ARAŞTIRMA MAKALESİ/ORIGINAL RESEARCH

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Comparison of Framingham, SCORE, PROCAM and TEKHARF Risk Scoresfor Prediction of 10 Year Cardiovascular Disease Risk in Patients with Essential Hypertension

Şikayetsiz Hipertansiyon Tanısı Almış Türk Hasta Populasyonunda Framingham, SCORE,PROCAM ve TEKHARF Risk Skorlarının 10-Yıllık Kardiyovasküler Hastalık Riskinin Öngörmedeki Yerlerinin Karşılaştırılması

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ABSTRACT

Introduction: Clinicians use several cardiac risk scoring systems in daily clinical practice. The most powerful cardiac risk scoring system in predicting the 10-year cardiovascular disease (CVD) risk in patients newly diagnosed with essential hypertension in Turkey has not yet been established. We aimed to compare the role of cardiac risk scoring systems to predict the 10-year CVD risk and to identify the most powerful cardiac risk scoring system in predicting CVD in asymptomatic patients withhypertension in the Turkish population.

Methods: A total of one hundred patients who applied to the cardiology outpatient clinic with essential hypertension were included in the study. The 10-year cardiovascular risk probability of the patients was calculated according to four commonly used cardiac risk scoring systems. The 10-year CVD prediction and major adverse cardiovascular events were compared.

Results: After a median follow-up period of 11±0.5 years, CAD developed in 40%,CVD in 52% and all-events in 65% of the patients. The study population was stratified as low-, intermediate- and high-risk according to FRS, SCORE, PROCAM and TEKHARF risk scores. The rate of CAD, CVD and all-events was significantly higher in the high-risk group of the SCORE scale compared to the low risk groups (chi square test, p <0.05). In FRS, the incidence of CVD and all events and in PROCAM, the incidence of all events in the low risk group were found to be high and statistically significant (p <0.05). In the ROC analysis for the prediction of CAD, CVD and all events, AUC for the SCORE scale were significantly higher than that for the other three scales (AUC: 0.774 P: 0.049).

Discussion and Conclusion: In conclusion, this study showed that the SCORE scoring system is the most appropriate scale to be used in predicting cardiovascular disease in the Turkish population compared to FRS, PROCAM and TEKHARF.

Keywords: cardiovascular diseases, score, Framingham risk score, PROCAM, TEKHARF

ÖZ

Giriş ve Amaç: Klinisyenler günlük klinik uygulamada sık kardiyak risk puanlama sistemi kullanmaktadır. Ancak Türk popülasyonundayeni tanılı şikayetsiz hipertansiyon hastalarının 10 yıllık kardiyovasküler hastalık (KVH) riskini öngörmede en güçlü kardiyak risk skorlama sistemi henüz değerlendirilmemiştir. Bu çalışma ile Türk popülasyonunda yeni tanı almış şikayetsiz hipertansiyon hastalarında 10 yıllık KVH riskini öngörmede en sık kullanılan kardiyak risk skorlama sistemlerinin rolünü karşılaştırmayı ve KVH'yi öngörmek için en güçlü kardiyak risk skorlama sistemini belirlemeyi amaçladık.

Yöntem ve Gereçler: Kardiyoloji polikliniğinde yeni tanılı hipertansiyon ile başvuran toplam 100 hasta çalışmaya dahil edildi. Hastaların 10-yıllık KVH olasılığı, yaygın olarak kullanılan dört kardiyak risk skorlama sistemine göre hesaplandı. 10 yıllık KVH tahminive majör advers kardiyovasküler olaylar karşılaştırıldı.

Bulgular: Ortalama 11±0.5 yıllık takipten sonra hastaların %40'ında koroner arter hastalığı (KAH), %52'sinde KVH ve %65'inde tüm olaylar gelişti. Çalışma popülasyonu FRS (Framingham risk skoru), SCORE, PROCAM ve TEKHARF risk skorlarına göre düşük, orta ve yüksek risk olarak sınıflandırıldı. KAH, KVH ve tüm olayların oranı, SCORE ölçeğinin yüksek risk grubunda düşük risk gruplarına göre anlamlı olarak daha yüksekti (ki-kare testi, p <0.05). FRS'de KVH ve tüm olayların insidansı ve PROCAM'da düşük risk grubundaki tüm olayların insidansı yüksekti ve istatistiksel olarak anlamlı bulundu (p<0.05). ROC analizinde, KAH, KVS ve tüm olayların öngörülmesinde, SCORE ölçeği diğer üç ölçeğe göre önemli ölçüde daha yüksekti (AUC: 0.774 P: 0.049).

Tartışma ve Sonuç: CBu çalışmada, FRS, PROCAM ve TEKHARF ile karşılaştırıldığında, SCORE skorlama sisteminin Türk toplumunda şikayetsiz hipertansiyon hastalarında kardiyovasküler hastalıkları tahmin etmede kullanılacak en uygun ölçek olduğu gösterilmiştir.

Anahtar Kelimeler: kardiyovasküler hastalık, score, Framingham risk skoru, PROCAM, TEKHARF

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INTRODUCTION

Cardiovascular disease (CVD) is the most important cause of mortality and morbidity worldwide. Despite the ongoing advances in the treatment of CVD, the mortality and morbidity rate of these diseases remains high (1,2). CVD etiology is multifactorial and many risk factors have been identified (3). The patients may have more than one risk factor, or a single risk factor. For long-term cardiovascular risk assessment, risk scoring systems have been developed by combining cardiovascular risk factors. Long-term estimation of CVD risk and determining the primary prevention and treatment approach in CVD based on this risk increase the importance of risk scores in daily clinical use (4). The Framingham risk scale (FRS), SCORE and PROCAM are the most acknowledged and the most widely used systems for primary prevention in global clinical practice (5). TEKHARF study was a Turkish adult population-based, observational cohort study that was initiated in 1990 to prospectively investigate the epidemiology and the 10year followup risk factors for cardiovascular disease (6). A comparison of CVD risk prediction of the local scoring system and the globally used scoring systems has not been performed to date. While it is important to document the most appropriate risk scale system for the Turkish adult population, it is also a clinically important issue to reveal which scoring system provides the strongest prediction of CAD in addition to the evaluation of CVD. Hypertension (HT) is a very important risk factor for CVD and responsible for 35% of atherosclerotic cardiovascular events (7,8). HT is a common CVD risk factor in the Turkish population and the first step in diagnosis and treatment is to evaluate the patient's total CVD risk (9). It is also important to determine the 10year CVD risk in patients on treatment due to newly diagnosed HT. There are limited studies in the literature regarding the comparison of existing risk scoring systems in a patient group with longterm follow-up (10,11). The aim of this study is to compare the role of the cardiac risk scoring systems to predict cardiovascular disease risk and identify the most powerful cardiac risk scoring system in predicting cardiovascular disease in patients with newly diagnosed hypertension without any end-organ damaged in the Turkish population.

METHODS

Study Population

Between Sultan Abdulhamid Han Training And Research Hospital The 2000-2002, 1256 patients who were newly diagnosed with essential hypertension without any end-organ damaged and started receiving treatment at Hypertension Outpatient Cardiology Clinic were retrospectively screened. Patients with hypertension without cardiovascular disease and diabetes mellitus were included in the study. Patients with risk factor records entered in cardiovascular risk score charts were included. Particularly, patients with records of lipid values, blood glucose, height, weight, waist circumference, smoking status, family history, blood pressure values, personal history, and address and telephone information from 10 years ago were identified. A total of 785 patients who were registered were contacted by phone. After the patients were informed about the study, they were asked about prespecified cardiovascular events upon their consent to participate in the study. Patients with a known diagnosis of CVD, valvular heart disease, patients with cardiomyopathy, renal and hepatic disease, cardiac rhythm other than the sinus rhythm, malignancy, chronic obstructive pulmonary disease (COPD), those previously diagnosed with hyperlipidemia and those who received these diseases medication were excluded from the study. The patient records included in the study were obtained by retrospectively screening the hospital records. A hundred patients were included after assessment by phone or medical records.

Clinical Definitions

All risk factors were based on regularly recorded values 10 years ago. Age, weight, height, waist circumference, smoking status, family history, hypertension (HT) and diabetes mellitus (DM) were screened and recorded.

Endpoints were determined as coronary artery disease (CAD), cardiovascular disease (CVD) and allevents. CAD was defined as fatal and non-fatal myocardial infarction (MI), newonset angina, CABG (Coronary Artery Bypass Graft) and PTCA (Percutaneous Transcoronary Angioplasty). CVD was defined as fatal and non-fatal myocardial infarction, newonset angina, CABG and PTCA, fatal and non-fatal cerebrovascular accident (CVA), sudden death, and heart failure. Allevents were defined as fatal and non-fatal myocardial infarction, newonset angina, CABG, PTCA, fatal and non-fatal CVA and sudden death, peripheral artery disease, heart failure, DM and renal failure. These three endpoints were determined to cover the endpoints of the four cardiac risk scoring systems.

Smoking status: Those who were still smokers and those who had quitted smoking for less than 10 years were considered smokers. Those who never smoked and had quitted for more than 10 years were included in the non-smoking group.

Family history: Family history was evaluated as positive in the presence of cardiovascular disease in first-degree male relatives under 55 years of age or in first-degree female relatives under 65 years of age.

Hypertension: Hypertensive cases diagnosed ten years ago and those receiving antihypertensive treatment were evaluated in this group. Blood pressure values were recorded as systolic and diastolic blood pressure.

The most acknowledged and most widely used scores across the globe, i.e. the Framingham Risk score (FRS), SCORE Risk score, PROCAM risk score and the TEKHARF risk score, which is the local risk score, were compared.

SCORE risk score: A European scoring system that estimates 10-year CVD risk (sudden cardiac death, fatal MI and fatal CVO). Age, gender, total cholesterol levels, systolic blood pressure values and smoking status of the patients were used in the score system. The patients were categorized as <1%, 2-4% and >5%, respectively; low, medium and high. Unlike the Framingham risk scale; the primary endpoint was CVD mortality rather than total CVD events.

Framingham risk score (FRS): It is a multivariate North American risk scoring system designed to estimate the risk of developing CVD (coronary heart disease, CVA, peripheral artery disease or heart failure) within 10 years. Scoring is based on gender, age, lipid profile, systolic blood pressure, hypertension under treatment, smoking and diabetic status. The 10year risk of cardiovascular events is categorized as low risk if below 10%, intermediate risk if 10-20% and high risk if more than 20% (12,13).

PROCAM risk score: It is a risk score system designed in Northern Europe to estimate the 10year risk of coronary events (fatal and non-fatal MI and sudden death). Unlike Framingham and SCORE systems, this scoring system includes triglycerides and the presence of premature atherosclerosis in the family and uses 8 independent risk factors to calculate the risk. These risk factors in order of importance are age, LDL cholesterol, smoking, HDL cholesterol, systolic blood pressure, family history of premature atherosclerosis, diabetes and triglyceride levels. The 10year risk of coronary events is categorized as low risk if below 10%, intermediate risk if 10%-20% and high risk if more than 20% (14).

TEKHARF risk score: This scoring system has been developed from a need to predict the individual 10-year risk of coronary disease (angina, fatal and non-fatal MI and sudden death) of Turkish adults. Inspired by Framingham and PROCAM scoring systems, this scale was developed using the TEKHARF cohort data.

The PROCAM score is limited to only males and the age range of 35–65 years. However, MI not covered by Framingham scoring system which includes family history and triglyceride levels. In addition to Framingham parameters, TEKHARF includes waist circumference, triglyceride level and physical inactivity. In this scoring system, patients categorized as <10%, 10-20% and> 20% are stratified into lowrisk, intermediaterisk and highrisk groups, respectively (15).

Statistics

The Kolmogorov-Smirnov test was used to detect normality of variables. Student's t-test was utilized to compare normally distributed continuous variables. The chi-square test or Fisher's exact test was used to compare categorical variables, when appropriate. Receiver operating characteristic (ROC) analysis was used to determine the diagnostic value of risk scales in terms of predicting CVD. The relationship of risk scoring systems with mortality and incident exposure was revealed by the chi-square test and ROC analysis. In the risk scales, low-risk groups were accepted as negative and high-risk groups as positive, and the sensitivity, specificity, positive and negative predictive values (PPV and NPV) of the scales in terms of developing a cardiovascular event were calculated. Pvalues less than 0.05 were considered significant. Statistical analyses were performed using the SPSS software (Version 18.0, SPSS, Inc., Chicago, IL, USA).

RESULTS

A total of 100 patients were included in the study. The demographic, clinical and laboratory characteristics of the study population at admission are summarized in Table 1. Thirty-seven (37%) of the study population were male. The mean age was 54.1 ± 11.6 years.

Table 1. Baseline Characteristics of the Study Population (N = 100).

Gender, (m/f)	37/63	**LABORATORY**	
Age (years)	54.1 ± 11.6	Total Cholesterol (mg/dl)	202, 4 ± 38,3
Heigh (cm)	165.9 ± 7.6	TG (mg/dl)	146.7 ± 72,4
Weigh (kg)	75.6 ± 10.6	LDL (mg/dl)	131.5 ± 35,2
BMI (kg/m2)	28 ± 4	HDL (mg/dl)	45,40 ± 11,9
SBP (mmHg)	160 ± 20	Waist circumference , female (cm)	
DBP (mmHg)	88.4 ± 10	<86(n)	50(%50)
Pulse Pressure (mmHg)	72.3 ± 10	>86(n)	50(%50)
HISTORY		Waist circumference, male (cm)	
Smoking (n)	78 (%78)	<94(n)	71(%71)
Positive Familiy History(n)	57 (%57)	>94(n)	29(%29)
Hypertansion,(n)	100 (%100)		
Doing sports (n)	0 (%0)		

SBP, systolic blood pressure; DBP, diastolic blood pressure; TG, triglyceride; HDL, high density lipoprotein; LDL, low density lipoprotein

Events and Outcomes

The mean follow-up period was 11 ± 0.5 years. Follow-up results and distribution are demonstrated in Table 2. It was seen that 40 patients (40%) had CAD, 52 patients (52%) had CVD, and 65 patients (65%) had all events.The 10-year risk scores of the patients were calculated and demonstrated in Table 3 according to the risk scoring systems used in the study. Upon evaluation of the data,

it was noteworthy that when different risk scoring systems were applied to the same study population, each risk scoring system categorized the population in different percentages as risk groups.

Table 2. Events and Outcomes		
Followup period, years	11±0.5	
Events	**n**	**%**
Sudden death	2	2%
CVD death (fatal stroke, MI and sudden death)	9	9%
Coronary artery disease	40	40%
Non-fatal myocardial infarction	5	5%
Revascularization (CABG, PTCA)	17	17%
New angina	24	24%
Non-fatal stroke (CVA, TIA)	12	12%
Diabetes mellitus	24	24%
Renal failure	6	6%
Heart failure	11	11%
Cardiovascular disease	52	52%
Allevents	65	65%
CVD, Cardiovascular disease; CVA, Cerebrovascular accident; TIA, Transient ischemic attack		

Table 3. Risk Groups in the Study Population According to Different Risk Scoring Systems			
	Low	**Intermediate**	**High**
SCORE	28%	23%	49%
FRS	42%	38%	20%
PROCAM	56%	19%	25%
TEKHARF	40%	27%	33%

The comparison of the study population according to risk scales and the relationship between the risk scales and occurance of 10 years CAD, CVD and all-events are shown in Table 4. As seen in Table 4, the rate of CAD, CVD and allevents was significantly higher in the high-risk group of the SCORE scale compared to the low-risk groups (chi-square test, $p < 0.05$). In the FRS scale, the incidence of CVD and all events in the intermediate risk group was found to be high and statistically significant ($p < 0.05$). Likewise, as the risk group increases, the rates of CAD, CVD and all-events increased significantly in SCORE. However, the rate of CAD in the high-risk group of the FRS scale was higher than in the low-risk group, but it was not statisticallysignificant. Occurrence of allevents in thelowrisk group was found to be higher and statistically significant on the PROCAM scale ($p<0.05$). Other endpoints of PROCAM were not statistically significant. Although there was difference in the occurrence rates of CAD, CVD and allevents in the low, intermediate andhigh risk groups on the TEKHARF scale, the difference was not statistically significant.

Logistic regression analysis of scores is shown in Table 5. Differences in CAD was not significant between Framingham groups (Fisher's exact test pvalue:0.088). Differences in CVD was significant between SCORE groups (Fisher's exact test p value:0.015; the post-hoc analysis showed a significant difference between low- and high risk groups, p value:0.011). Differences in CAD was not significant between SCORE groups (Fisher's exact test p value: 0.076)

Table 6 shows the specificity, sensitivity, AUC, PPV, and NPV of the risk scoring systems in predicting CAD, CVD and allevents. As seen in Table 6, it was found that sensitivity, PPV and NPV were significantly better in predicting allevents in the SCORE scale than the other risk scales. PROCAM was found to be superior in specificity. The SCORE scale was found to be superior in sensitivity, PPV and NPV values in predicting CVD, while FRS and PROCAM were equally superior in specificity. SCORE was found to be superior in terms of specificity, PPV and NPV values in predicting CAD, while FRS was found to be superior in sensitivity.

Table 4: The Comparison of the Risk Scales and Occurence of 10-Years CAD, CVD and All-events

	Coronary Artery Diseases				Cardiovascular Diseases				All Cardiovascular Events			
	Category	Yes	No	p	Category	Yes	No	P	Category	Yes	No	p
FRS	Low (n:42- %42)	12(%28,6)	30(%71,4)		Low (n:42- %42)	15(%35,7)	27(%64,3)		Low (n:42- %42)	20(%47,6)	22(%52,4)	
	Intermediate (n:38-%38)	19(%50)	19(%50)	>0.05	Intermediate (n:38-%38)	25(%65,8)	13(%34,2)	<0,05	Intermediate (n:38-%38)	31(%81,6)	7(%18,4)	<0,05
	High (n:20-%20)	9(%45)	11(%55)		High(n:20-%20)	12(%60)	8(%40)		High (n:20-%20)	14(%70)	6(%30)	
SCORE	Low (n:28-%28)	1(%3,6)	27(%96,4)		Low (n:28-%28)	1(%3,6)	27(%96,4)		Low (n:28-%28)	5(%17,9)	23(%82,1)	
	Intermediate (n:23-%23)	13(%56,5)	10(%43,5)	<0,05	Intermediate (n:23-%23)	15(%65,2)	8(%34,8)	<0,05	Intermediate (n:23-%23)	20(%87)	3(%13)	<0,05
	High (n:49-%49)	26(%53,1)	23(%46,9)		High (n:49-%49)	36(%73,5)	13(%26,5)		High (n:49-%49)	40(%81,6)	9(%18,4)	
PROCAM	Low (n:56-%56)	20(%35,7)	36(%64,3)		Low (n:56-%56)	24(%4,9)	32(%57,1)		Low (n:56-%56)	30(%53,6)	26(%46,4)	
	Intermediate (n:19-%19)	8(%42,1)	11(%57,9)	>0,05	Intermediate (n:19-%19)	11(%57,9)	8(%42,1)	>0,05	Intermediate(n:19-%19)	15(%78,9)	4(%21,1)	<0,05
	High (n:25-%25)	12(%48)	13(%52)		High (n:25-%25)	17(%68)	8(%32)		High (n:25-%25)	20(%80)	5(%20)	
TEKHARF	Low (n:40-%40)	16(%40)	24(%60)		Low (n:40-%40)	19(%47,5)	21(%52,5)		Low (n:40-%40)	22(%55)	18(%45)	
	Intermediate (n:27-%27)	11(%40,1)	16(%59,3)	>0,05	Intermediate (n:27-%27)	15(%55,6)	12(%44,4)	>0,05	Intermediate (n:27-%27)	19(%70,4)	8(%29,6)	>0,05
	High (n:33-%33)	13(%39,4)	20(%60,6)		High (n:33-%33)	18(%54,5)	15(%45,5)		High (n:33-%33)	24(%72,7)	9(%27,3)	

Table 5. Logistic Regression of Scores

	All events		**CAD**		**CVD**	
Risk Scores	RR (95% CI)	p value	RR (95% CI)	p value	RR (95% CI)	p value
			UNIVARIABLE			
Framingham						
intermediate risk	4.871(1.826-14.308)	0.002	2.499(0.993-6.292)	0.052	3.461(1.403-8.918)	0.0082
high risk	2.567(0.855-8.450)	0.103	2.045(0.672-6.264)	0.205	2.700(0.917-8.348)	0.0754
Procam						
intermediate risk	3.250(1.030-12.512)	0.028	1.309(0.442-3.780)	0.619	1.833(0.644-5.413)	0.259
high risk	3.467(1.208-11.592)	0.059	1.662(0.636-4.358)	0.298	2.833(1.075-7.976)	0.039
Score						
intermediate risk	30.656(7.364-173.847)	<0.0001	-	-	-	-
high risk	20.444(6.566-75.558)	<0.0001	2.988(1.317-7.012)[&]	0.01	6.058(2.605-14.870)[&]	<0.0001
Tekharf						
intermediate risk	1.943(0.704-5.673)	0.208	1.031(0.377-2.790)	0.951	1.382(0.519-3.732)	0.518
high risk	2.182(0.827-6.047)	0.122	0.975(0.377-2.505)	0.958	1.326(0.527-3.375)	0.549
			MULTIVARIABLE			
Framingham	0.894(0.815-0.973)	0.0126	0.971(0.901-1.045)	0.432	0.955(0.878-1.033)	0.258
Procam	0.818(0.018-58.792)	0.921	0.349(0.011-8.876)	0.529	0.260(0.007-9.001)	0.452
Score	1.436(1.178-1.796)	0.0007	1.316(1.111-1.591)	0.0027	1.558(1.279-1.950)	<0.0001
Tekharf	1.074(0.981-1.180)	0.128	0.967(0.888-1.049)	0.428	0.981(0.894-1.073)	0.682

** Reference category: low risk*
& Reference category; low and intermediate

Table 6. Sensitivity, Specificity, PPV and NPV Values of High-Risk Groups of the Scoring Systems for Predicting All-events, CVD and CAD.

	Specificity	Sensitivity	PPV	NPV	AUC
		All-events			
Framingham	62.9	21.5	70	52.4	0.608
Score	65.7	61.5	81.6	82.1	0.768
Procam	74.3	30.8	80	46.4	0.665
Tekharf	51.4	36.9	72.7	45	0.603
		CVD			
Framingham	56.3	23.1	60	64.3	0.652
Score	56.3	69.2	73.5	96.4	0.838
Procam	66.7	32.7	68	57.1	0.412
Tekharf	43.8	34.6	54.5	52.5	0.496
		CAD			
Framingham	50	22.5	45	71.4	0.541
Score	45	65	53.1	96.4	0.707
Procam	60	30	48	64.3	0.711
Tekharf	40	32.5	39.4	60	0.667

AUC, Area Under Curve; CAD, Coronary Artery Disease; CVD, Cardiovascular Disease PPV, Positive Predictive Value; NPV, Negative Predictive Value

Table 7. Sensitivity, Specificity, PPV and NPV Values of High-risk Groups of the Scoring Systems for Predicting All-events, CVD and CAD.

	Specificity	Sensitivity	PPV	NPV
		Allevents		
Framingham	62.9	21.5	70	52.4
Score	65.7	61.5	81.6	82.1
Procam	74.3	30.8	80	46.4
Tekharf	51.4	36.9	72.7	45
		CVD		
Framingham	56.3	23.1	60	64.3
Score	56.3	69.2	73.5	96.4
Procam	66.7	32.7	68	57.1
Tekharf	43.8	34.6	54.5	52.5
		CAD		
Framingham	50	22.5	45	71.4
Score	45	65	53.1	96.4
Procam	60	30	48	64.3
Tekharf	40	32.5	39.4	60

PPV, Positive Predictive Value; NPV, Negative Predictive Value; CAD, Coronary Artery Disease; CVD, Cardiovascular Disease

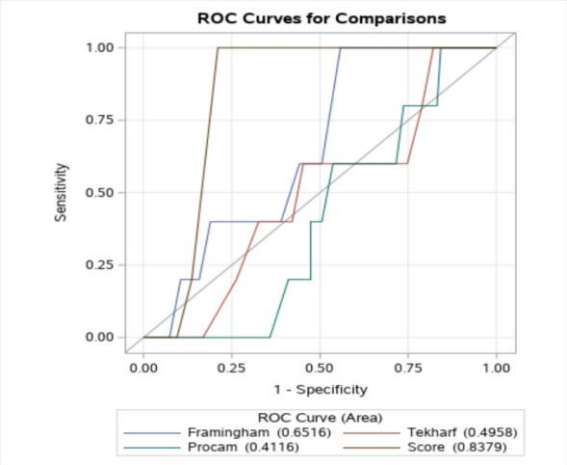

Figure 1. ROC analysis of FRS, SCORE, PROCAM and TEKHARF score in CAD.

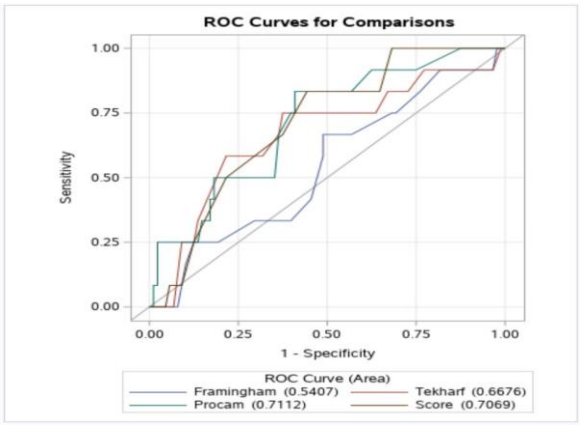

Figure 2. ROC analysis of FRS, SCORE, PROCAM and TEKHARF score in CVD.

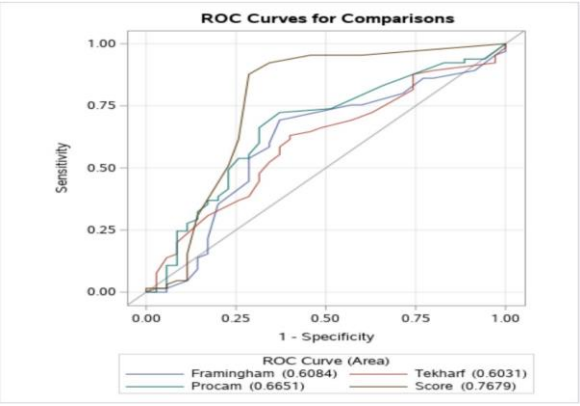

Figure 3. ROC analysis of FRS, SCORE, PROCAM and TEKHARF score in All events.

DISCUSSION

In the present study, in the evaluation of cardiovascular event endpoints, the high-risk group according to SCORE had more cardiovascular events while those in the low-risk group had less. The results obtained with the ROC analysis support these findings. On the other hand, in PROCAM and TEKHARF risk scales, the rate of cardiovascular death was similar between low-, intermediate- and high risk groups. In ROC analysis, it was observed that the number of patients diagnosed with cardiovascular events increased significantly as the PROCAM and TEKHARF risk scores increased. According to the FRS scale, there was no significant difference in rates of the groups defined as intermediate and highrisk, while a statistically significant difference was found in the low risk group for predicting CVD and allevents. In the ROC analysis, it was also observed that the area under the ROC curve of the FRS scoring system did not have a statistically significant diagnostic value. PROCAM and TEKHARF scales were not sensitive enough to predict cardiovascular events. This suggests that the SCORE system is more sensitive in predicting cardiovascular events in Turkish population.

Risk scores underestimated all predicted cardiovascular events in our study population. It was observed that events occurred at much higher rates than expected, especially in low- and intermediate risk groups. Based on these data, the results showed that the risk scores were less predictive of future events in our study population and we therefore miss patients in prophylactic treatment. Although these results show us that the SCORE risk scale is more reliable in predicting all cardiovascular events for the Turkish population than other scales, the significant differences in risk scores in predicting actual events indicate the need for a new risk scale for the Turkish population. In our study population, when the relationship between the SCORE scale and endpoints was

examined, the actual endpoints were found to be significantly higher in the high-risk group compared to the low-risk group. Likewise, as the risk group increased according to this scale, the ratios of the endpoints of the SCORE scale increased significantly. In our study, the realization rate of the endpoints of the SCORE scale were 0%, 4.3% and 16.3%, respectively, according to the risk group. The SCORE scale estimates the 10-year risk of CVD events as <1% in the low-risk group, 2-4% in the intermediate-risk group, and> 5% in the high-risk group. When evaluated according to this prediction rate, it was seen that the SCORE scale correctly predicted the events in our study population as expected. Although the specificity and positive predictability were low in the SCORE scale, it was observed that the sensitivity and negative predictive values were higher. Accordingly, the SCORE system was found to be reliable in predicting endpoints for our study population in terms of primary prevention.

In our study, the rate of finding endpoints for FRS in the low, intermediate, and high risk groups were 23.8%, 42.1%, and 35%, respectively. The FRS scale estimates the 10-year CVD risk as <10% in the low-risk group, 10-20% in the intermediate-risk group, and> 20% in the high-risk group. Accordingly, it was seen that the FRS scale predicted events under realization in our study population. Especially in the low- and intermediate risk groups, it was observed that more events than predicted occurred. The FRS scale was found to have low specificity, positive predictive sensitivity and negative predictive values. According to our study, the FRS scale was not found to be reliable in predicting endpoints for our study population in terms of primary prevention.

In our study population, when the relationship between the TEKHARF scoring system and endpoints was examined, the rates of all cardiovascular events in the groups defined as low-, intermediate- and highrisk according to the scale were high, but the difference was not statistically significant. In our study, the rate of finding endpoints for the TEKHARF scale in the low, intermediate-, and high risk groups were 35%, 29.6% and 33.3%, respectively. The TEKHARF scoring system estimates the 10-year CVD risk as <10% in the low-risk group, 10-20% in the intermediate-risk group, and> 20% in the high-risk group. Especially in the low and intermediate risk groups, it was observed that more events than expected occurred. When the data were examined, thespecificity, positive predictive, sensitivity and negative predictive values were found to be low in the TEKHARF scale. According to our study, when the TEKHARF scoring system was used, the findings related to primary prevention among the endpoints were not found reliable for the Turkish population.

The SCORE scoring system was the best predictor of cardiovascular events in our study. The reason why the SCORE system was found more reliable in this study is that the SCORE system developed a high-risk scale system for countries with a high rate of cardiovascular diseases such as Turkey. There is no such arrangement in PROCAM and FRS scale systems. Another reason can be explained by the proximity of the geographical location of this study and the geographic location of the SCORE system and the similar distribution of risk factors. In addition, the number of patients followed in the SCORE study was higher than in other studies and this system has been established more recently than the FRS risk score. Also, since the endpoints in the SCORE study are only fatal CVDs, the endpoint can be easily determined. Thus, the occurrence rate becomes more reliable and objective. For this reason, it was thought that a more accurate scoring was established in the risk groups when the SCORE system was developed. While developing the FRS scale, a different distribution of risk factors and different geographical conditions were considered based on the population from which it originated. This result is expected

when the geographical location of Turkey is considered. It is seen that the systems used in Europe are more suitable for our country. The reason is that the risk factor distributions in Turkey are similar to the European population. Although the TEKHARF scoring system was developed for our country using the data of the population in Turkey, it was created based on PROCAM and FRS systems while arranging the risk scale. In the TEKHARF study, both the number of patients and the duration of follow-up are less than the other risk scores. For these reasons, it may be concluded that it is early to say that the TEKHARF risk score is the appropriate cardiovascular risk score for the Turkish population.

This is a retrospective study with a small patient population. As such, it is not possible to say that scoring systems other than SCORE are poor in predicting cardiovascular events. Since this type of analysis was documented in the original studies of each risk scale system after evaluation of a very large number of patients and long-term follow-up, it would be appropriate to examine the original data of the studies to evaluate the relationship of all cardiovascular events with these risk scoring systems.

CONCLUSION

In conclusion, this study showed that the SCORE scoring system is the most appropriate scale to be used in predicting cardiovascular diseases in the Turkish population compared to FRS, PROCAM and TEKHARF. However, due to the inadequacy of studies on the subject, there is a need for comprehensive prospective studies to determine the appropriate system for the Turkish population. Until such a scoring system is established, we believe that the SCORE system is the most suitable scale for the Turkish population in predicting patients who need primary prevention for cardiovascular events.

Ethics Committee Approval: Sultan Abdulhamid Han Training And Research Hospital The Local Ethics Committee of our institute approved the study (Date: 29.05.2012 No: 2012/34).

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