Scientific Foundation SPIROSKI, Skopje, Republic of Macedonia
Open Access Macedonian Journal of Medical Sciences. 2022 Apr 30; 10(A):924-929.
https://doi.org/10.3889/oamjms.2022.9648
eISSN: 1857-9655
Category: *A - Basic Sciences*
Section: *Sports Medicine*

Cardiovascular Disease Risk Profiles in Indonesian Athletes

Bayu Fandhi Achmad[1]*, Syahirul Alim[1], Happy Indah Kusumawati[1], Akbar Satria Fitriawan[2], Dedi Kurniawan[3], Raisa Farida Kafil[4]

[1]Department of Basic and Emergency Nursing, Faculty of Medicine, Public Health and Nursing, Universitas Gadjah Mada, Yogyakarta, Indonesia; [2]Department of Nursing, Faculty of Health Sciences, Universitas Respati Yogyakarta, Yogyakarta, Indonesia; [3]Department of Nursing, Kepanjen School of Health Sciences, Malang, Indonesia; [4]Department of Anesthesiology Nursing, Faculty of Health Science, Universitas Aisyiyah, Yogyakarta, Indonesia

Edited by: Slavica Hristomanova-Mitkovska
Citation: Achmad BF, Alim S, Kusumawati HI, Fitriawan AS, Kurniawan D, Kafil RF. Cardiovascular Disease Risk Profiles in Indonesian Athletes. Open-Access Maced J Med Sci. 2022 Apr 30; 10(A):924-929. https://doi.org/10.3889/oamjms.2022.9648
Keywords: Athlete; Cardiovascular disease; Heart disease; Risk factors
***Correspondence:** Bayu Fandhi Achmad, Farmako St., Sekip Utara, Mlati, Special Region of Yogyakarta, 55281, Indonesia. E-mail: bayu.fandhi.a@ugm.ac.id
Received: 05-Apr-2022
Revised: 19-Apr-2022
Accepted: 20-Apr-2022

Funding: This research did not receive any financial support
Competing Interest: The authors have declared that no competing interest exists

Abstract

BACKGROUND: Notwithstanding how physical exercise lessens cardiovascular and all-cause mortality, young and active athletes might have cardiovascular risk factors or fundamental cardiovascular diseases, putting them at increased risk for sudden cardiac death during times of strenuous exercise.

AIM: The study aimed to assess the cardiovascular risk profile possessed by Indonesian athletes.

METHODS: This research was a quantitative study using a cross-sectional design, involving 234 Indonesian athletes (163 men and 71 women) from three sports, including football, basketball, and swimming. Data were collected between December 2020 and March 2021 using the Jakarta Cardiovascular Risk Score instrument adapted from the Framingham risk score. Descriptive statistics were used to dissect data information for frequency distribution, percentage, mean, and standard deviation.

RESULTS: Most of the participants in this study had excessive weekly exercise duration (over 255 min/week) (n = 177 athletes, 75.64%). Twenty-one participants (8.97%) had a higher MAP than normal, and 51 participants (21.79%) had overweight BMI. In addition, 142 participants (60.68%) had a cardiovascular genetic disease from their parents (family history) and most of the participants also were active smokers (n=150, 64.10%). Based on the Jakarta Cardiovascular Risk Score, the Indonesian athletes who participated in this study had a mean cardiovascular risk of −1.5 (SD = 3.088, min–max = (−7) – 6). Most of the participants had low cardiovascular risk (n = 193, 82.48%). However, some participants had moderate and high cardiovascular risk, 32 (13.67%) and 9 (3.85%), respectively.

CONCLUSIONS: Most of the participants had low cardiovascular risk, however, some participants had moderate and high cardiovascular risk.

Introduction

Cardiovascular diseases (CVDs) can happen to anyone, including young and highly active athletes [1]. Athletes are expected to have a safe cardiovascular profile because of the standard youthful grown-up age and the impact of customary activity programs, which are instinctually accepted to fulfill the healthy model of an athletic way of life [2]. Remarkably, CVD risk factors are expanded and can be related to the specific ways that athletes behave, particularly in sports. For instance, with time-limited goal-seeking intentions and extensive conditioning, they frequently are pitted against the opposition in games that end in what is called “sudden death,” which ultimately can risk the exhausting of their cardiovascular well-being [3].

Athletes have a high risk of experiencing hypertrophic cardiomyopathy (HCM), coronary anomalies, and arrhythmogenic right ventricular cardiomyopathy, which can cause Sports-related Sudden Cardiac Death (SrSCD) [4]. The incidence of SrSCD reaches 80,000/year in young, competitive athletes in the USA [5]. The incidence of SrSCD in Germany is 500,000 deaths/year in athletes aged >18 years, and another 2.5 million deaths occur in younger athletes [6]. In Asian countries, research regarding SrSCD is scarce and not very thorough. For example, the prevalence of SrSCD in Singapore is only about 86.7%, which was 72 out of 83 patients [7]. Recent research showed that the increased risk of CVDs in athletes is associated with several factors [8].

Athletes’ cardiovascular sickness risk factors are divided into two classes, non-modifiable and modifiable. Non-modifiable risk factors comprise gender, race, age, and family ancestry [9]. A previous study stated that men have a higher risk (0.002% of athletes/year) than women (0.0008% of athletes/year) [10]. In addition, athletes over 35 years of age who experienced SCD were associated with atherosclerosis [11].

Modifiable risk factors associated with cardiovascular disorders in athletes are smoking habits and exercise duration [12]. A high-risk factor for chronic diseases associated with premature death is tobacco

consumption, both in clove (*kretek*) cigarettes and e-cigarettes. The nicotine content in tobacco could negatively affect athletes both active and passive smokers [13]. Exercise duration is also a risk factor for CVDs in athletes. Heart rate will increase by 80% of the maximum heart rate during 1 hour of resistance training. There is a possibility that the athlete's heart will dilate if the exercise is carried out for hours [14]. A study stated that exercise performed for approximately 112 min/week could reduce the risk of cardiovascular disorders, while these benefits will be lost if exercises duration is over 255 min/week [15].

It is important to identify CVDs risk profiles in athletics as early prevention against SrSCD in athletes. Thus, the identification of the CVDs risk profile is not only essential for the athletes but also the trainers and related stakeholders in terms of future planning. Along these lines, we arranged the current review to survey the cardiovascular risk profile of Indonesian athletes, aiming to address the model of a truly dynamic and sound way of life. We looked to evaluate the level and dissemination of the CV risk profile given the athletes' attributes.

Materials and Methods

Participants

The study participants consisted of 234 Indonesian athletes (163 males and 71 females) aged 18–29 years (with a mean age of 20.78 ± 1.745 years). Participants came from three sports, including football, basketball, and swimming. Each athlete was enrolled based on the sport mastered.

Inclusion criteria involved were at least 18 years old, at least 1 year as an athlete had participated in a national competition in an Olympic sport, and joined a national athletic association. Exclusion criteria were having congenital CVD, not providing an informed consent form, and not fully completing the questionnaire.

Measures

The instrument consists of two sections. The principal segment was the information concerning the participant utilizing a demographic characteristics questionnaire. It consists of age, weight, height, heart rate (HR), respiratory rate (RR), sport, length of time being an athlete, duration of exercise per week, and family CVDs history. The second section was the Jakarta Cardiovascular Risk Score adapted from the Framingham Risk Score [16]. The Jakarta Cardiovascular Risk Score contains seven items that aim to identify risk factors for cardiovascular disorders that participants may experience. The items include gender, age, systolic blood pressure, body mass index (BMI), smoking behavior, diabetes, and physical activity. The score obtained is between −7 and 18. The higher the score indicates the higher risk of CVD. Therefore, we classified participants' scores into three categories: −7–1 for low risk, 2–4 for moderate risk, and 5 or above as high risk.

Procedures

This observational study utilized a cross-sectional design. The participants' information was collected from December 2020 to March 2021. All participants were enrolled after signing informed consent forms. The Institutional Ethics Committee approved the study with the ethical expediency number KE/FK/1036/EC/2020. We used the Declaration of Helsinki on Biomedical Research Involving Human Subjects as a guideline for this study. In addition, the sphygmomanometer and digital weight scale used in this study have received a health parameters certificate from the Health Laboratory and Calibration of the Health Office of the Special Region of Yogyakarta, Indonesia.

Data collection was conducted in the following way: First, we explained the stages and objectives of the research, and then, we asked about the participants' willingness to be involved in this research. Next, participants who had signed the informed consent form were asked to sit for 10 min. Afterward, research assistants measured participants' blood pressure, heart rate, respiratory rate, weight, and height. Next, the research assistant asked participants to fill out the instrument entirely. Finally, the blinded instrument that the participant has completed is given an identity code with a combined letter and number.

Statistical analysis

This study used descriptive statistical data analysis. Gender, sport, family CVDs history, and smoking habits were described using frequency distribution and percentage. The mean and standard deviation (SD) were used to display the analysis results of age, HR, RR, systolic blood pressure, and diastolic blood pressure. Variables of the length of time as an athlete, duration of exercise per week, BMI, mean arterial pressure (MAP), and cardiovascular risk scores were shown by a blend of frequency distribution, percentage, mean, and SD. The analyses were performed utilizing the SPSS v.23 (IBM Corp, Armonk, NY).

Results

Participant's characteristics

Table 1 shows the characteristics of the participants. The majority of participants were male

(n = 163, 69.66%), with the mean age of 20.78 (SD = 1.745), and range between 18 and 29 years. Most of the participants are soccer athletes (n = 120, 51.28%). Most of the participants have been athletes for less than 10 years (n = 121, 51.71%). The participants' cardiorespiratory profile showed a mean resting heart rate of 76.27 beats/min (SD = 12,132, min–max= 48–114 beats/min) with a mean respiratory rate of 20.05 beats/min (SD= 3.297, min–max = 13–32 times/min). Furthermore, participants had a mean systolic blood pressure (SBP) of 118.97 mmHg (SD= 10,187, min–max= 90–140 mmHg) and a mean diastolic blood pressure (DBP) of 73.29 mmHg (SD= 9,112, min-max= 50–100 mmHg).

Table 1: Frequency distribution of respondent characteristics (n = 234)

Participants' characteristics	Frequency (%)	Mean (SD)	Min–max
Gender			
Male	163 (69.66)		
Female	71 (30.34)		
Age (year)		20.78 (1.745)	18–29
Sports			
Football	120 (51.28)		
Basketball	70 (29.91)		
Swimming	44 (18.81)		
Duration of being an athlete (year)		9.71 (4.175)	3–22
1–10 years	121 (51.71)		
>10 years	113 (48.29)		
Cardiorespiratory status			
Resting heart rate (HR) (/min)		76.27 (12.132)	48–114
Respiratory rate (RR) (/min)		20.05 (3.297)	13–32
Blood pressure status			
Systolic blood pressure (SBP) (mmHg)		118.97 (10.187)	90–140
Diastolic blood pressure (DBP) (mmHg)		73.29 (9.112)	50–100

SD: Standard deviation.

Cardiovascular risk profile in Indonesian athletes

This study observed five cardiovascular risk profiles: Weekly exercise duration, MAP, BMI, family CVDs history, and smoking habits. Most of the participants in this study had excessive weekly exercise duration (over 255 min/week) (n = 177 athletes, 75.64%). Twenty-one participants (8.97%) had a higher MAP than normal, and 51 participants (21.79%) had overweight BMI. In addition, 142 participants (60.68%) had a cardiovascular genetic disease from their parents (family history) and most of the participants also were active smokers (n = 150, 64.10%) (Table 2).

Based on the Jakarta Cardiovascular Risk Score, the Indonesian athletes who participated in this study had a mean cardiovascular risk of –1.5 (SD = 3.088, min-max= (–7) – 6). Most of the participants had low cardiovascular risk (n = 193, 82.48%). However, some participants had moderate and high cardiovascular risk, 32 (13.67%) and 9 (3.85%), respectively (Table 3).

Discussion

CVDs in athletes are a "silent killer" whose incidence is increasing every year [17]. Despite their high wellness level, athletes can display raised cardiovascular risk of CVDs. Most athletes determined to have CAD were asymptomatic and knew nothing about their raised cardiovascular risk [18]. Risk factors that can increase the incidence possibility of cardiovascular disease in athletes include high exercise duration, overweight, hypertension, family history (genetic), and smoking habits [19].

Table 2: Cardiovascular risk profile in Indonesian athletes

Cardiovascular risk factors	Frequency (%)	Mean (SD)	Min–max
Exercise duration per week (min)		525.64 (378.221)	60–2.640
Less (<112 min)	4 (1.71)		
Optimum (112–255 min)	53 (22.65)		
Excessive (>255 min)	177 (75.64)		
Mean arterial pressure (MAP) (mmHg)		88.51 (8.543)	70–110
Normal MAPs (70–100 mmHg)	213 (91.03)		
Abnormal MAPs (>100 mmHg)	21 (8.97)		
Body mass index (BMI)		22.71 (3.044)	17.62–28.93
Underweight (<18.5)	16 (6.84)		
Normal (18.5–24.9)	167 (71.37)		
Overweight/obesity (>25)	51 (21.79)		
Family illness history			
Exist	142 (60.68)		
Not any	92 (39.32)		
Smoking habit			
Smoke	84 (35.90)		
Do not smoke	150 (64.10)		

SD: Standard deviation.

Table 3: Cardiovascular risk profile in Indonesian athletes based on the Jakarta Cardiovascular Risk Score

Participants' characteristics	Frequency (%)	Mean (SD)	Min-max
Cardiovascular diseases risk		−1.5 (3.088)	(−7)–6
Low risk	193 (82.48)		
Moderate risk	32 (13.67)		
High risk	9 (3.85)		

SD: Standard deviation.

This study found that most participants had exercise duration exceeding the recommended duration (over 255 min/week). Exercise for a long duration can increase the workload of the cardiovascular system, especially in the athlete's cardiac output (CO), which increases continuously and repeatedly. It will increase the hemodynamic load so that it can cause aortic dilatation [20]. A prolonged increase in CO is also associated with decreased function as heart fatigue, leading to decreased athletic performance [21]. In addition, the increased work demands of the cardiovascular system cause the left and right ventricles to enlarge and increase in volume, which is common among athletes [22], [23].

Being overweight is a risk factor for cardiovascular disorders in an athlete [24]. The overweight condition may be caused by excess intake of nutrients. It can also be caused by the restricted activity during the COVID-19 pandemic [25]. The normal BMI ranges from 28.5 to 24.5 Kg/m^2 [26]. People with BMI above 25 kg/m^2 can have increased cholesterol levels in the blood and trigger atherosclerotic plaques in blood vessels [27]. The plaque could narrow the blood vessels, thus increasing the possibility of hypertension. Then, hypertension causes heart pump ineffectiveness because the heart muscles have to work harder [28]. In the long term, it will cause heart failure [29]. In addition, the plaque in atherosclerosis can also harm the arterial endothelium. Repeated injuries can cause inflammation and trigger atherosclerosis blockage [30]. As a result,

atherosclerosis blockage increases the risk of heart attack and stroke [31].

Smoking is a significant risk factor for cardiovascular disorders [32]. Nicotine, an ingredient in cigarettes, causes damage to the walls of blood vessels or the endothelium by releasing catecholamines and increasing the risk of blood clots [33]. In addition, nicotine in the body can stimulate the adrenaline hormone, increase blood pressure and heart rate, and change fat metabolism. As a result, high-density lipoprotein (HDL) levels decrease, and low-density lipoprotein (LDL) levels increase [34]. Besides the inversion of HDL and LDL, carbon monoxide in the cigarettes can bind to hemoglobin to reduce oxygen flow to tissues, one of which is the myocardium, and increase the risk of atherosclerosis [35]. Smoking is also known to increase the perception of fatigue, which can affect the performance of athletes [36].

The Jakarta Cardiovascular Risk Score assessment shows that most participants in this study are in a low category. Participants with a score in the low category have a probability of having cardiovascular disorders of 10%. Participants in a low category are recommended to maintain good habits or healthy life [37]. On the other hand, some participants had moderate and high cardiovascular risk; 32 people (13.67%) and 9 people (3.85%), respectively. Some of the participants not only have a modifiable CVDs risk factor but also have a family history of CVDs as an unmodifiable risk factor. This study showed that 60.68% of participants have a family history of CVDs. A family history of CVDs reflects a genetic predisposition that underlies the occurrence of cardiovascular disorders. Individuals with a family history of cardiovascular disorders are twice as likely to have cardiovascular disorders [38]. Participants with a score in the medium category have a probability of experiencing CVD of 10–20%. In comparison, the high-risk category has a probability of suffering from CVD of more than 20%. Participants in both categories are encouraged to consult a doctor, address the risk factors for cardiovascular disorders that may be experienced, and change any unhealthy lifestyles [39].

This study has several potential limitations. In this study, only athletes from three sports were involved. In addition, due to the small sample population, the results are not generalizable. Furthermore, the activity restrictions due to the COVID-19 pandemic have made it difficult to enroll more participants. Future studies should be conducted with a larger number of participants and a wider variety of sports involved.

Conclusions

This study showed that the duration of excessive exercise, high blood pressure, excessive BMI, family history of CVDs, and smoking habits are the risk factors that increase the occurrence of CVDs in Indonesian athletes. Furthermore, the Jakarta Cardiovascular Risk Score assessment shows that most participants (82.48%) in this study are in a low category.

Acknowledgment

The authors would express gratitude to Universitas Gadjah Mada, Universitas Negeri Yogyakarta, and Universitas Atma Jaya Yogyakarta, for permission to conduct the study. We would also like to thank the research respondents and research assistants who have assisted in the smooth running of the research process.

References

1. Morrison BN, Mckinney J, Isserow S, Lithwick D, Taunton J, Nazzari H, *et al*. Assessment of cardiovascular risk and preparticipation screening protocols in masters athletes: The masters athlete screening study (MASS): A cross-sectional study. BMJ Open Sport Exerc Med. 2018;4(1):e000370. https://doi.org/10.1136/bmjsem-2018-000370
   PMid:30112182
2. Schmehil C, Malhotra D, Patel DR. Cardiac screening to prevent sudden death in young athletes. Transl Pediatr. 2017;6(3):199-206. https://doi.org/10.21037/tp.2017.05.04
   PMid:28795011
3. Eijsvogels TM, Molossi S, Lee DC, Emery MS, Thompson PD. Exercise at the extremes: The amount of exercise to reduce cardiovascular events. J Am Coll Cardiol. 2016;67(3):316-29. https://doi.org/10.1016/j.jacc.2015.11.034
   PMid:26796398
4. Chung KC, Lark ME, Cederna PS. Treating the football athlete: coaches' perspective from the university of michigan. Hand Clin. 2017;33(1):1-8. https://doi.org/10.1016/j.hcl.2016.08.001
   PMid:27886827
5. Yasargil MG. Sport paradox: Sudden cardiac death. World J Adv Res Rev. 2022;13(1):626-30. https://doi.org/10.30574/wjarr.2022.13.1.0084
6. Bohm P, Scharhag J, Meyer T. Data from a nationwide registry on sports-related sudden cardiac deaths in Germany. Eur J Prev Cardiol. 2016;23(6):649-56. https://doi.org/10.1177/2047487315594087
   PMid:26130495
7. Wang L, Yeo TJ, Tan B, Destrube B, Tong KL, Tan SY, *et al*. Asian pacific society of cardiology consensus recommendations for pre-participation screening in young competitive athletes. Eur Cardiol. 2021;16:e44. https://doi.org/10.15420/ecr.2021.26
   PMid:34815752
8. Barbieri D, Chawla N, Zaccagni L, Coklo M. Predicting cardiovascular risk in athletes: Resampling improves classification performance. Int J Environ Res Public Health. 2020;7(21):7923. https://doi.org/10.3390/ijerph17217923

PMid:33126737

9. D'Ascenzi F, Caselli S, Alvino F, Digiacinto B, Lemme E, Piepoli M, *et al*. Cardiovascular risk profile in Olympic athletes: An unexpected and underestimated risk scenario. Br J Sports Med. 2019;53(1):37-42. https://doi.org/10.1136/bjsports-2018-099530
PMid:30217832
10. Harmon KG, Asif IM, Maleszewski JJ, Owens DS, Prutkin JM, Salerno JC, *et al*. Incidence, cause, and comparative frequency of sudden cardiac death in national collegiate athletic association athletes: A decade in review. Circulation. 2015;132(1):10-9. https://doi.org/10.1161/CIRCULATIONAHA.115.015431
PMid:25977310
11. Wasfy MM, Hutter AM, Weiner RB. Sudden cardiac death in athletes. Methodist Debakey Cardiovasc J. 2016;12(2):76-80. https://doi.org/10.14797/mdcj-12-2-76
PMid:27486488
12. Mchugh C, Hind K, Cunningham J, Davey D, Wilson F. A career in sport does not eliminate risk of cardiovascular disease: A systematic review and meta-analysis of the cardiovascular health of field-based athletes. J Sci Med Sport. 2020;23(9):792-9. https://doi.org/10.1016/j.jsams.2020.02.009
PMid:32139313
13. Zandonai T, Tam E, Bruseghini P, Pizzolato F, Franceschi L, Baraldo M, *et al*. The effects of oral smokeless tobacco administration on endurance performance. J Sport Health Sci. 2018;7(4):465-72. https://doi.org/10.1016/j.jshs.2016.12.006
PMid:30450256
14. Bangsbo J, Hansen PR, Dvorak J, Krustrup P. Recreational football for disease prevention and treatment in untrained men: A narrative review examining cardiovascular health, lipid profile, body composition, muscle strength and functional capacity. Br J Sports Med. 2015;49(9):568-76. https://doi.org/10.1136/bjsports-2015-094781
PMid:25878072
15. Eijsvogels TM, Thompson PD, Franklin BA. The "Extreme exercise hypothesis": Recent findings and cardiovascular health implications. Curr Treat Options Cardiovasc Med. 2018;20(10):84. https://doi.org/10.1007/s11936-018-0674-3
PMid:30155804
16. Kusmana D, Setianto B, Sutedjo S, Basuki B. Lesson learnt from cardiovascular risk factors studies in urban population of Jakarta and house-hold survey in Indonesia, 1988 - 2018. Indones J Cardiol. 2019;40(3): 269-274. https://doi.org/10.30701/ijc.v40i3.951
17. D'Silva A, Papadakis M. Sudden cardiac death in athletes. Eur Cardiol Rev. 2015;10(1):48-53. https://doi.org/10.15420/ecr.2015.10.01.48
18. Ackerman MJ, Giudicessi JR. Sudden cardiac arrest in sport: Reactive success versus proactive failure? J Am Coll Cardiol. 2022;79(3):247-9. https://doi.org/10.1016/j.jacc.2021.11.012
PMid:35057910
19. Lammlein KP, Stoddard JM, O'Connor FG. Preparticipation screening of young athletes: Identifying cardiovascular disease. Prim. Care. 2018;45(1):95-107. https://doi.org/10.1016/j.pop.2017.11.005
PMid:29406947
20. Jarcho JA, Corrado D, Link MS, Calkins H. Arrhythmogenic right ventricular cardiomyopathy. N Engl J Med. 2017;376(1):61-72. https://doi.org/10.1056/NEJMra1509267
PMid:28052233
21. Parry-Williams G, Sharma S. The effects of endurance exercise on the heart: Panacea or poison? Nat Rev Cardiol. 2020;17(7):402-12. https://doi.org/10.1038/s41569-020-0354-3
PMid:32152528
22. Bohm P, Scharhag J, Egger F, Tischer KH, Niederseer D, Schmied C, Meyer T. Sports-related sudden cardiac arrest in Germany. Can J Cardiol. 2021;37(1):105-12. https://doi.org/10.1016/j.cjca.2020.03.021
PMid:32464107
23. Sheikh N, Papadakis M, Schnell F, Panoulas V, Malhotra A, Wilson M, *et al*. Clinical profile of athletes with hypertrophic cardiomyopathy. Circ Cardiovasc Imaging. 2015;8(7):e003454. https://doi.org/10.1161/CIRCIMAGING.114.003454
PMid:26198026
24. Mascherini G, Petri C, Ermini E, Bini V, Calà P, Galanti G, *et al*. Overweight in young athletes: New predictive model of overfat condition. Int J Environ Res Public Health. 2019;16(24):5128. http://doi.org/10.3390/ijerph16245128
PMid:31888120
25. Hołowko J, Michalczyk MM, Zając A, Czerwińska-Rogowska M, Ryterska K, Banaszczak M, *et al*. Six weeks of calorie restriction improves body composition and lipid profile in obese and overweight former athletes. Nutrients. 2019;11(7):1461. https://doi.org/10.3390/nu11071461
PMid:31252598
26. World Health Organization. Cardiovascular Disease. Geneva, Switzerland: World Health Organization; 2020.
27. Silva AM, Nunes CL, Matias CN, Jesus F, Francisco R, Cardoso M, *et al*. Champ4life study protocol: A one-year randomized controlled trial of a lifestyle intervention for inactive former elite athletes with overweight/obesity. Nutrients. 2020;12(2):286. https://doi.org/10.3390/nu12020286
PMid:31973208
28. Servatius H, Raab S, Asatryan B, Haeberlin A, Branca M, de-Marchi S, *et al*. Differences in atrial remodeling in hypertrophic cardiomyopathy compared to hypertensive heart disease and athletes' hearts. J Clin Med. 2022;11(5):1316. http://doi.org/10.3390/jcm11051316
PMid:35268407
29. Berge HM, Isern CB, Berge E. Blood pressure and hypertension in athletes: A systematic review. Br J Sports Med. 2015;49(11):716. http://doi.org/10.1136/bjsports-2014-093976
PMid:25631543
30. Aengevaeren VL, Eijsvogels TM. Coronary atherosclerosis in middle-aged athletes: Current insights, burning questions, and future perspectives. Clin Cardiol. 2020;43(8):863-71. http://doi.org/10.1002/clc.23340
PMid:32031291
31. Caselli S, Sequì AV, Lemme E, Quattrini F, Milan A, D'Ascenzi F, *et al*. Prevalence and management of systemic hypertension in athletes. Am J Cardiol. 2017;119(10):1616-22. http://doi.org/10.1016/j.amjcard.2017.02.011
PMid:28325568
32. O'Neil A, Scovelle AJ, Milner AJ, Kavanagh A. Gender/sex as a social determinant of cardiovascular risk. Circulation. 2018;137(8):854-64. https://doi.org/10.1161/CIRCULATIONAHA.117.028595
PMid:29459471
33. Sevilla-Montero J, Labrousse-Arias D, Fernandez-Perez C, Barreira B, Mondejar-Parreno G, Cogolludo A, *et al*. Direct effects of cigarette smoke in pulmonary arterial cells alter vascular tone through arterial remodeling and kv7.4 channel dysregulation. Cold Spring Harb Perspect Med. 2019;7(Suppl 6):269-274. http://doi.org/10.1101/555953
34. Song Q, Chen P, Xiang-Ming L. The role of cigarette smoke-induced pulmonary vascular endothelial cell apoptosis in COPD. Respir. Res. 2021;22(1):39. http://doi.org/10.1186/s12931-021-01630-1
PMid:33546691

35. Ardiana M, Santoso A, Hermawan, HO, Nugraha RA, Pikir BS, I Gde RS. Acute effects of cigarette on endothelial nitric oxide synthase, vascular cell adhesion molecule 1 and aortic intima media thickness “cigarette smoke–induced pro-atherogenic changes”. Cold Spring Harb. 2021;10:369. http://doi.org/10.1101/2021.01.17.426972

36. Häcker AL, Oberhoffer R, Hager A, Ewert P, Müller J. Age-related cardiovascular risk in adult patients with congenital heart disease. Int J Cardiol. 2019;277:90-6. https://doi.org/10.1016/j.ijcard.2018.09.042

PMid:30262228

37. Powell KL, Stephens SR, Stephens AS. Cardiovascular risk factor mediation of the effects of education and genetic risk score on cardiovascular disease: A prospective observational cohort study of the Framingham heart study. BMJ Open. 2021;11(1):e045210. http://doi.org/10.1136/bmjopen-2020-045210

PMid:33436477

38. Valerio L, Peters RJ, Zwinderman AH, Pinto-Sietsma SJ. Association of family history with cardiovascular disease in hypertensive individuals in a multiethnic population. J Am Heart Assoc. 2016;5(12):e004260. https://doi.org/10.1161/JAHA.116.004260

PMid:28003252

39. Maharani A, Sujarwoto S, Praveen D, Oceandy D, Tampubolon G, Patel A. Cardiovascular disease risk factor prevalence and estimated 10-year cardiovascular risk scores in Indonesia: The SMARThealth extend study. PLoS One. 2019;14(4):e0215219. http://doi.org/10.1371/journal.pone.0215219

PMid:31039155