri 0,612 ile 0,851 arasında değişen ve toplam varyansın %78,63'ünü açıklayan 7 maddeden oluşan 3 boyut ortaya koymuştur. Doğrulayıcı faktör analizinde uyum ölçümleri kabul edilebilir düzeydedir ($\chi 2/df = 3.271$; RMSEA = 0.072; CFI = 0.912; NFI = 0.875; GFI = 0.874; TLI = 0.889; IFI = 0.876; $p < 0.001$). Ölçeğin genel Cronbach alfa değeri 0.730 iken, alt boyutlar sırasıyla 0.791, 0.891 ve 0.781'dir. Test-tekrar test güvenilirlik korelasyonu pozitif, çok güçlü ve istatistiksel olarak anlamlıdır ($r=0.962$, $p<0.001$).

Sonuç: DAO'nun Türkçe versiyonunun faktör yapısının orijinal versiyonun faktör yapısı ile aynı olduğu, geçerli ve güvenilir bir araç olduğu bulunmuştur. Dijital aşı okuryazarlığının ölçülmesi, eğitim stratejilerinin geliştirilmesinde, doğru bilgiye ulaşmada, halk sağlığının korunmasında, aşı kararlarının desteklenmesinde ve dijital sağlık becerilerinin geliştirilmesinde önemli bir rol oynayacaktır.

Anahtar Kelimeler: Dijital, Aşı, Okuryazarlık, Geçerlik, Uyarlama

Vaccines are a key ingredient in healthcare systems because of their proven track record in the prevention of a wide range of diseases. Their pertinent function is reducing the calamitous influence of outbreak epidemic diseases on humanity by immunizing the whole of society against pathogens. The first successful vaccine was developed by Edward Jenner in 1796 which panders smallpox (1). After that, vaccines for several diseases were developed, such as rabies, tuberculosis, pneumococcus, and ones against many childhood illnesses. In the recent past, COVID-19 showed that along with other measures, vaccines are key in preventing these diseases from spreading on large scales. The COVID-19 pandemic showed up that healthcare systems and societies in virtually all parts of the world have undergone significant upheavals. This pandemic has underlined the significance of vaccination that can be done on a mass level eventually and benefit to maintain public health. Only the timely development of the vaccine was a way to break the pandemic chain, and this work process was implemented by involving a large number of people and it was speeded up considerably (2).

With the COVID-19 crisis, vaccination has started to attract greater attention in the digital world, leading to an increase in online inquiries about vaccination (3). Information about vaccines is provided through various online platforms, including government official websites, forum sites, and social media. However, the reliability and accuracy of this information vary greatly. While official government websites are generally considered reliable, social media platforms often propagate misleading or unscientific content (4). Online communication can disseminate controversial information, resulting in uncertainty and doubt about vaccines (5). Information pollution on online platforms about the safety and accuracy of vaccines can make it difficult for people to make the right decisions and harm public health. This can lead to dangerous behaviors such as vaccine refusal and hinder the containment of the pandemic.

Misconceptions about the effectiveness of vaccines and lack of knowledge about their role in public health have led to a decrease in vaccination rates and an increase in vaccine hesitancy (6). In addition to these factors, incidents like the 1955 Cutter Incident and the more recent Dengvaxia controversy have also contributed to growing concerns about vaccine safety among the public. Many children contracted the disease and several deaths occurred due to the failure of Cutter Laboratories' polio vaccine to fully inactivate the virus (7). Similarly, the use of the Dengvaxia vaccine in the Philippines led to serious side effects, severely undermining public trust in vaccine safety (8). In Malaysia, a study found that vaccine hesitancy is a concern, with a minority of students not supporting vaccination due to safety issues (9). Therefore, models such as the Increasing Vaccination Model and the 5C Model are developed to understand the complex factors influencing vaccination decisions (10). These models indicate that the content of online information has the potential to determine the decision to vaccinate or not. Access to accurate information about the efficacy of vaccines, as well as understanding this information correctly, is of critical importance to enhance the success of vaccination efforts. Given the increasing reliance on digital platforms for health information, the fusion of Digital Health Literacy (DHL) with vaccine literacy becomes imperative, leading to the emergence of Digital Vaccine Literacy (DVL) as a pivotal component in empowering individuals to make informed choices regarding vaccination.

Health literacy refers to the extent to which a person can obtain, understand, and utilize fundamental health information and services, enabling them to engage in health-related choices (11). DHL necessitates a distinct set of skills, encompassing the capacity to search for, assess, analyze, incorporate, and utilize health information obtained from online platforms (12). Vaccine literacy, built upon the concept of health literacy, involves acquiring knowledge about vaccines and establishing a simple mechanism for their delivery and administration (13). Thus, the convergence of DHL and vaccine literacy gives rise to the concept of DVL. DVL influences both the motivation and the competence required to navigate online information to make well-informed decisions regarding vaccination theoretically.

In light of the above information, it is important to develop reliable tools for measuring knowledge and perceptions regarding vaccines. Such a scale can be used as a tool to assess the effectiveness of interventions designed to increase DVL and reduce vaccine hesitancy. Questionnaires commonly featured in the literature typically emphasize general vaccine literacy rather than specifically addressing online vaccine literacy (14). Therefore, in this study, we analyzed the Turkish reliability and validity of the scale

developed by Montagni et al. (2022) specifically to assess DVL. Assessing DVL in the Turkish community will allow for the identification of strengths and weaknesses in this area and facilitate the development of more effective education and information strategies. It is believed that the scale will assist public health experts, researchers, and policymakers in devising policies and interventions aimed at enhancing DVL. This can lead to the reduction of vaccine hesitancy and better informed communities.

Methods

Study Design

This study used a descriptive and methodological approach to adapt the DVL developed by Montagni et al. (2022) into Turkish and assess its validity and reliability. The study was conducted with staff working at a foundation university hospital. Research questions to be answered in the study;

(a) Is the DVL a valid measurement tool in the Turkish population?

(b) Is the DVL a reliable measurement tool in the Turkish population?

Linguistic Validity

The scale's linguistic validity was established through the translation-back translation technique. This process involved ensuring semantic equivalence by comparing the items of the original scale with those of the back-translated version. Two independent specialized translators translated the scale into Turkish, preserving the original content. A collaborative translation was then developed by evaluating these individual translations. Next, the translated scale underwent back-translation into English by an expert with a strong understanding of the culture in the scale's country of origin. Both the original and translated versions were evaluated for language equivalence before finalizing the scale for expert review.

Expert Reviews

In order to evaluate the items in the Turkish version of the scale for linguistic and cultural equivalence, researchers developed an Expert Review Form. This form was distributed via email to 10 experts with backgrounds in public health and methodological research. The Davis technique was employed to compute the content validity index (CVI) of the scale. In this technique, experts' opinions are rated on a scale from A to D, indicating the relevance of each item. The Item-Content Validity Index (I-CVI) value for each item is calculated by dividing the number of experts who selected ratings A and B by the total number of experts, while the Scale-Content Validity Index (S-CVI) is obtained by dividing the sum of I-CVIs for each item by the total number of experts. The acceptable threshold for I-CVI is set at 0.78, and for S-CVI it is set at 0.80 (15).

Pilot Test

Before implementing the scale in the main study sample, a pilot test involving 50 individuals was conducted to evaluate the clarity of the scale's questions. Participants in the pilot test were distinct from those included in the main study sample. Although adding the option "I don't know, I don't look for vaccine-related information" alongside the 4-point Likert scale is recommended, during the pilot study, it was concluded that it would be more accurate not to include this item. Individuals who do not search for vaccine-related information were identified with a question included in the Personal Information Form. Participants who selected the statement "I don't know, I don't look for vaccine-related information" were not included in the factor analysis. After the pilot tests, the final version of the scale was administered to the main study sample. In addition, the participants reported that they could not fully comprehend the 4-point Likert scale ranging from "1" (Disagree) to "4" (Agree), so it was deemed appropriate to change the scoring to "1: Strongly Disagree, 2: Disagree, 3: Agree, 4: Strongly Agree".

Sample and Settings

The population of the research consists of staff working at a foundation university hospital. The sample size for the study was determined based on the number of items in the scale. It is recommended to have a sample size of at least five times the number of scale items or a minimum of 100 participants for scale development and adaptation studies (16). However, increasing the sample size enhances the appropriateness of factor analysis and improves reliability. Consequently, the study was conducted with 236 individuals who volunteered to participate. Due to the limited sample size in our study, exploratory factor

analysis (EFA) and confirmatory factor analysis (CFA) were conducted on the same sample (17).

Data Collection and Instruments

The data were collected using an online survey administered to participants after providing an explanation about the study's purpose. Throughout the data collection phase, both the Personal Information Form and the DVL scale were utilized. The Personal Information Form comprises 9 questions designed to gather information about participants' gender, age, marital status, education level, department, presence of chronic illness, history of previous infectious diseases, vaccines received, and vaccine-related information search. The DVL scale, developed by Montagni et al. (2022), consists of 3 dimensions and 7 items. The scale assesses the understanding, reliability, and application of online vaccine-related information (18). Responses to the items are rated on a 4-point Likert scale, ranging from "1" (Disagree) to "4" (Agree). The total score from the scale ranges from 7 to 28. A higher score indicates an increased level of digital vaccine literacy. The Cronbach's alpha coefficient for the scale is 0.71.

Statistical Analysis

Data analysis was conducted using the Statistical Product and Service Solutions (SPSS) version 27.0 and the Analysis of Moment Structures (AMOS) version 22.0 software packages. The normality of the data was assessed using histogram graphs and z-scores of skewness and kurtosis values. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to present the findings. The Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test of sphericity were employed to evaluate sample adequacy and item suitability for factor analysis. A KMO value above 0.50 was considered acceptable for factor analysis (19). EFA was utilized to examine item-factor relationships, while CFA was employed to assess the underlying structure of the scale. Principal Component Analysis (PCA) was employed as the factor extraction method in EFA. The reliability of the scale was evaluated using Cronbach's alpha coefficient, item-total correlation, test-retest reliability, Hotelling's T-squared test, Tukey's Additivity test, average variance explained (AVE) and composite reliability (CR) values. Test-retest reliability was assessed by administering the scale to 50 participants who completed the DVL scale again after a 15-day interval. Internal consistency reliability was considered satisfactory if Cronbach's alpha exceeded 0.70, and items with a factor loading of ≥ 0.30 were deemed acceptable (20). A significance level of $p < 0.05$ was applied in all statistical analyses.

Results

The process leading to the final version of the DVL scale is given below in three steps.

Characteristics of the Participants

A total of 236 participants, 137 women and 99 men, participated in the study. Of these, 136 were single and 100 were married. When their educational status was analyzed, the majority of the participants were high school graduates (n=72, 30.5%). The average age of the participants was 37.10 ± 9.68 years. Out of 236 staff, 103 are healthcare workers (43.6%), 49 are academic personnel (20.8%), 40 are administrative personnel (16.9%), and 44 are technical and support services personnel (18.6%). Among 236 participants, 97 reported having a chronic disease, while 139 reported not having a chronic disease. Also, 157 people had previously had an infectious disease, while 79 had not. The most commonly identified chronic conditions are hypertension (n=26), COPD/asthma (n=14), and diabetes (n=11), respectively. The most commonly identified infectious diseases are COVID-19 (n=105), influenza (n=72), and pneumonia (n=15), respectively.

Among the 222 staff vaccinated outside the routine vaccination program, the most common vaccines administered were COVID-19 (n=192), tetanus (n=102), influenza (n=37), rabies (n=23), HPV (n=11), meningitis (n=5), pneumococcus (n=4) and rotavirus (n=4). When evaluating where participants accessed vaccine-related information, it was found that 108 individuals obtained information from the internet, 105 from official websites of government institutions, 45 from television, 39 from social media, 19 from newspapers/magazines, and 17 from forum websites. The number of individuals who did not look for vaccine-related information was 32 (Table 1).

Table 1: Demographic Information of the Participants		
Variable	**n**	**%**
Gender		
Male	99	41.9
Female	137	58.1
Marital status		
Single	136	57.6
Married	100	42.4
Educational level		
High School	72	30.5
Associate Degree	48	20.3
Bachelor's Degree	53	22.5
Master's Degree	37	15.7
Doctorate	26	11.0
Profession		
Healthcare personnel	103	43.6
Academic personnel	49	20.8
Administrative personnel	40	16.9
Technical and support services personnel	44	18.6
Presence of chronic illness		
I don't know	38	17.1
Hypertension	26	11.7
Diabetes	11	5.0
Cholesterol	8	3.6
COPD/Asthma	14	6.3
Arthritis	8	3.6
I have no chronic illness.	139	62.6
Presence of infectious disease		
I don't know	16	5.4
Covid-19	105	35.4
Influenza	72	24.2
Pneumonia	15	5.1
Tuberculosis	3	1.0
Hepatitis	7	2.4
I have not had any infectious disease.	79	26.6
Vaccinations received outside the routine immunization schedule		
Influenza	37	9.4
Covid-19	192	49.0
Tetanus	102	26.0
Rabies	23	5.9
HPV	11	2.8
Meningitis	5	1.3
Pneumococcus	4	1.0
Rotavirus	4	1.0
I have never been vaccinated.	14	3.6
Place where vaccine-related information is accessed		
Television	45	12.3
Newspaper/Magazine	19	5.2
Internet	108	29.6
Social media	39	10.7
Forum sites	17	4.7
Official websites of government agencies	105	28.8
I am not looking for information about the vaccine.	32	8.8

COPD: Chronic Obstructive Pulmonary Disease, HPV: Human Papillomavirus.

Validity Analysis of the DVL

To verify the content validity of the DVL, expert reviews were sought. The Davis technique was employed to assess expert opinions, and the CVI was computed. Based on feedback from 10 experts, the I-CVI was 1.0, and S-CVI was 0.92. This outcome indicates that experts unanimously considered the scale to be suitable, highlighting the high level of content validity of the Turkish version of DVL.

In order to assess the structural validity of the scale, both EFA and CFA were conducted. To obtain a more accurate result, participants who did not look for vaccine-related information were not included in the EFA and CFA. Prior to conducting factor analysis, the suitability of the dataset and sample size adequacy was evaluated using the KMO measure and Bartlett's test of sphericity. The KMO value obtained was 0.637, and Bartlett's test of sphericity yielded a significant result ($\chi2=618.720$; $p<0.001$), indicating that the data were suitable for factor analysis. In conducting the EFA, the PCA method was employed for factor extraction. EFA analysis revealed a three-factor structure consisting of 7 items with factor loadings ranging from 0.612 to 0.851 and explaining 78.63% of the total variance (Table 2). Subsequently, CFA was conducted (Figure 1). Looking at the goodness of fit indices of DVL, RMSEA was 0.072 and $\chi2/df$ was 3.271, indicating that the model showed an acceptable fit. Other fit indices according to CFA results were as follows: AGFI: 0.865, GFI = 0.874, NFI = 0.875, CFI = 0.912, TLI = 0.889, and IFI = 0.876 (Table 3). No high values were observed among items within the same factors. Therefore, it was not necessary to introduce a covariance link between the items or to repeat the CFA.

Table 2: Factors and Factor Loadings of the DVL

Items	Factors			Eigenvalues	% of variance	% Cumalative
	F1	F2	F3			
m1	0.852			2.758	39.39	39.39
m2	0.710					
m3		0.825		1.513	21.61	61.01
m4		0.795				
m5			0.811	1.234	17.62	78.63
m6			0.743			
m7			0.612			

F1: Understanding and trust official information, F2: Understanding and trust information in social media; F3: Appraisal of vaccine information online in terms of evaluation of the information and its application for decision making.

Table 3: Fit Index of the DVL

Fit Index	Excellent Fit	Acceptable Fit	DVL
/df	$0 \leq \chi^2/df \leq 3$	$3 \leq \chi^2/df \leq 5$	3,271
RMSEA	0,00 0,05	0,05	0,072
SRMR	0,00 0,05	0,05	0,056
CFI	0,95 ≤ CFI	0,85 ≤ CFI	0,912
GFI	0,90 ≤ GFI	0,85 ≤ GFI	0,874
AGFI	0,90 ≤ AGFI	0,85 ≤ AGFI	0,865
IFI	0,90 1,00	0,80	0,876
TLI	0,90 ≤ TLI	0,80 ≤ TLI	0,889
NFI	0,90 ≤ NFI	0,80 ≤ NFI	0,875

Reliability Analysis of the DVL

The item-total correlation values were examined, and it was determined that there were no items below 0.30. When each sub-dimension was evaluated within itself, it was found that the item-total correlation coefficients of the "F1 (understanding and trust official information)" sub-dimension of the scale were between 0.450-0.475, the item-total correlation coefficients of the "F2 (understanding and trust information in social media)" sub-dimension were between 0.511-0.566, and the item-total correlation coefficients of the "F3 (appraisal of vaccine information online in terms of evaluation of the information and its application for decision making)" sub-dimension were between 0.357-0.443. All items on the scale exhibited item-total correlations ranging from 0.357 to 0.566, surpassing the threshold. For the Turkish version of DVL, the Cronbach's alpha value for F1 sub-dimension was 0.791, for F2 sub-dimension was 0.891, for F3 sub-dimension was 0.781, and the total Cronbach's alpha value for the DVL scale was calculated as 0.730 (Table 4).

Table 4: Reliability Values of the DVL

Scale	Number of items	Item-total correlation	$\bar{X} \pm SD$	Skewness Kurtosis	Cronbach's alpha
DVL	7	0.357 - 0.566	2.81 ± 0.42	,031 / ,075	0.730
F1	2	0.450 – 0.475	2.18 ± 0.70	-,074 / -,691	0.791
F2	2	0.511 – 0.566	3.03 ± 0.69	-,643 / ,951	0.891
F3	3	0.357 – 0.443	3.08 ± 0.45	-,416 / -,129	0.781

F1: Understanding and trust official information, F2: Understanding and trust information in social media; F3: Appraisal of vaccine information online in terms of evaluation of the information and its application for decision making.

The response bias of DVL was analyzed with Hotelling's T-squared test. As a result of this test, it was determined that there was no response bias in the scales with an F statistic of 117.125 (Hotelling $T^2 = 718.027$; $p < 0.001$). In addition, Tukey's test of additivity was conducted to obtain a total score from the scale. The results showed that the scale was summable and the traits measured showed sufficient diversity ($p < 0.001$). When the AVE of the measurement model was evaluated, it was found that F1 was 0.615, F2 was 0.656, and F3 was 0.528, and when the CR was evaluated, it was found that F1 was 0.760, F2 was 0.792, and F3 was 0.768. Finally, a re-test was administered to 50 individuals after 15 days. Upon retesting the questionnaires, the test-retest reliability for the scale exceeded 0.70. A very strong, positive, and statistically significant correlation ($r=0.962$, $p<0.001$) was observed between the two measurements, indicating time invariance for the scale.

Discussion

This study aimed to assess the validity and reliability of the Turkish version of the DVL. This study included 236 participants from various professions, including healthcare personnel, academic personnel, administrative personnel, and technical and support services personnel. The results of the study showed that the Turkish version of the DVL has good validity and reliability.

The content validity of a measurement tool should be verified to ensure that it is indeed a true reflection of the concept that was targeted for measurement. Validity of the content was ensured by using the experts who were consulted to make an assessment for the Turkish version of the scale. The CVI of all items in the scale was greater than 0.80, showing that the scale items were comprehensible and the scale had adequate content validity (21). Before conducting the EFA and CFA, the suitability of the sample for factor analysis was checked via the KMO coefficient and Bartlett's sphericity test. The range of KMO values falls between 0 and 1, and KMO values ≥.50 are deemed as appropriate (22). The analysis results indicate that the KMO measure is 0.637 and Bartlett's test of sphericity is significant, which confirms the suitability of the sample for factor analysis.

The findings of EFA suggest that the factor structure of the Turkish version of the DVL aligns with that of the original version. The analysis revealed 3 dimensions comprising seven items, with factor loadings ranging from 0.612 to 0.852. Factor loading values greater than 0.30 indicate the considerable influence of the scale items on the overall construct (23). It is particularly the case with multi-dimensional scales that the explanation of more than 40% of the variance is taken as a good performance. A larger explained variance indicates a higher construct validity (24). In our study, the variance explained was more than

50% and reached the value of 78.63% which signified strong construct validity. The goodness-of-fit index results obtained from CFA show an acceptable fit for the Turkish version of the DVL (25).

The item-total correlation coefficients for the scale items range from .362 to .648, all indicating positive correlations. With values above 0.30 and being positive, these correlations suggest that the items in the instrument exhibit consistent behaviours and contribute to the scale's acceptable internal consistency (26). Hence, all items measure DVL in the same direction and are linked to the total score. Cronbach's alpha coefficient was found to be 0.791 for F1, 0.891 for F2, 781 for F3, and 0.730 for the overall score. The fact that Cronbach's alpha coefficient was above 0.70 for both the subscale and the overall score indicates that the scale has satisfactory reliability (27). In addition, regarding the test-retest method, a 15–21 day interval is typically recommended between administration (28). A correlation coefficient (r) of at least 0.70 is desirable for test-retest reliability, with higher values indicating increased reliability (29). In our study, the test-retest reliability coefficient correlation of 0.962 showed that the internal consistency reliability of the scale was at an acceptable level.

In our study, we also utilized the Hotelling T^2 test to identify a response bias. For there to be no response bias, the statistical result obtained from the test must be significant (30). The results showed that the scale had no response bias, and the responses' distribution was homogeneous (Hotelling $T^2 = 718.027$, $p < 0.001$). The Tukey Additivity test which is used to verify whether the two-factor interactions are additive has been conducted and revealed that the factors are indeed additive ($p < 0.05$).

Finally, when the AVE of the measurement model was evaluated, it was found to be 0.615, 0.656, and 0.528 for F1, F2, and F3, respectively, and 0.760, 0.792, and 0.768 for CR. Our results show that the AVE value is above the threshold value of 0.50 and the CR value is above the threshold value of 0.70 (25). Consequently, when all reliability and validity criteria are evaluated, it can be said that the Turkish version of DVL is a valid and reliable scale.

Limitation

The main limitation of the study is that EFA and CFA were conducted on the same sample. In addition, the generalizability of the findings to other populations is limited since the study was conducted on staff working in a foundation university hospital. To improve the development of the scale, future research should verify its validity and reliability with a larger sample size.

Conclusions

This study revealed that the Turkish version of the DVL is a valid and reliable instrument for assessing digital vaccine literacy. Factor analysis results show that the Turkish version has a factor structure consistent with the original version. Moreover, the internal consistency and test-retest reliability of the scale support the reliability of its use. The use of the Turkish version of the DVL may allow healthcare providers and public health professionals in Turkey to develop more effective strategies to identify and improve the level of digital vaccine literacy in the community. In this context, the use of the scale could be an important step towards the protection and promotion of public health, as well as an important contribution towards achieving social equity in digital health communication and access to information.

Declarations

Funding

This study had no external funding.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Ethics Approval

Approval was secured via email from the creators of the scale to conduct a validity and reliability study in Turkish. Following this, ethical clearance was obtained from the Bezmialem Vakıf University Ethics Committee (dated March 22, 2023, reference number 101249), and permission to conduct the study was granted by the hospital where the research was conducted (dated March 1, 2023, reference number 98706). Participants were informed about the study, and both written and verbal consent were obtained.

Availability of Data and Material

Data are available upon request from the corresponding author.

Authors' Contributions

ADK: Conceptualization, Methodology, Data curation, Formal Analysis, Investigation, Resources, Software, Validation, Visualization, Writing – original draft, Writing – review & editing. **ÖE:** Conceptualization, Methodology, Project administration, Supervision, Writing - Original Draft, Writing – review & editing.

References

1. Fan J, Toth I, Stephenson RJ. Recent Scientific Advancements towards a Vaccine against Group A *Streptococcus*. *Vaccines (Basel)*. 2024;12(3):272. https://doi.org/10.3390/vaccines12030272.
2. Zasada AA, Darlińska A, Wiatrzyk A, et al. COVID-19 Vaccines over Three Years after the Outbreak of the COVID-19 Epidemic. *Viruses*. 2023;15(9):1786. https://doi.org/10.3390/v15091786.
3. Goel RK, Nelson MA. COVID-19 internet vaccination information and vaccine administration: evidence from the United States. Journal of Economics and Finance. 2021;45(4):716-734. https://doi.org/10.1007/s12197-021-09551-x.
4. Loomba S, De Figueiredo A, Piatek SJ, De Graaf K, Larson HJ. Measuring the impact of COVID-19 vaccine misinformation on vaccination intent in the UK and USA. Nature Human Behaviour. 2021;5(3):337-348. https://doi.org/10.1038/s41562-021-01056-1.
5. MacDonald NE. Vaccine hesitancy: Definition, scope and determinants. Vaccine. 2015;33(34):4161-4164. https://doi.org/10.1016/j.vaccine.2015.04.036.
6. Machingaidze S, Wiysonge CS. Understanding COVID-19 vaccine hesitancy. Nature Medicine. 2021;27(8):1338-1339. https://doi.org/10.1038/s41591-021-01459-7.
7. Fitzpatrick M. The Cutter Incident: How America's First Polio Vaccine Led to a Growing Vaccine Crisis. J R Soc Med. 2006;99(3):156.
8. Halstead SB. Dengvaxia sensitizes seronegatives to vaccine enhanced disease regardless of age. Vaccine. 2017;35(47):6355-6358. https://doi.org/10.1016/j.vaccine.2017.09.089.
9. Elkalmi RM, Dyab E, Mohd Suhaimi A, et al. Attitude, Familiarity and Religious Beliefs about Vaccination among Health Science and Non-Health Science Students in a Malaysian Public University. Eur J Investig Health Psychol Educ. 2021;11(4):1462-1473. https://doi.org/10.3390/ejihpe11040104.
10. Betsch C, Schmid P, Heinemeier D, Korn L, Holtmann C, Böhm R. Beyond confidence: Development of a measure assessing the 5C psychological antecedents of vaccination. PloS One. 2018;13(12):e0208601. https://doi.org/10.1371/journal.pone.0208601.
11. Smith BR, Magnani JW. New technologies, new disparities: The intersection of electronic health and digital health literacy. International Journal of Cardiology. 2019;292:280-282. https://doi.org/10.1016/j.ijcard.2019.05.066.
12. Berkman ND, Davis TC, McCormack L. Health literacy: what is it?. J Health Commun. 2010;15 Suppl 2:9-19. https://doi.org/10.1080/10810730.2010.499985.
13. Gusar I, Konjevoda S, Babić G, et al. Pre-Vaccination COVID-19 Vaccine Literacy in a Croatian Adult population: A Cross-Sectional Study. International Journal of Environmental Research and Public Health/International Journal of Environmental Research and Public Health. 2021;18(13):7073. https://doi.org/10.3390/ijerph18137073.
14. Biasio LR, Giambi C, Fadda G, Lorini C, Bonaccorsi G, D'Ancona F. Validation of an Italian tool to assess vaccine literacy in adulthood vaccination: a pilot study. Ann Ig. 2020;32(3):205-222. https://doi.org/10.7416/ai.2020.2344.
15. Polit, D. F., Beck, C. T., & Owen, S. V. (2007). Is the CVI an acceptable indicator of content validity? Appraisal and recommendations. *Research in Nursing & Health*, *30*(4), 459–467. https://doi.org/10.1002/nur.20199.
16. Gorsuch, R. L. (2014). *Factor Analysis*. Routledge. https://doi.org/10.4324/9781315735740.
17. Doğan N, Soysal S, Karaman H. Aynı örnekleme açımlayıcı ve doğrulayıcı faktör analizi uygulanabilir mi? In: Demirel Ö, Dinçer S, eds. Küreselleşen Dünyada Eğitim. Pegem Akademi; 2017:373-400. https://doi.org/10.14527/9786053188407.25.
18. Montagni I, Pouymayou A, Pereira E, et al. Measuring Digital Vaccine Literacy: Development and Psychometric Assessment of the Digital Vaccine Literacy Scale. J Med Internet Res. 2022;24(12):e39220. Published 2022 Dec 14. https://doi.org/10.2196/39220.
19. Ponnam, A., Sahoo, D., Sarkar, A., & Mohapatra, S. N. (2014). An exploratory study of factors affecting credit card brand and category selection in India. *Journal of Financial Services Marketing*, *19*(3), 221–233. https://doi.org/10.1057/fsm.2014.17.
20. Hair, J., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate data analysis: a global perspective* (7th ed.). Pearson Education.
21. Can, A. (2014). SPSS Ile Bilimsel araştırma sürecinde nicel veri analizi. Pegem Akademi.
22. Watkins MW. Exploratory Factor Analysis: A Guide to Best Practice. *Journal of Black Psychology*. 2018;44(3):219-246. https://doi.org/10.1177/0095798418771807.
23. Finch HW. Exploratory Factor Analysis. SAGE Publications; 2019
24. Boateng GO, Neilands TB, Frongillo EA, Melgar-Quiñonez HR, Young SL. Best Practices for Developing and Validating Scales for Health, Social, and Behavioral Research: A Primer. *Front Public Health*. 2018;6. https://doi.org/10.3389/fpubh.2018.00149.
25. Kriston, L., Günzler, C., Harms, A., & Berner, M. (2008). Confirmatory Factor Analysis of the German Version of the International Index of Erectile Function (IIEF): A Comparison of Four Models. The Journal of Sexual Medicine, 5(1), 92–99. https://doi.org/10.1111/j.1743-6109.2007.00474.x.
26. Cristobal, E., Flavián, C., & Guinalíu, M. (2007). Perceived e-service quality (PeSQ): Measurement validation and effects on consumer satisfaction and web site loyalty. Managing Service Quality: An International Journal, 17(3), 317–340. https://doi.org/10.1108/09604520710744326.
27. Taber, K. S. (2018). The use of cronbach's alpha when developing and reporting research instruments in science education. *Research in Science Education*, *48*(6), 1273–1296. https://doi.org/10.1007/s11165-016-9602-2.
28. Wyse, A. E. (2020). How days between tests impacts alternate forms reliability in computerized adaptive tests. Educational and Psychological Measurement, 81(4), 001316442097965. https://doi.org/10.1177/0013164420979656.
29. Ratner, B. (2009). The correlation coefficient: Its values range between +1/−1, or do they? Journal of Targeting, Measurement and Analysis for Marketing, 17(2), 139–142. https://doi.org/10.1057/jt.2009.5.
30. Rattray J, Jones MC. Essential elements of questionnaire design and development. *J Clin Nurs*. 2007;16(2):234-243. https://doi.org/10.1111/j.1365-2702.2006.01573.x.