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Determining the Psychometric Properties of the Turkish Version of the Nurses' Alarm Fatigue Questionnaire

Hemşirelerin Alarm Yorgunluğu Ölçeği'nin Türkçe Psikometrik Özelliklerinin Belirlenmesi

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ABSTRACT

Objective: This study was conducted to examine the psychometric properties of the Nurses' Alarm Fatigue Questionnaire.

Materials and Methods: In this methodological study, the sample consisted of 142 nurses working in neonatal and pediatric intensive care. In order to test the psychometric properties of the scale, language equivalence, content and construct validity were used for validity analysis. The data were evaluated using descriptive and confirmative factor analyses, Cronbach's alpha, split-half, and item-total score correlation.

Results: The total explained variance of the Turkish version of the Nurses' Alarm Fatigue Questionnaire consisting of a single sub-dimension and nine items was determined as 41%. The total factor loading was >0.30. In the confirmatory factor analysis, all the goodness of fit indexes were >0.90, and the root mean square error of approximation (RMSEA) was <0.08. The correlation between the two halves was 0.71, and the Guttman split-half and Spearman-Brown coefficients were 0.83. The Cronbach's alpha coefficient for the scale was found to be 0.80.

Conclusion: The study's findings suggest that the scale is a valid and reliable tool in determining the alarm fatigue of nurses working in newborn and pediatric intensive care units in Türkiye.

Keywords: Alarm fatigue, nurses, reliability, validity

ÖZ

Amaç: Bu çalışma Hemşirelerin Alarm Yorgunluğu Ölçeği'nin psikometrik özelliklerini incelemek amacıyla yapılmıştır.

Materyal ve Metot: Metodolojik çalışmanın örneklemini yenidoğan ve çocuk yoğun bakımlarında çalışan toplam 142 hemşire oluşturmuştur. Ölçeğin psikometrik özelliklerinin geçerlik analizinde dil eşdeğerliği, içerik ve yapı geçerliliği kullanılmıştır. Veriler açımlayıcı ve doğrulayıcı faktör analizleri, Cronbach alfa katsayısı, iki yarı tekniği ve madde-toplam korelasyonu kullanılarak değerlendirilmiştir.

Bulgular: Bir alt boyut ve dokuz maddeden oluşan Hemşirelerin Alarm Yorgunluğu Ölçeği'nin Türkçe formunun açıklanan toplam varyansı %41 olarak belirlenmiştir. Toplam faktör yükü >0,30'dur. Doğrulayıcı faktör analizinde, tüm model uyum indeksleri >0,90 ve yaklaşık hataların ortalama karekökü (RMSEA) <0,08'dir. İki yarı arasındaki korelasyon 0,71, Guttman ve Spearman-Brown katsayıları 0,83'tür. Cronbach alfa değeri 0,80 olarak bulunmuştur.

Sonuç: Araştırmanın bulguları, ölçeğin Türkiye'de yenidoğan ve çocuk yoğun bakım ünitelerinde çalışan hemşirelerin alarm yorgunluğunu belirlemede geçerli ve güvenilir bir araç olduğunu göstermektedir.

Anahtar Kelimeler: Alarm yorgunluğu, geçerlik, güvenirlik, hemşire

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INTRODUCTION

Alarm fatigue is caused by the high frequency of alarms and actual sound, as well as an excess of out-of-process and false alarm signals generated by machinery in a patient care unit.[1] Alarm response accounts for 35% of nurses' work time in an intensive care unit (ICU).[2]

Alarm fatigue is a cognitive stress control technique that results in solutions such as disabling alarms, muting the alarm too low, delaying the response to alarms, or setting device parameters to unsafe values.[3,4] While alarms are important and sometimes life-saving, they can endanger patients' safety if ignored.[5] When so many alarms are generated, it is difficult to know which alarms are important or vital to the patient's health.[6] The majority of clinically nonactionable alarms raised overload clinicians and the care delivery system, resulting in missed instability and threatening patient safety (Hravnak, Johnson). Also, it leads to a decrease in productivity and has a detrimental impact on nurses' concentration.[7] According to the U.S. Food and Drug Administration's (FDA) Manufacturer and User Facility Device Experience (MAUDE) database, between 2005 and 2010, 566 alarm-related patient deaths were documented.[8] Moreover, alarm, alert, and notification overload have been identified as the sixth health technology risk for 2020 by the Emergency Care Research Institute (ECRI).[9]

Being aware of the effect of alarm fatigue on nurses and patients, nurses are an important health discipline that can plan strategies to reduce alarm hazards, especially regarding patient safety. For this reason, it is important to identify and inform nurses about their impact on this issue. A measurement tool was needed to measure alarm fatigue for nurses to take the necessary precautions to provide care in a quality environment and for patient and nurse safety. In particular, it is useful to determine alarm fatigue in nurses working in newborn and pediatric ICUs with different physiological structures and needs. Therefore, this study aims to perform the Turkish validity and reliability study of the Nurses' Alarm Fatigue Questionnaire.

MATERIALS AND METHODS

***Ethical Considerations*:** The study was carried out by the Helsinki declaration. Ethics committee approval Pamukkale University Non-Invasive Research Ethics Committee (Date: 06/09/2018, decision no: 17), and written consent was obtained.

***Setting and Sample*:** This methodological cross-sectional study involved nurses who worked in neonatal and pediatric intensive care units. The population of the study consisted of nurses working in the pediatric intensive care unit and neonatal intensive care unit in two hospitals in İzmir. In determining the sample of the study, it is recommended to take 5-10 times the scale items.[10] It was aimed to reach 130 nurses who are 10 times of the scale items. The study's sample included 142 nurses, with the addition of 10% for losses.

***Data Collection*:** The study was carried out with the survey method. Data were collected through face-to-face interviews. The sociodemographic form and Nurses' Alarm Fatigue Questionnaire were used for data collection. The original questionnaire was developed by Torabizadeh et al.[7] consists of 13 items. The scale's items are assessed on a 5-point Likert scale, with 0 indicating "Never" and 4 indicating "Always". The scale has no subscales, and items 1 and 4 are reverse-scored. The scale has a minimum of 8 points and a maximum of 44 points. Alarm fatigue, which impacts nurses' performance, is indicated by a high score on the scale.

***Language Equivalence*:** Two academics with advanced levels of English, a linguist, and an educator who lives abroad and speaks English as a native language independently translated the scale from English to Turkish for the language validity of the scale. The researchers examined all of the translations and combined them into a single document, and subsequently, the Turkish version of the questionnaire was translated back from Turkish to English.

The Content Validity: The Turkish version of the questionnaire was sent to 13 experts (seven nurse academicians, six PICU and NICU specialist physicians and nurses). CVR values are calculated using the formula: CVR= (Ne/ N-2) / (N/2). "Ne" in the formula indicates the number of experts who selected the appropriate option, "N" indicates the number of experts who participated in the study. The content validity ratio (CVR) value should be at least 0.54; values below this value should be excluded from the study.[11] The CVR of the 13-item scale was found to be 0.57. Items 1, 4, 5 and 9 with a CVR value less than 0.54 were excluded from the scale.

The Construct Validity: Confirmatory factor analyses (CFA) and explanatory factor analysis (EFA) using principal component analysis were performed. In the principal component analysis, components with an eigenvalue in excess of 1 were evaluated.

***Statistical Analysis*:** Means, standard deviations, numbers, and percentages were used to evaluate the descriptive data. The validity analyses were conducted using language equivalency, content validity, and construct validity. Quantitative content validity was assessed based on Lawshe's content validity ratio (CVR).

The measure's construct validity was determined using exploratory factor analyses (EFA) and confirmatory factor analyses (CFA). Using principal com-

ponent analysis, EFA was used to determine the relationship between the item and the factor. Prior to performing the EFA, the Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of sphericity were used to assess whether the data were adequate for factor analysis. CFA was employed to determine whether the factor structure of an original version of a scale was consistent with its modified form. Model fit indices were used to assess model fit: $\chi 2/df$ where less than 3 is a good fit, root mean square error of approximation (RMSEA) values of 0.05 and less designate a good fit while between 0.05 and 0.08 is adequate to fit, Normed fit index (NFI), Non-normed fit index (NNFI) and Comparative fit index (CFI) where a value of ≥0.95 is considered a good fit, Goodness-of-fit index (GFI) and Adjusted Goodness of Fit Index (AGFI) where a value of ≥0.90 is regarded as a good fit.

The item-to-total correlation (Pearson correlation), and Cronbach's alpha coefficient were calculated, and the split-half technique (Spearman-Brown and Guttman split-half values) was used to evaluate the internal consistency and reliability of the questionnaire. The CFA was performed using LISREL 8.8, and the remaining analyses were performed using the IBM SPSS (version 21.0).

RESULTS

Among the nurses who participated in the study, 91.5% were female, 41.5% were between 25 to 30 years old, 51.6% (n = 94) were married, and 55.6% had a bachelor's degree. In addition, 31.0% of the participants have been working in nursing for 6 to 10 years, 88.0% work on night and day shifts, 44.3% work between 36 and 48 hours per week, 57% work in the neonatal intensive care unit and 50.7% of them worked in intensive care for 0 to 5 years (Table 1).

The calculated KMO was 0.82, and Bartlett's Test of Sphericity was $\chi 2 = 405.969$ ($p<0.001$). In the principal component analysis, components with an eigenvalue in excess of 1 were evaluated. The questionnaire was found to have a structure of 2 factors with eigenvalues in excess of 1: factor 1, with an eigenvalue of 3.69, accounted for 41% of the total variance; factor 2, with an eigenvalue of 1.07, accounted for 11% of the total variance, and this structure of two factors accounted for 53% of the total variance. As a result of the component matrix that was made to determine the items in each factor and their

Table 1. Sociodemographic characteristics.

Characteristics		n (%)
Gender	Female	130 (91.5)
	Male	12 (8.5)
Age (years)	19-24	23 (16.2)
	25-30	59 (41.5)
	31-36	25 (17.6)
	37-40	25 (17.6)
	More than 41	10 (7.1)
Marital status	Married	73 (51.4)
	Single	69 (48.6)
Education	Health Vocational High School	23 (16.2)
	Associate degree	25 (17.6)
	Bachelor's degree	79 (55.6)
	Master's degree	15 (10.6)
Working year	0-1 years	15 (10.5)
	2-5 years	38 (26.8)
	6-10 years	44 (31.0)
	11-20 years	39 (27.5)
	More than 21 years	6 (4.2)
Working shift	Night and day shift	125 (88.0)
	Day shift	11 (7.8)
	Night shift	6 (4.2)
Weekly working hours, (h)	36-45	112 (44.3)
	46-55	20 (39.5)
	56-65	16 (11.3)
	More than 66	7 (4.9)
Unit	Pediatric Intensive Care Unit	61 (43)
	Neonatal Intensive Care Unit	81 (57)
Working years in ICU	0-5 years	72 (50.7)
	6-10 years	52 (36.6)
	More than 10 years	18 (12.7)

factor loads, it was found that the items were loaded on a single factor. The scale was evaluated on a single dimension with an eigenvalue of 3.69 and accounted for 41% of the total variance. The factor loads of the scale items in this study ranged from 0.36 to 0.87 (Table 2).

Following the CFA, the goodness-of-fit indexes of the one-factor model were good; nonetheless, the model suggested a modification between items 7 and 13. The inter-item modification indices were reassessed after the CFA, and a PATH diagram was drawn by establishing covariance between the 7th and 13th items. Figure 1 illustrates the modified PATH diagram.

Table 2. Principal factors of Nurses' Alarm Fatigue Questionnaire Items (N = 142).

	Factor Loads
Item number	**Factor 1**
Item 11	0.87
Item 8	0.81
Item 12	0.81
Item 6	0.64
Item 3	0.60
Item 13	0.50
Item 7	0.48
Item 10	0.45
Item 2	0.36
Percentage of variance explained (%)	41
Eigenvalue	3.69
Kaiser–Meyer–Olkin	0.82
Bartlett $\chi 2$, p	405.969, p = 0.000

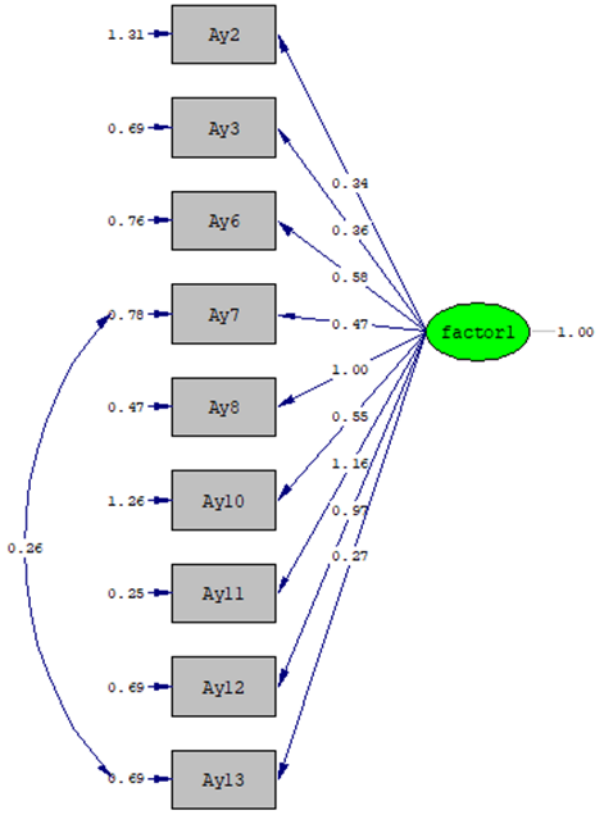

Figure 1. Modified PATH diagram.

Following the modification, better goodness of fit values were obtained. Before and after modification, the goodness of fit indexes was given in Table 3.
The Cronbach's alpha value was found to be 0.80. The total item correlation of all scale items was between 0.27 and 0.77. The correlation between the two halves was 0.71, the Guttman split-half and Spearman-Brown coefficients were 0.83, and the average score was 14.97 ± 6.35 (Table 4).

Table 3. CFA goodness of fit indexes.

Model	χ2/sd	RMSEA	NFI	NNFI	CFI	GFI	AGFI
Before modification	1.66	0.06	0.92	0.96	0.97	0.93	0.89
After modification	1.11	0.02	0.95	0.99	1.00	0.96	0.92

RMSEA: Root mean square error of approximation; NFI: Normed fit index; NNFI: Nonnormed fit index; CFI: Comparative fit index; GFI: Goodness of fit index; AGFI: Adjusted goodness of fit index.

Table 4. Results of scale reliability.

	Cronbach's α	Spearman's Brown	Guttman split-half	Correlation between two halves	M ± SD (Min-Max)
Total scale	0.80	0.83	0.83	0.71	14.97 ± 6.35 (2-32)

DISCUSSION AND CONCLUSION

The complexity of setting the alarms, limited training and false alarms may have serious consequences for both patients and nurses.[12] Alerts and alarms impact clinical care, as alerts and alarms by design interrupt clinical workflow.[13] Nurses and health professionals feel overburdened with an excessive amount of duties and a continuous wave of alarms. Intensive care nurses cannot spare enough time for the care of patients due to burdensome and frequent alarms, and their trust in alarm systems decreases.[1] As the false alarm rate increased, the response rate of nurses to these alarms decreased.[14] One study revealed that more than 50% of alarms were irrelevant.[15] Also, alarm fatigue has an impact on nurses' social life, sleep, intolerance to sounds and level of social activities in their personal life.[16] These situations endanger patient safety. To ensure patient safety, intensive care nurses must stay current with technological advancements through alarm-specific training.[12]
The content validity of the scale was evaluated by thirteen experts, and CVR was used to evaluate the expert opinions. The CVR value must be at least 0.54, and values below this should be excluded from the study.[11] Items 1, 4, 5 and 9 with a CVR value less than 0.54 were excluded from the scale. The Turkish version had nine items in total after four items were removed. In the current study, the results of CVR showed that the content validity was ensured.
EFA and CFA analyses were used to assess the construct validity of the Turkish version of the Nurses' Alarm Fatigue Questionnaire. KMO and Bartlett's test of sphericity were used to assess whether the data were appropriate and sufficient for factor analysis.[10] In the literature, the calculated KMO must be 0.60 or higher proceeding with factor analysis and Bartlett's test of sphericity value should be statistically significant.[11,17,18] In this study, the KMO coefficient was >60 and Bartlett's test χ2 value <0.05. Our results showed that the sample was suitable for factor analysis. This study's sampling size and data sets were similar to those of the original[7] and Chinese[19] versions.
Kaiser Criterion, the most commonly used eigenvalue criteria, states that factors should be retained if their eigenvalues are greater than or equal to one, was used for extracting the factors.[20] As a result of the component matrix that was made to determine the items in each factor and their factor loads, it was found that the items were loaded on a single factor. When evaluating a scale in a single dimension; a) Eigenvalue of the first factor should be 3 times greater than the eigenvalue of the second factor. Although the scale appeared to be 2-dimensional, it was evaluated in a single factor because the eigenvalue (3.69) of the first factor was 3.45 times greater than the eigenvalue (1.07) of the second. b) The variance explained by the first factor is remarkable. c) The

variances described in single-factor scales must be 30% or more, and those described in multifactor scales must be greater.[21] The scale was evaluated on a single dimension and accounted for 41% of the total variance can be interpreted as an indication that the scale adequately measures nurses' alarm fatigue. In the Chinese version, after four common factors were extracted by exploratory factor analysis, the cumulative variance contribution rate was 59.568%.[19]

As a result of the EFA, the factor loads of the scale items in this study ranged from 0.36 to 0.87. According to the literature, the minimum factor load should be 0.30 and above, and items below 0.30 should be removed from the scale.[17,21] In this study, the factor loads were >0.30. The factor loadings ranged from 0.43 to 0.99 in the original study,[7] and 0.49 to 0.80 in the Chinese version.[19] In this study, since the factor loads of all items were greater than 0.30 the scale had valid and strong construct validity for the Turkish sample.

The literature suggests performing CFA, which aims to explore how well a predefined theoretical model "fits" the collected data.[22] Goodness of fit indexes were used to evaluate the model's goodness of fit. The RMSEA values of 0.05 and less designate a good fit, while between 0.05 and 0.08 is an adequate fit. The NFI, NNFI and CFI scores of more than 0.95 indicate good- fitting, whereas a score of more than 0.90 and 0.95, respectively, indicates acceptable-fitting. GFI and ANGFI scores of more than 0.90 indicate good-fitting, whereas a score of more than 0.85 indicates acceptable-fitting.[23,24] When the value derived from the ratio of the $\chi 2$ value to the degree of freedom (df) is less than three, good fit is suggested, and when the value is less than five, a satisfactory fit is indicated.[25] In this study, it was determined that the $\chi 2$/df value was less than three, the RMSEA was < 0.08, the NFI, NNFI, and CFI indices were >0.95, and the GFI and AGFI indices were >0.90. All of the goodness of fit indices indicated good concordance in this study. Our CFA results were consistent with the criteria stated in the literature. Both in the original[7] and adaptation studies,[15,19] the results could not be compared since the analysis of CFA could not be carried out. The results of the CFA indicate that the data were consistent with the model and confirmed the one-factor structure. Supporting the scale's construct validity, the results of the EFA and CFA in the current study suggest that a scale is a valid tool.

An important and widely used measure for assessing the internal consistency of a set of items is Cronbach's coefficient. Values for Cronbach's alpha should range between 0 and 1, with higher values indicating greater reliability among the items in the set.[20] The Cronbach's alpha value was found to be 0.80. The original scale's Cronbach's alpha value was found to be 0.91.[7] In the Chinese version, it was reported as 0.77,[19] and in the Arabic version, it was 0.91.[15] Item-total score correlation, Guttman split-half and Spearman-Brown coefficients are another analyzes to determine internal consistency. It is recommended that items with a correlation coefficient should be over 0.20.[10] Total item correlation of all scale items was between 0.27 and 0.77. The Guttman split-half and Spearman-Brown coefficients were 0.83. In the original study of the scale, they were 0.79 and 0.99, respectively[7] and, in the Chinese study split-half coefficient was 0.79.[19]

In conclusion, in this study, it was found that the Turkish version of the Nurses' Alarm Fatigue Questionnaire had sufficient validity and reliability. It can be said that the scale has sufficient psychometric properties to evaluate the alarm fatigue of nurses in newborn and pediatric intensive care units in our country. It is recommended that this scale be used in programs to be planned to examine the factors affecting alarm fatigue, to conduct studies with large samples, and to reduce the problems associated with alarm fatigue. In another study, the validity and reliability of the alarm fatigue scale were found to be sufficient.[26]

Ethics Committee Approval: Our study was approved by the Pamukkale University Non-Interventional Clinical Research Ethics Committee (Date: 06/09/2018, decision no: 17). The study was carried out by the Helsinki declaration.

Conflict of Interest: No conflict of interest was declared by the authors.

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