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Determination of Cut-off Value of the Turkish Vaccine Hesitation Scale for Healthcare Workers

Sağlık Çalışanları İçin Türk Aşı Tereddüt Ölçeği Kesme Değerinin Belirlenmesi

Mehmet Göktuğ KILINÇARSLAN[1], Cihan COŞKUNTUNCEL[1], Erkan Melih ŞAHİN[1]

Abstract

Introduction: Physician advice is the most crucial factor in accepting vaccines. Therefore, evaluating the vacccine hesitancy of healthcare workers has gained more significance. This study aimed to determine the cut-off values of the Turkish vaccine hesitancy scale for healthcare workers.

Method: This cross-sectional study was conducted in a tertiary hospital. There were 1281 staff at the hospital and 891 were included in the study. The survey which consisted of vaccine rejection history and the Turkish Vaccine Hesitancy Scale was applied to participants. Precision-recall plot and F1 score were used to determine the cut-off value.

Results:

Of the total 891 participants, 525(58.9%) were female. The mean age was 31.3±8.1 years. The number of participants who have rejected a vaccine at least once in their life was 91(10.2%). The area under the ROC curve was 0.727 (95% CI:0.665-0.790), p<0.001. The threshold point which has the highest F1 score (0.3587) was 44.5.

Conclusion

Healthcare workers who get 45 or higher points from the Turkish Vaccine Hesitancy Scale can be grouped as vaccine-hesitant while others who get lower than 45 points can be grouped as vaccine acceptor.

Keywords: health personnel; vaccine hesitancy; tertiary hospital; ROC analysis

Özet

Giriş: Doktor tavsiyesi, aşıları kabul etmede en önemli faktördür. Bu nedenle sağlık çalışanlarının aşı tereddütlerinin değerlendirilmesi daha da önem kazanmıştır. Bu çalışmada sağlık çalışanları için Türk Aşı Tereddüt Ölçeğinin kesme değerlerinin belirlenmesi amaçlanmıştır.

Yöntem: Bu kesitsel çalışma üçüncü basamak bir hastanede yapılmıştır. Hastanedeki 1281 personelden 891 kişi çalışmaya dahil edildi. Katılımcılara aşı reddi öyküsü ve Türkiye Aşı Tereddüt Ölçeğinden oluşan anket uygulandı. Precision-recall grafiği ve F1 skoru kesme değerini belirlemek için kullanıldı.

Bulgular: Toplam 891 katılımcının 525'i (%58,9) kadındı. Ortalama yaş 31,3±8,1 idi. Hayatında en az bir kez aşıyı reddeden katılımcı sayısı 91(%10,2) oldu. ROC eğrisi altındaki alan 0,727 (%95 GA:0,665-0,790), p<0,001 idi. En yüksek F1 puanına (0,3587) sahip kesme değeri 44,5'tir.

Sonuç: Türkiye aşı tereddüt ölçeğinden 45 ve üzeri puan alanlar aşı çekingen, 45 puanın altında olanlar ise aşı kabul eden olarak gruplandırılabilir.

Anahtar kelimeler: sağlık personeli; aşı kararsızlığı; üçüncü basamak hastane; AİÖ analizi

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[1]Department of Family Medicine, Faculty of Medicine, Canakkale Onsekiz Mart University, Canakkale, Turkey

Address for Correspondence / Yazışma Adresi: Mehmet Göktuğ KILINÇARSLAN, Health Research Hospital of Canakkale Onsekiz Mart University, B Blok Oda:5042, 17100, Merkez, Çanakkale/TURKEY
E-posta: goktugmk@gmail.com Tel: +90 05066108540

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INTRODUCTION

Vaccines generally have been accepted as the most effective public health interventions.[1] Even small declines in vaccination coverage due to vaccine hesitancy may have significant public health and economic consequences.[2]

Vaccine hesitancy is defined as a "delay in acceptance or refusal of vaccines despite availability of vaccination services" by the Strategic Advisory Group of Experts (SAGE).[3] Vaccine hesitancy includes a heterogeneous group that can extend from accepting all vaccines to rejecting all vaccines.[4] To determine people's attitudes in the range from vaccine-hesitant to vaccine-acceptor, the first scale in the Turkish language was developed by Kılınçarslan et al.[5] Turkish Vaccine Hesitancy Scale was developed in 2020 for people older than 18 years old. It has two forms as the long form with 21 items and 4 factors while the short form is with 12 items and 3 factors. Explained variances by the long form and the short form were 57.4% and 65.3%, respectively. Cronbach alpha values for the long form and the short form were 0.905 and 0.855, respectively. But in the literature, there are no cut-off values for the scale to classify people as vaccine-hesitant or vaccine-acceptor.

Low vaccination coverage among healthcare workers may lead to the spread of nosocomial infections and may increase absenteeism.[6,7] Vaccination remains the main element of protection from infectious diseases for healthcare workers , their patients, and healthcare institutions and their colleagues.[8]

It has been shown that physician advice is the most crucial factor in accepting vaccines.[9] So addressing determinants of vaccine hesitancy in healthcare workers may exhibit the great potential to handle vaccine hesitancy in the general population.[10] Therefore evaluating vaccine hesitancy of healthcare workers has gained more attention recently. Vaccine hesitancy levels of healthcare workers must be measured, and they should be classified accurately to lead interventions that would have a better impact. This study aimed to determine the cut-off values of the Turkish Vaccine Hesitancy Scale[5] for the healthcare workers.

METHOD

Setting and Participants

This cross-sectional study was conducted in a tertiary hospital between November and December 2020. All staff who works in the tertiary hospital were selected for the study except those who didn't give consent to participate. There were a total of 1281 staff but only 891 could be reached due to night shifts and rotational working. None of the participants rejected to give consent.

Data Measurement and Variables

A survey was applied to participants which consists of socio-demographic variables, a question of "Have you ever rejected to be vaccinated when suggested?" and the Turkish Scale of Vaccine Hesitancy. Participants had choices of 1. Never suggested, 2. No, 3. Yes, to answer the question of "Have you ever rejected to be vaccinated when suggested?". Healthcare workers who gave the answer "yes" were vaccine rejectors

The long-form of Turkish Vaccine Hesitancy Scale was developed by Kılınçarslan et. al.[5] Turkish Vaccine Hesitancy Scale has 4 factors and 21 questions. Points that can be obtained from the scale vary from 21 to 105. A higher point means higher levels of vaccine hesitancy.

Statistics

Continuous variables are presented as mean ± standard deviation while categoric variables are presented as frequenciThe precision-Recall curve was used to determine the threshold to differentiate people as vaccine-hesitant or vaccine acceptor. Receiver operating characteristics (ROC) plots are generally used to determine the cut-off values for scales, but precision-recall plots are more appropriate to evaluate binary classifiers on imbalanced datasets (few numbers of positives with high number of negatives or vice-versa).[11] F1 score is the harmonic mean of precision and recall and it provides equilibrium between precision and recall. A higher F1 score for the classifier means a better classification performance. In this study, the threshold which has the highest F1 score was determined as the cut-off point for classification of participants into vaccine-hesitant or vaccine-acceptor. Healthcare workers who rejected vaccination against the suggestion of applying were accepted as a positive group for calculation of the F1-score.

Ethics and Consents

This study was approved by the Clinical Research Ethics Committee of ****** ****** **** University by the ID number of 2020-12. Informed consents were obtained from all participants.

RESULTS

Of the total 891 participants, 525(58.9%) were female. The mean age was 31.3±8.1 years. Number of participants who have rejected a vaccine at least once in their life was 91(10.2%). The profession of participants and vaccine rejection rate in each profession were given in Table 1 with detail.

Table 1: *Profession of participants*

Profession	Number	Percent	Frequency (Ever vaccine rejected)	Percentage (Ever vaccine rejected)
Medical staff-academic	72	8.1	5	6.9
Medical residents	173	19.4	13	7.5
Medical students	80	9.0	3	3.8
Nurse/Midwife	175	19.6	22	12.6
Medical technician	54	6.1	18	33.3
Administrative staff	55	6.2	9	16.4
Cleaning staff	146	16.4	4	2.7
Other	136	15.3	17	12.5
Total	**891**	**100**	**91**	**10.2**
Other: psychologist, cafeteria staff, nutritionist, security officer, secretary etc.				

Participants' mean scores on the Turkish Vaccine Hesitancy Scale was 37.8±11.4. Area under the ROC curve was 0.727 (95% CI:0.665-0.790), p<0.001. The threshold points which have highest F1 score (0.3587) was 44.5. The cut-off value as 45 for the Turkish Vaccine Hesitancy Sscale shows 53.8% sensitivity, 26.9% precision, and 83.4% specificity when grouping participants into vaccine-hesitant. Sensitivity, precision, F1 score, and specificity for all cut-off points were given in Table 2.

Table 2: *Sensitivity, precision, F1 score, and specificity for all cut-off points*

Cut-off	Precision	Sensitivity	F1 score	Specificity	Cumulative percent of participants under the cut-off
20	0.102	1	0.1851	0	0
21.5	0.104	1	0.1884	0.016	1.5
22.5	0.103	0.989	0.1866	0.021	2.0
23.5	0.103	0.978	0.1864	0.027	2.7
24.5	0.103	0.967	0.1862	0.037	3.7
25.5	0.102	0.934	0.1839	0.061	6.2
26.5	0.104	0.923	0.1869	0.091	9.0
27.5	0.106	0.912	0.1899	0.124	12.0
28.5	0.110	0.901	0.1961	0.167	16.0
29.5	0.114	0.890	0.2021	0.215	20.4
30.5	0.121	0.868	0.2124	0.280	26.5
31.5	0.129	0.846	0.2239	0.350	33.0
32.5	0.137	0.835	0.2354	0.403	37.8
33.5	0.151	0.813	0.2547	0.479	44.9
34.5	0.154	0.780	0.2572	0.514	48.4
35.5	0.167	0.769	0.2744	0.565	53.1
36.5	0.178	0.747	0.2875	0.609	57.2
37.5	0.191	0.736	0.3033	0.645	60.6
38.5	0.202	0.714	0.3149	0.679	63.9
39.5	0.215	0.703	0.3293	0.707	66.6
40.5	0.216	0.648	0.3240	0.733	69.4
41.5	0.232	0.615	0.3369	0.769	73.0
42.5	0.247	0.582	0.3468	0.797	75.9
43.5	0.255	0.560	0.3504	0.814	77.6
44.5	0.269	0.538	0.3587	0.834	79.6
45.5	0.275	0.505	0.3561	0.849	81.3
46.5	0.273	0.462	0.3432	0.860	82.7
47.5	0.279	0.451	0.3447	0.868	83.5
48.5	0.301	0.440	0.3575	0.884	85.1
49.5	0.303	0.407	0.3474	0.894	86.3

Table 2(continuation): *Sensitivity, precision, F1 score, and specificity for all cut-off points*

50.5	0.307	0.385	0.3416	0.901	87.2
51.5	0.323	0.352	0.3369	0.916	88.9
52.5	0.319	0.330	0.3244	0.920	89.5
53.5	0.337	0.308	0.3218	0.931	90.7
54.5	0.351	0.286	0.3152	0.940	91.7
55.5	0.379	0.275	0.3187	0.949	92.6
56.5	0.381	0.264	0.3119	0.951	92.9
57.5	0.390	0.253	0.3069	0.955	93.4
58.5	0.404	0.253	0.3111	0.958	93.6
59.5	0.415	0.242	0.3057	0.961	94.1
60.5	0.449	0.242	0.3145	0.966	94.5
61.5	0.419	0.198	0.2689	0.969	95.2
62.5	0.368	0.154	0.2171	0.970	95.7
63.5	0.378	0.154	0.2188	0.971	95.8
64.5	0.343	0.132	0.1906	0.971	96.1
65.5	0.364	0.132	0.1937	0.974	96.3
66.5	0.400	0.132	0.1985	0.978	96.6
67.5	0.320	0.088	0.1380	0.979	97.2
68.5	0.348	0.088	0.1405	0.981	97.4
69.5	0.350	0.077	0.1262	0.984	97.8
70.5	0.412	0.077	0.1298	0.988	98.1
71.5	0.375	0.066	0.1122	0.988	98.2
72.5	0.333	0.055	0.0944	0.988	98.3
73.5	0.273	0.033	0.0589	0.990	98.8
74.5	0.300	0.033	0.0595	0.991	98.9
76.5	0.333	0.033	0.0600	0.993	99.0
79.5	0.250	0.022	0.0404	0.993	99.1
82	0.286	0.022	0.0409	0.994	99.2
84	0.333	0.022	0.0413	0.995	99.3
86.5	0.250	0.011	0.0211	0.996	99.6
89	0.333	0.011	0.0213	0.998	99.7
93	0	0	-	0.999	99.9
97	0	0	-	1	100.0

DISCUSSION

The most appropriate cut-off point of the Turkish vaccine hesitancy scale was determined as 44.5 to classify healthcare workers into vaccine-hesitant or vaccine acceptor. Healthcare workers who get 45 or higher points on the Turkish vaccine hesitancy scale can be grouped as vaccine-hesitant while others who get lower than 45 points can be grouped as vaccine acceptor.

Vaccine hesitancy is one of the most important public health problems. Healthcare workers have an incontrovertible role in handling this problem.[10,12] So, attitudes of healthcare workers towards vaccine hesitancy should be evaluated. Unless it can be measured, no one can be aware of there is a problem.[13] To measure the vaccine hesitancy levels of Turkish people, Kılınçarslan et al.[5] developed the first scale of vaccine hesitancy in the Turkish language. In this study, a cut-off value was determined to classify healthcare workers as vaccine-hesitant or vaccine-acceptor. Healthcare workers who get 45 or more on the Turkish Vaccine Hesitancy Scale can be classified as vaccine-hesitant.

While deciding cut-off values, some criteria should be considered. Sensitivity, precision, and specificity are the most important criteria. While deciding the cut-off value, each should be taken into account. Standardized methods such as the F1 score can be used to find the optimum point when determining the cut-off value. F1 score ensures equilibrium between sensitivity and precision. The highest F1 score means the better classification.

In this study, the cut-off value for the Turkish Vaccine Hesitancy Scale was determined as 45 by F1 score. At this threshold, sensitivity of 53.8% sounds low. There were other cut-off points which have higher sensitivity but in return of lower precision or specificity. To obtain higher sensitivity, lower scores should be determined as the cut-off but it means labelling much higher percentage of healthcare workers as vaccine-hesitant. For the cut-off value of 45, only 20.4% of healthcare workers can be classified as vaccine-hesitant while if we decided the cut-off value as 40 (higher sensitivity), this would lead to classifying 33.4% of healthcare workers as vaccine-hesitant (Table 2).

The cut-off level determined in this study probably will be used to decide which group should undergo interventions so classifying at least one third of healthcare workers as vaccine-hesitant would be impractical for interventions. According to both our view and standardized method (F1 score), the cut-off value (45) has best equilibrium between sensitivity, precision, and specificity. Moreover, it can give a lead to feasible interventions by classifying optimal amount of healthcare workers as vaccine-hesitant.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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