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SCREENING OF CARDIOVASCULAR RISKS IN ACTIVE ATHLETES WITHIN THE PROVINCIAL DIRECTORATE OF YOUTH AND SPORTS

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Abstract

Objectives: This study aimed to assess the cardiovascular risks of athletes engaged in sports activities in various branches.

Materials and Methods: In this cross-sectional study, a 20-item questionnaire including demographic information and sports history was applied to 181 athletes. In addition to physical examinations, complete blood count, biochemistry, lipid profile, TSH, T4, ECG and ECHO tests were conducted.

Results: Of the athletes, 25 (13.81%) had a pathology that could impede them from doing sports was detected. When the data was examined by comparing participants with and without the pathological status, statistically significant differences were found in terms of cardiac rate, the presence of ventricular hypertrophy, T-wave, deviation in cardiac axis, HDL, LDL, calcium, ALT, diastolic blood pressure and the frequency of training per week.

Conclusion: The presence of conditions posing any health risk among actively engaged athletes suggests that some risky situations can be overlooked in the examinations necessary for entry into sports. Family physicians should take a full anamnesis when evaluating people who want to do sports, and accordingly carry out a detailed examination, and predicate their findings on laboratory findings.

Keywords: Athletes, cardiovascular risk, general practice, risk management, screening.

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Introduction

In recent years, the number of young and adult sports professionals has been increasing. Sport is considered to be a useful activity in the physical and mental development of individuals due to its positive contribution to the continuation of health status, prevention of obesity and diseases that may develop due to sedentary life and to the person's social life.[1,2] Regular exercise has proven to be an effective method to prevent obesity, cardiovascular diseases, diabetes, and breast, colon, rectal and prostate cancers.[1,3-7] Physical activity is known to reduce depression, lower blood pressure, positively affect bone health, improve symptoms in fibromyalgia patients, and reduce the risk of dementia.[8-12]

Various screening and risk classification tools are used before participation in sports activities. Leading institutions such as the American Heart Association (AHA), the American College of Sports Medicine (ACSM), and the American Society of Cardiovascular and Pulmonary Rehabilitation (AACVPR) have developed important screening recommendations for the general population. Screening and risk classification prior to participation in sports or physical education activities is accepted as a standard practice. In the 'Physical Activity Reading Questionnaire for All (PAR-Q +)' and 'Electronic Physical Activity Preparedness Questionnaire' (ePARmed-X +) developed for this purpose, the barriers to physical activities have been greatly reduced, and it has led to an increase in participation in physical activities for apparently healthy individuals and people with chronic health problems.

Although the benefits of exercise for staying healthy are undeniable, it is a fact that it brings some risks. Loading the organism above a certain level can trigger unexpected cardiac deaths.[13] The underlying silent pathologies are usually responsible for such events.[14] Although the incidence of sudden cardiac death (SCD) during sports and exercise activities is difficult to pinpoint, the general rate is 1-3 per 100 000.[15] However, although not very high, unexpected sudden deaths cause deep sorrow and anxiety in the community and family members. It is possible to identify most of these sudden deaths by pre-accession health assessments. On the other hand, exercise overloads can also cause musculoskeletal injuries. The importance of these evaluations in determining and monitoring these cannot be denied.

Health fitness reports for sports are organized by family physicians, sports physicians and cardiologists in Turkey. This necessitates a systematic approach for physicians beyond being a legal and professional responsibility. A medical report is required only for sports licenses in Turkey. However, like many reports, a health report is sometimes considered a formality. Therefore, some families and sports clubs do not give the necessary importance to the health control of the athletes. Family doctors have a great responsibility in this regard. If the family physician approves the medical report, he or she takes full legal responsibility.

Unfortunately, there is no guide or form available to family physicians prior to physical education activities. The effectiveness of the evaluations made before the sporting activities is also discussed.

The aim of this study is to make cardiovascular risk assessments of athletes engaged in sports activities in various branches of the Youth Center operating within the Provincial Directorate of Youth and Sports and to reveal the importance of laboratory studies before sports activities.

Materials and Methods

This research was conducted as a cross-sectional study. The reporting of the study was carried out in accordance with the STROBE criteria.[16] At the same time, approval was obtained from the Academic Board of the medical faculty of a university (Date: 06.02.2019, issue: 08).

The athletes who accepted to participate in the study were invited to the Family Medicine Polyclinic of the medical faculty of a university. A 20-item questionnaire including the anamnesis of the athletes was prepared by scanning the literature and was conducted on participants between November 2018 and April 2019. The questionnaire was completed by face-to-face interview method in the family medicine policlinic. Anthropometric measurements were taken by the researcher, physical examinations were performed, and the findings were recorded on cardiovascular risk screening forms in athletes. Hemogram, biochemistry and electrocardiographic (ECG) examinations of the participants were also requested. The ECGs of the athletes were analyzed by the cardiologist, and the findings were recorded on the same screening form. Athletes with pathological findings were referred to the relevant departments.

The population of the research consisted of 4400 athletes operating in Kahramanmaraş Provincial Directorate of Youth and Sports. From the list received from the Directorate, 200 of these athletes were identified using a table of random numbers, and they were sent a written invitation to participate in the research. A total of 181 people agreed to participate in the study, and the data of all participants were analyzed; there was no data loss (Figure 1).

The inclusion criteria of the study were determined to be active in moderate and heavy sports activities at least three days a week and at least 1 hour regularly with the coaches of Kahramanmaraş youth and sports provincial directorate and to be between the ages of 6-65.

The sample calculation was based on the presence of any pathology that could prevent sports in athletes. In a sample of 4400 individuals with a population of 179, an estimated 14% prevalence is required to determine

the 5% error margin and 95% confidence interval.[17] Considering data loss and the possibility of rejecting the invitation, the sample of the study was determined as 200 athletes.

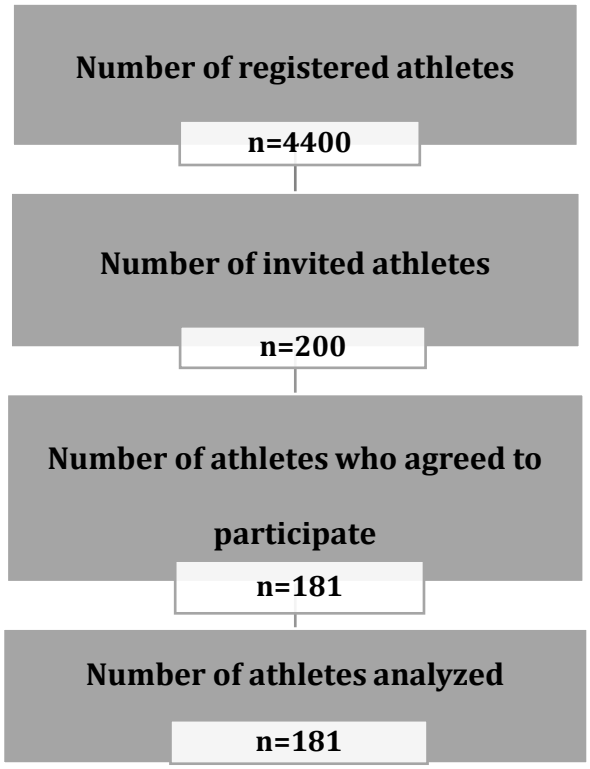

Figure 1. Participant flowchart of the study.

The dependent variable of the study is whether there is a pathology that may pose a risk for sports in physical examination, laboratory and ECG examinations. Other variables; include dizziness, blackout, fainting, chest pain or shortness of breath during or after exercise, fatigue before friends, heart rate different or faster than normal when resting, high blood pressure and high cholesterol levels, heart murmur in the family before the age of 50, death due to heart disease, family history of the sudden death of unknown cause at a young age, heart-related infectious disease in the last month, having close relatives of SCD, the type of sport performed and how many years of the sport.

The body weight of the patients was measured with Tanita SC 30 bioelectrical impedance analyzer, and the lengths were measured with a 1mm spacing. BMI values were calculated using the following formula using body weight and height.

BMI (kg / m2) = Body Weight (kg) / Length (m) ^{2})

Data were entered into the computer and analyzed with SPSS 25.0 program (Chicago, IL, USA). The findings of the study were presented as numbers and percentages for categorical variables and as the mean and standard deviation for numerical variables. The suitability of the numerical variables to the normal distribution was evaluated by looking at the skewness and kurtosis coefficients. Comparisons of the groups were made by independent samples t-test for parametric test conditions. In cases where parametric test conditions were not met, the Mann-Witney U test was used. The chi-square test was used in cases where categorical data should be compared. Statistical significance was taken as $p < 0.05$.

Results

When the data of the participants were examined, it was seen that 148 (81.77%) were male, 33 (18.23%) were female, and the mean age was 21.27±6.72 years (10-45 years). None of the participants had been smoking.

The mean±SD of QTc (msn), QRS (msn) and PR (msn) were 392.55±21.94; 85,31±10,14 and 133.02±17.50, respectively. The mean±SD of systolic and diastolic blood pressure were 102.63±12.07 and 65.45±8.30, respectively. Descriptive statistics of numerical variables are given in Table 1.

When the distribution of the participants was examined according to their sports branch, it was seen that football was the most preferred branch, with 16.57%, followed by volleyball and swimming (Table 2).

As a result of the study, 25 (13.81%) of the participants were identified to be inconvenient in terms of sports. The most common disorders were; triglyceride (n = 12), hemoglobin (n = 3) and TSH (n = 2) elevation. ECG revealed left ventricular hypertrophy and T negativity, left axis deviation, right bundle branch block, short PR and delta wave and short QT in one athlete.

When the relationship between the variables was examined, significant correlations were found. It is noteworthy that many variables are associated with age. It is observed that QTc tends to shorten and QRS and PR to lengthen, especially with age (p=0.001, 0.018 and 0.025, respectively).

When the data were compared in terms of the presence of pathology that may pose a risk to health, a statistically significant difference was found in terms of cardiac rate, HDL, LDL, calcium, ALT, diastolic blood pressure, and the number of training times per week, there was no significant difference in other variables (Table 3). When the categorical variables were compared, a statistically significant difference was found in terms of ventricular hypertrophy, t wave and deviation in the cardiac axis (Table 4).

Table 1. Descriptive information about the participants

	Min	Max	Mean	SD
QTc (ms)	330	453	392.55	21.94
QRS (ms)	64	121	85.31	10.14
PR (msn)	86	200	133.02	17.50
Sport time (years)	1	8	2.71	1.07
Length (cm)	130	187	169.82	8.11
Weight (kg)	35	98	67.93	11.65
Body Mass Index (kg / m2)	17.06	32.45	23.43	3.00
Systolic blood pressure (mmHg)	80	130	102.63	12.07
Diastolic blood pressure (mmHg)	50	82	65.45	8.30
Cardiac Speed (min)	58	92	72.15	7.46
Hemoglobin (g / dl)	10	18.1	14.31	1.62
Number of white spheres (mm3)	4000	14000	7171.99	1667.39
Platelets (mm3)	120000	540000	257668	59480
Glucose (mg / dL)	66	134	87.61	7.84
BUN (mg / dl)	6	20	12.01	2.80
Creatinine (mg / dL)	0.4	1	0.78	0.15
AST (IU / L)	11	39	20.07	4.43
SUB (IU / L)	9	52	18.32	6.53
Na (mmol / L)	132	145	139.69	2.54
K (mmol / L)	4	5.2	4.64	0.43
Ca (mg / dl)	8	10.3	9.40	0.56
Triglyceride (mg / dL)	39	330	93.92	39.94
LDL (mg / dL)	30	187	86.41	23.65
HDL (mg / dL)	29	74	47.06	8.79
TSH (mU / L)	0.9	7	2.32	0.85
ST4 (ng/dl)	0.9	1.7	1.09	0.15

(SD: Standard deviation.)

Table 2. Distribution of participants according to their sport

	n	%
Football	30	16.58
Volleyball	22	12.16
Swimming	21	11.60
Athletics	14	7.74
Shooting	12	6.64
Canoe	12	6.64
Tae-kwon-do	10	5.52
Basketball	10	5.52
Karate	10	5.52
Boxing	10	5.52
Wrestle	10	5.52
Barbell	10	5.52
Ping pong	10	5.52
Total	181	100.00

Table 3. Comparison of age, anthropometric, biochemistry and ECG measurement results

Variables	Result of evaluation	n	Mean	SD	t/Z	p
Age (year)	No pathology	156	21.12	6.31	-0.554	0.584
	Pathology	25	22.16	9.02		
QRS (msn)	No pathology	156	84.92	10.01	-1.282	0.201
	Pathology	25	87.72	10.85		
Training (day/week)	No pathology	156	2.42	0.45	-2.961	**0.006**
	Pathology	25	2.72	0.50		
Length (cm)	No pathology	156	169.79	8.43	-0.886	0.144
	Pathology	25	170.04	5.84		
Weight (kg)	No pathology	156	67.27	11.32	-1.915	0.057
	Pathology	25	72.04	13.07		
BMI	No pathology	156	23.20	2.71	-1.942	0.063
	Pathology	25	24.88	4.19		
Systolic Blood Pressure	No pathology	156	101.9	11.27	-1.624	0.115
	Pathology	25	107.2	15.68		
Diastolic Blood Pressure	No pathology	156	64.91	8.27	-2.199	**0.029**
	Pathology	25	68.8	7.81		
White Blood Cell	No pathology	156	7189.68	1726.78	0.356	0.722
	Pathology	25	7061.6	1256.72		
Platelets	No pathology	156	256512.8	57716.49	-0.652	0.654*
	Pathology	25	264880	70412.67		
BUN	No pathology	156	12.14	2.83	1.567	0.119
	Pathology	25	11.2	2.48		
Creatinine	No pathology	156	0.778	0.15	0.554	0.581
	Pathology	25	0.76	0.14		
AST	No pathology	156	19.94	4.51	-0.982	0.327
	Pathology	25	20.88	3.90		
ALT	No pathology	156	17.59	5.73	-3.294	**0.001***
	Pathology	25	22.88	9.12		
Na	No pathology	156	139.63	2.57	-0.826	0.410
	Pathology	25	140.08	2.36		
K	No pathology	156	4.624	0.43	-0.951	0.343
	Pathology	25	4.712	0.40		
Ca	No pathology	156	9.362	0.54	-2.390	**0.018**
	Pathology	25	9.644	0.60		
LDL	No pathology	156	81.12	16.84	-5.802	**<0.001***
	Pathology	25	119.44	32.33		
HDL	No pathology	156	47.86	8.80	3.665	**0.001**
	Pathology	25	42.08	7.05		
sT4	No pathology	156	1.086	0.15	-0.192	0.848
	Pathology	25	1.092	0.15		
Cardiac Speed	No pathology	156	71.38	7.46	-4.428	**<0.001**
	Pathology	25	76.92	5.49		

Table 4. Comparison of categorical variables according to results

Variables		Examination of pathology				p	$\chi 2$
		Not exist		Exist			
		n	%	n	%		
Sex	Male	127	85.81	21	14.19	0.756	0.097
	Female	29	87.88	4	12.12		
Delta wave	Not Exist	155	86.11	25	13.89	0.688	0.161
	Exist	1	100.00	0	0.00		
Right bundle branch block	Not exist	155	86.59	24	13.41	0.136	2.225
	Exist	1	50.00	1	50.00		
General ECG review	Normal	153	86.44	24	13.56	0.512	0.43
	Pathological	3	75.00	1	25.00		
Axis	Normal	155	86.59	24	13.41	**0.040**	6.425
	Right Axis	1	100.00	0	0.00		
	Left Axis	0	0.00	1	100.00		
T wave	Normal	156	86.67	24	13.33	**0.012**	6.275
	Pathological	0	0.00	1	100.00		
Ventricular hypertrophy	Not exist	156	86.67	24	13.33	**0.012**	6.275
	Exist	0	0.00	1	100.00		
Dizziness, blackout, or fainting during or after exercise	Not exist	150	86.21	24	13.79	0.97	0.001
	Exist	6	85.71	1	14.29		
Chest pain or shortness of breath during or after exercise	Not exist	138	85.71	23	14.29	0.600	0.274
	Exist	18	90.00	2	10.00		
Fatigue during exercise. before friends	Not exist	129	87.16	19	12.84	0.421	0.647
	Exist	27	81.82	6	18.18		
Different or fast heartbeats while resting	Not exist	145	86.31	23	13.69	0.865	0.029
	Exist	11	84.62	2	15.38		
Death due to heart disease before the age of 50 in the family	Not exist	155	86.59	24	13.41	0.136	2.225
	Exist	1	50.00	1	50.00		
Family history of the sudden death of unknown cause at a young age	Not exist	154	86.03	25	13.97	0.569	0.324
	Exist	2	100.00	0	0.00		

Discussion

Sudden athlete deaths, injuries during sports and variability in athlete performances have led to the discussion of the examination of athletes. The athletes underwent an evaluation including potential personal health history, family history, history of drug use, physical examination and possible diagnostic tests to identify potential risks for heart disease, musculoskeletal disease, neurological diseases, respiratory disease, bleeding disorders and psychiatric disorders that they kept.

The distribution of participants according to their sports branches revealed that football was the most preferred branch, followed by volleyball and swimming. Furthermore, when the data were analyzed with respect to the dependent variables, several statistically significant differences emerged. Specifically, significant variations were observed in cardiac rate, HDL, LDL, calcium, ALT, diastolic blood pressure, and the number of

training times per week. These findings indicate that engagement in different sports branches can significantly influence various physiological factors related to cardiovascular health and metabolic profiles. Moreover, the comparison of categorical variables in relation to the main outcome measures provided further insights. The results demonstrated a statistically significant difference in terms of ventricular hypertrophy, T wave alterations, and deviation in the cardiac axis. These findings suggest that participation in specific sports branches can have notable implications for cardiac structure and electrical activity.

Blood tests and ECG can be used to assess the structure and function of the heart and the health status of the organs. Abnormal findings detected in history, physical examination, blood tests, or ECG may lead to further diagnostic tests and evaluations.[18] In our study, pathology was detected in the light of these findings in 13.81% of the participants (25 people) and referred to internal medicine, cardiology and pediatric hematology departments for further diagnostic tests and evaluations. However, it was concluded that the pathologies identified as a result of the analyzes did not prevent the participants from doing sports.

The fact that there are many interested in football among the participants may be due to the interest in football in our country as well as the fact that it requires more team players compared to other branches. The relatively high number of those who are interested in swimming among the participants in the study may be due to the ease of access to semi-Olympic swimming pools in the city.

There is solid evidence showing that adequate and regular physical activity can have positive cardiovascular, endocrine, metabolic and neurological effects.[19,20] However, it has also been shown that excessive and strenuous physical training forms can generally damage the cardiovascular system.[21] In our study, hemoglobin level was found to be significantly higher in the group with pathology. The fact that the number of training days per week was higher in the group with pathology was considered a finding compatible with the literature.

An important reason for pre-accession screening in athletes is the effort to prevent sudden deaths. The main cardiac causes of sudden death in athletes are; hypertrophic cardiomyopathy, cardiac conduction problems, coronary artery anomalies, cardiac arrest due to severe blows to the chest, and upper respiratory tract infection may be considered carditis.[22] Hypertrophic cardiomyopathy (20.6%), idiopathic left ventricular hypertrophy (13.4%) and coronary anomalies (12.0%) were found in the top three in a study that investigated sudden deaths in 331 competing athletes in the United States.[23]

Both the American Heart Association (AHA) and the European Cardiology Association (ESC) panel recommendations agreed that young competing athletes should be screened for cardiac exposure.[24,25] However, there are differences in screening methods. While AHA recommends a complete medical history and family history with physical examination, ESC recommends the routine use of a 12-lead ECG in the initial screening.[26]

Hypertrophic cardiomyopathy or right ventricular cardiomyopathy shows various ECG changes, including straight or deeply inverted T waves and deep Q waves (including a dramatic increase in R or S wave voltage), indicating the presence of structural cardiovascular disease. In a study conducted with 1005 individuals from 38 different sports branches comparing ECG with echocardiography, 40% of the participants had abnormal ECG findings, and 5% had structural heart problems.[27]

In our study, ECG findings were interpreted pathologically in 4 people (2.20%); one person had delta wave, two had right bundle branch block (one with axial deviation), and one had short QTc. It appears that the pathological ECGs are interpreted as belonging to men. This may be due to the fact that most of the participants (81.83%) are men. On the other hand, it has been considered that the male gender is a risk factor in itself for sudden cardiac death.[22] Also, in our study, it was found that QTc shortening with increasing age was consistent with the literature.[20] Therefore, it can be said that age is an independent risk factor for athletes. However, it was understood that these findings did not predict the important pathologies that would prevent the individuals from continuing their sports life.

There are different applications for screening methods. The main reason for this difference is the variability in the cost approach. According to a study conducted in the USA in 2012, the cost of more than $ 10 million is saved in every case where sudden death is prevented by ECG.[28] In the same study, it is strangely argued that ECG is a financial burden on the US economy and may hinder the implementation of some methods that can be used to prevent cardiac death. In addition, according to another study led by Italian researchers, a screening program in which ECG will not be used will be both more expensive and insufficient to identify heart disease.[29] It is thought that this difference in opinion on cost-effectiveness depends on different structuring of health systems. In this regard, the health system in terms of cost-effectiveness of screening with ECG in Turkey closer to European Union countries that have been evaluated would be more useful.

The existence of family medicine practice in our country can be used as a great advantage in this respect. From birth to death, it will be very easy for a family physician to monitor and record at least one ECG record for participation in sports to a person with records. In addition, 12-lead ECG is not widely used and interpretable in our country.[30] It is considered that it would be beneficial to take measures to eliminate the lack of education in this regard.

It will be necessary to interpret this research with some limitations. First, the age range of athletes is distributed over a wide range. The possibility of such a wide range of influences should be kept in mind. On the other hand, muscle-building protein contents and anabolic steroids that athletes may use are not considered. In addition, the lack of examination and laboratory data of athletes before starting sports can be considered a limitation.

The presence of conditions that may pose a risk to the health of athletes in people who are engaged in active sports suggests that some findings have been missed in the examinations for entry to sports. This research shows that health screening is important for the health of the athlete. Although a health report is obtained to start sports in the current practice, some pathologies can be omitted. On the other hand, only anamnesis and physical examination may not be sufficient to determine the health problems, and basic laboratory tests should be performed. Based on this research, a national guide for sports entry examinations and screening of athletes should be developed with larger samples and multi-center studies.

The following conclusions and recommendations can be drawn from our research:

- Although screening tests do not fully capture diseases, they are very helpful in identifying those who can perform sports.
- Laboratory and ECG can be used to increase the sensitivity in sports examinations.
- Family medicine practice can provide a significant advantage in terms of cost-effectiveness.

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Ethical Considerations: Ethical approval for the study was obtained from Kahramanmaraş Sütçü İmam University Faculty of Medicine Clinical Research Ethics Committee on 06.02.2019 with approval number 08.

Conflict of Interest: The authors declare no conflict of interest.

References

1 Miko HC, Zillmann N, Ring-Dimitriou S, Dorner TE, Titze S, Bauer R. Auswirkungen von Bewegung auf die Gesundheit [Effects of Physical Activity on Health]. Gesundheitswesen. 2020;82(S 03):S184-S195 (doi:10.1055/a-1217-0549).

2 Çelik A, Şahin M. Spor ve Çocuk Gelişimi. Int J Soc Sci. 2013;6:467–78.

3 Fonseca-Junior SJ, Sa CGA de B, Rodrigues PAF, Oliveira AJ, Fernandes-Filho J. Physical exercise and morbid obesity: a systematic review. Arq Bras Cir Dig. 2013;26 Suppl 1:67–73 (doi: 10.1590/s0102-67202013000600015).

4 Friedenreich CM. Physical activity and breast cancer: review of the epidemiologic evidence and biologic mechanisms. Recent Results Cancer Res. 2011;188:125-39 (doi: 10.1007/978-3-642-10858-7_11).

5 Brown JC, Winters-Stone K, Lee A, Schmitz KH. Cancer, physical activity, and exercise. Compr Physiol. 2012;2:2775–809 (doi:10.1002/cphy.c120005).

6 Liu Y, Hu F, Li D, et al. Does physical activity reduce the risk of prostate cancer? A systematic review and meta-analysis. Eur Urol. 2011;60:1029–44 (doi:10.1016/j.eururo.2011.07.007).

7 Bozhüyük A, Özcan S, Kurdak H, Akpınar E, Saatçı E, Bozdemir N. Sağlıklı yaşam biçimi ve aile hekimliği. Turkish J Fam Med Prim Care. 2012;6:88–92.

8 Pearce M, Garcia L, Abbas A, et al. Association Between Physical Activity and Risk of Depression: A Systematic Review and Meta-analysis. JAMA Psychiatry. 2022;79(6):550-559 (doi:10.1001/jamapsychiatry.2022.0609).

9 Aucella F, Valente GL, Catizone L. The role of physical activity in the CKD setting. Kidney Blood Press Res. 2014;39:97–106 (doi:10.1159/000355783).

10 Moreira LDF, Oliveira ML de, Lirani-Galvao AP, Marin-Mio RV, Santos RN dos, Lazaretti-Castro M. Physical exercise and osteoporosis: effects of different types of exercises on bone and physical function of postmenopausal women. Arq Bras Endocrinol Metabol. 2014;58:514–22 (doi: 10.1590/0004-2730000003374).

11 Busch AJ, Schachter CL, Overend TJ, Peloso PM, Barber KAR. Exercise for fibromyalgia: a systematic review. J Rheumatol. 2008;35:1130–44. Estévez-López F, Maestre-Cascales C, Russell D, et al. Effectiveness of Exercise on Fatigue and Sleep Quality in Fibromyalgia: A Systematic Review and Meta-analysis of Randomized Trials. Arch Phys Med Rehabil. 2021;102(4):752-761 (doi:10.1016/j.apmr.2020.06.019).

12 Krell-Roesch J, Feder NT, Roberts RO, et al. Leisure-Time Physical Activity and the Risk of Incident Dementia: The Mayo Clinic Study of Aging. J Alzheimers Dis. 2018;63:149–55 (doi:10.3233/JAD-171141).

13 Sharalaya Z, Phelan D. Cardiac Risk of Extreme Exercise. Sports Med Arthrosc Rev. 2019;27(1):e1-e7 (doi:10.1097/JSA.0000000000000215).

14 Açar B, Kara M. Sudden Cardiac Death in Athletes : Current Approaches in Clinical Practice Sporcularda Ani Kardiyak Ölüm : Klinik Pratikte Güncel Yaklaşımlar. Turkish J Sport Med. 2017;52 (doi:10.5152/tjsm.2017.002).

15 Harmon KG, Asif IM, Klossner D, Drezner JA. Incidence of sudden cardiac death in National Collegiate Athletic Association athletes. Circulation. 2011;123:1594–600 (doi:10.1161/CIRCULATIONAHA.110.004622).

16 Von Elm E, Altman DG, Egger M, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guildelines for reporting observational studies. J Clin Epidemiol. 2008;61:344–9 (doi: 10.1016/j.jclinepi.2007.11.008).

17 Lenth R. Java Applets for Power and Sample Size [Computer software] 2009. https://homepage.divms.uiowa.edu/~rlenth/Power/ (accessed Dec 24, 2022).

18 Lehman PJ, Carl RL. The Preparticipation Physical Evaluation. Pediatr Ann. 2017;46:e85–92 (doi:10.3928/19382359-20170222-01).

19 Posadzki P, Pieper D, Bajpai R, Makaruk H, Könsgen N, Neuhaus AL, et al. Exercise/physical activity and health outcomes: an overview of Cochrane systematic reviews. BMC Public Health. 2020 Nov 16;20(1):1724 (doi: 10.1186/s12889-020-09855-3).

20 Vink AS, Clur SB, Wilde AAM, Blom NA. Effect of age and gender on the QTc-interval in healthy individuals and patients with long-QT syndrome. Trends Cardiovasc Med. 2018;28(1):64-75 (doi:10.1016/j.tcm.2017.07.012).

21 Tiller NB, Stewart GM, Illidi CR, Levine BD. Exercise Is Medicine? The Cardiorespiratory Implications of Ultra-marathon. Curr Sports Med Rep. 2020;19(8):290-297 (doi:10.1249/JSR.0000000000000738).

22 Wasfy MM, Hutter AM, Weiner RB. Sudden Cardiac Death in Athletes. Methodist Debakey Cardiovasc J. 2016;12:76–80 (doi:10.14797/mdcj-12-2-76).

23 Peterson DF, Kucera K, Thomas LC, Maleszewski J, Siebert D, Lopez-Anderson M, et al. Aetiology and incidence of sudden cardiac arrest and death in young competitive athletes in the USA: a 4-year prospective study. Br J Sports Med. 2021;55(21):1196-1203 (doi:10.1136/bjsports-2020-102666).

24 Maron BJ, Levine BD, Washington RL, Baggish AL, Kovacs RJ, Maron MS. Eligibility and Disqualification Recommendations for Competitive Athletes With Cardiovascular Abnormalities: Task Force 2: Preparticipation Screening for Cardiovascular Disease in Competitive Athletes: A Scientific Statement From the American Heart Associ. J Am Coll Cardiol. 2015;66:2356–61 (doi:10.1016/j.jacc.2015.09.034).

25 Heidbuchel H, Adami PE, Antz M, Braunschweig F, Delise P, Scherr D, et al. Recommendations for participation in leisure-time physical activity and competitive sports in patients with arrhythmias and potentially arrhythmogenic conditions: Part 1: Supraventricular arrhythmias. A position statement of the Section of Sports Cardiology and Exercise from the European Association of Preventive Cardiology

(EAPC) and the European Heart Rhythm Association (EHRA), both associations of the European Society of Cardiology. Eur J Prev Cardiol. 2021 Dec 20;28(14):1539-1551 (doi: 10.1177/2047487320925635).

26 Dhutia H, MacLachlan H. Cardiac Screening of Young Athletes: a Practical Approach to Sudden Cardiac Death Prevention. Curr Treat Options Cardiovasc Med. 2018;20:85 (doi: 10.1007/s11936-018-0681-4).

27 Pelliccia A, Maron BJ. Athlete's heart electrocardiogram mimicking hypertrophic cardiomyopathy. Curr Cardiol Rep. 2001;3:147–51 (doi: 10.1007/s11886-001-0042-9).

28 Schoenbaum M, Denchev P, Vitiello B, Kaltman JR. Economic evaluation of strategies to reduce sudden cardiac death in young athletes. Pediatrics. 2012;130:e380-9 (doi:10.1542/peds.2011-3241).

29 Assanelli D, Levaggi R, Carre F, et al. Cost-effectiveness of pre-participation screening of athletes with ECG in Europe and Algeria. Intern Emerg Med. 2015;10:143–50 (doi: 10.1007/s11739-014-1123-2).

30 Katı Y, Durak VA, Armağan E, Kaya H. Acil Serviste Patoloji Saptanmayan Elektrokardiyografilerin Tekrar Yorumlanması ve Çıkan Sonuçların Analizi. Uludağ Tıp Derg. 2019; 45(1): 99-104 (doi: 10.32708/uutfd.486804).