ORIGINAL ARTICLE

Football spectatorship and selected acute cardiovascular events: lack of a population-scale association in Poland

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KEY WORDS
acute myocardial infarction, football, football watching, sudden arrhythmia, sudden cardiac arrest

ABSTRACT

BACKGROUND The status of football spectatorship–induced emotional stress as a risk factor for acute cardiovascular events remains a matter of dispute.

AIMS This study aimed to investigate the relationship between football spectatorship and the incidence of selected acute cardiovascular events in the Polish male population.

METHODS Events that occurred in male patients aged 35 years and older in Poland during 3 tournaments (2012 and 2016 European Championships and 2018 World Cup) were retrospectively analyzed based on hospital admission codes (*International Statistical Classification of Diseases and Related Health Problems, Tenth Revision* [*ICD-10*]) obtained from the Polish National Health Fund (Narodowy Fundusz Zdrowia). The following primary diagnoses were of interest: acute myocardial infarction (AMI; I21), sudden cardiac arrest (I46), sudden arrhythmias (I47–I49). The corresponding dates in the years before and after the tournaments constituted the reference periods.

RESULTS A total of 255 383 patients were included in this study. There were no significant differences in the incidence of events between the combined exposure and reference periods: relative risk [RR] = 1.05 (95% CI, 0.97–1.14; $P = 0.2$) for AMI, RR = 1.08 (95% CI, 0.87–1.35; $P = 0.47$) for sudden cardiac arrest, and RR = 1.02 (95% CI, 0.98–1.06; $P = 0.32$) for sudden arrhythmias. Individual tournament analyses revealed a higher incidence of AMI (RR = 1.2; 95% CI, 1.12–1.3; $P < 0.001$) during the World Cup. However, day-by-day analysis for the World Cup did not show a higher incidence of AMI on match versus match-free days.

CONCLUSIONS Emotional stress evoked by football spectatorship is insufficiently potent to precipitate a population-scale increase in the incidence of selected acute cardiovascular events.

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INTRODUCTION As the leading cause of global mortality,[1] cardiovascular diseases have been an object of numerous preventive efforts. Among those, an attempt was made to understand and neutralize triggers that precipitate acute cardiovascular events.[2] Long-recognized triggers include episodes of emotional stress,[3] strenuous physical exercise,[4] and sexual activity.[5] Indeed, the empirical coexistence of emotional stress and cardiovascular diseases was described as early as in 1910, when stress provoked by a heated card game was said to directly precede myocardial infarction (MI).[6] While estimates suggest that triggers play a causative role in 20% of cases of acute coronary syndrome,[7] retrospective studies have shown that as many as half of patients with nonfatal cardiovascular disease self-report exposure to 1 or more triggers.[8,9] With regard to

WHAT'S NEW?

This is the first study to analyze the relationship between football spectatorship and acute cardiovascular events in Central Europe. It was based on data of the entire Polish male population aged 35 years or older. We found no evidence for increased rates of hospitalization for acute myocardial infarction, sudden cardiac arrest, or sudden arrhythmias during 3 major football tournaments—2012 and 2016 European Championships and 2018 World Cup—when analyzed together and separately. Similarly, day-by-day analysis provided no evidence for an increased risk of acute cardiovascular events associated with football matches played by the Polish national team during 2018 World Cup. We concluded that emotional stress evoked by football spectatorship in Poland is insufficiently potent to precipitate the onset of acute cardiovascular events at the population level. Our findings add to previous studies that shift the association between football spectatorship and the incidence of acute cardiovascular events towards the null hypothesis.

the triggering potential of emotional stress, there has been an extensive body of evidence supporting an association between disasters—both man-made and not—and the incidence of adverse cardiac outcomes.[10-14] However, there is no reason to suppose that acute emotional stress is unique to these events, and several teams have extended the study to short-term stressors such as decisive sporting events.

Currently, the status of sports spectatorship as a risk factor for acute cardiovascular events is a matter of debate.[15-23] Although this holds for a variety of team sports,[24,25] most studies have focused on football, because its emotional appeal is arguably unequalled among Europeans. As a result, whereas most studies have reported relative risk (RR) estimates spreading around the null value[18] ($0.7 \leq RR \leq 1.3$), a few have demonstrated alarmingly high rates of cardiovascular events on days when football matches were held.[16,19,21,23] In a recent meta-analysis, Lin et al[26] concluded that watching football matches is associated with a higher risk of fatal cardiovascular diseases and nonfatal MI in both men and women. Men with known coronary artery disease are particularly vulnerable to this phenomenon.[19] Moreover, no significant increase in fatal or nonfatal cerebrovascular events was noted. This corroborates the hypothesis that stressful situations increase the incidence of stroke on a more chronic basis,[27] in distinction to the acute stress response elicited by football spectatorship. Of note, that meta-analysis was limited by reporting RR values for fatal cardiovascular diseases and nonfatal MI alone.[26] Finally, the impact of the match result on the incidence of cardiovascular diseases is the most elusive of all.[24]

To address the inconsistencies in the literature, we performed a comprehensive analysis of selected acute cardiovascular events—acute MI (AMI), sudden cardiac arrest (SCA), and sudden arrhythmias (SAs)—and their relationship with 3 recent football tournaments in the entire Polish male population.

METHODS

Study periods We studied weekly hospitalizations for selected acute cardiovascular events in the Polish male population during 3 tournaments: 2012 UEFA European Championship (EC) held in Poland and Ukraine, 2016 UEFA EC in France, and 2018 FIFA World Cup (WC) in Russia.

The following tournament dates constituted our exposure periods: 1) May 28 to June 24, 2012 for EC 2012; 2) May 30 to July 10, 2016 for EC 2016; and 3) June 11 to July 8, 2018 for WC 2018.

The weeks corresponding to the tournament season in the odd-numbered years from 2011 to 2019 constituted our reference periods. The year 2014 was excluded to avoid the extraneous influence of the WC held then, although the Polish national football team did not participate in that event.

Study group The records of hospital admissions were retrieved from the database of the Polish Central Statistics Office of the Polish National Health Fund (Narodowy Fundusz Zdrowia). We selected the data of all male patients aged 35 years and older who were admitted to a hospital or an ambulatory care center in Poland during the exposure or reference periods with one of the following *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision* (*ICD-10*) codes as the primary diagnosis: I21 (AMI); I46 (SCA); and I47 (paroxysmal tachycardia), I48 (atrial fibrillation and flutter), I49 (all other tachyarrhythmias including ventricular tachycardia, grouped together as SAs). Besides the primary diagnosis, individual anonymous hospital admission forms provided information about patients' age, sex, and date of admission. To circumvent the confounding variable posed by the day of the week,[28,29] we systematized the data on a weekly rather than daily basis. The number of events was standardized per 100 000 persons of the male population.

Additionally, we collected data on outdoor temperature and air quality—assessed based on nitric dioxide levels ($\mu g/m^3$)—in 3 regions of Poland (Gdańsk, Warsaw, and Wrocław) in the selected time periods. These were obtained from the Institute of Meteorology and Water Management, the National Research Institute, and the Chief Inspectorate for Environmental Protection, respectively.

Statistical analysis Relative risk of hospitalization for each of the aforementioned primary diagnoses during the tournament weeks (the exposure period) compared with the control weeks (the reference period) was calculated using the algorithm described by Altman elsewhere.[30] We first determined RRs for all tournaments compared with all reference periods combined. Subsequently, we analyzed each tournament separately and, finally, performed

TABLE 1 Frequency of selected acute cardiovascular events per 100 000 men in Poland in the tournament (exposure period) and tournament-free (reference period) years

Diagnosis	Age, y	Tournament-free years (reference)	Tournament years (exposure)	RR (95% CI)	*P* value
Acute myocardial infarction	35–49	2.59	2.61	1.01 (0.77–1.32)	0.95
	50–64	12.94	13.78	1.06 (0.94–1.2)	0.33
	65–79	23.57	24.81	1.05 (0.92–1.2)	0.45
	80+	29.31	29.95	1.02 (0.81–1.29)	0.83
	35+	11.49	12.1	1.05 (0.97–1.14)	0.2
Sudden cardiac arrest	35–49	0.39	0.41	1.05 (0.53–2.08)	0.88
	50–64	1.34	1.47	1.1 (0.76–1.61)	0.61
	65–79	3.2	3.56	1.13 (0.8–1.59)	0.5
	80+	5.93	5.97	1.02 (0.61–1.71)	0.95
	35+	1.51	1.64	1.08 (0.87–1.35)	0.47
Sudden arrhythmias	35–49	7.47	7.49	1 (0.86–1.17)	0.97
	50–64	41.12	41.6	1.01 (0.94–1.08)	0.75
	65–79	132.77	134.64	1.01 (0.96–1.07)	0.62
	80+	178.54	182.11	1.02 (0.93–1.12)	0.68
	35+	50.76	51.75	1.02 (0.98–1.06)	0.32

Abbreviations: RR, relative risk

TABLE 2 Frequency of selected acute cardiovascular events per 100 000 men in Poland during 2012 European Championship and neighboring tournament-free years (2011 and 2013)

Diagnosis	Age, y	Tournament-free years (reference)	Tournament years (exposure)	RR (95% CI)	*P* value
Acute myocardial infarction	35–49	2.65	2.66	1.01 (0.77–1.32)	0.94
	50–64	12.37	12.5	1.01 (0.89–1.14)	0.87
	65–79	23.67	24.21	1.02 (0.89–1.18)	0.73
	80+	30.27	31.26	1.03 (0.81–1.31)	0.79
	35+	11.21	11.4	1.02 (0.94–1.1)	0.7
Sudden cardiac arrest	35–49	0.37	0.36	0.93 (0.45–1.93)	0.85
	50–64	1.42	1.28	0.91 (0.62–1.33)	0.62
	65–79	3.29	3.83	1.17 (0.82–1.68)	0.4
	80+	5.06	4.92	1 (0.55–1.8)	0.99
	35+	1.48	1.5	1.02 (0.81–1.28)	0.86
Sudden arrhythmias	35–49	7.16	7.53	1.05 (0.9–1.24)	0.53
	50–64	40.32	38.12	0.95 (0.88–1.01)	0.12
	65–79	129.22	122.61	0.95 (0.89–1.01)	0.09
	80+	151.96	141.66	0.93 (0.84–1.04)	0.21
	35+	47	44.69	0.95 (0.91–0.99)	0.02

Abbreviations: see TABLE 1

a detailed analysis of a single tournament (WC 2018) on a day-by-day, per-match basis. Match days were defined as the days on which a match was held (Poland–Senegal on June 19, 2018; Poland–Colombia on June 24, 2018; and Poland–Japan on June 28, 2018) as well as the day following the match, as events could have lasted past midnight. On the other hand, match-free

days comprised the 2 days preceding the match day and the 2 days following the day directly after the match day. All statistical calculations were performed using the MedCalc software (Ostend, Belgium). The significance level was set at P <0.05.

Ethics The study protocol complied with the Declaration of Helsinki. Owing to its retrospective design, neither written nor verbal patient consent was required for this study. However, each participant had signed a consent form to accept medical treatment, which included a statement of agreement to the use of data for scientific purposes.

RESULTS A total of 255 383 patients were included in this study, having satisfied all selection criteria, namely: male sex, age of 35 years or older, and admission to a hospital or an ambulatory care center in Poland for I21 (45 164 patients), I46 (6068), or I47–I49 (204 151) during either of the exposure or reference periods defined above. In line with our methodology, we reported the results of our analysis in a step-wise manner, starting with a comparison of the 3 tournament years combined and all 5 reference years combined. This was followed by an individual analysis of each of the 3 tournaments compared with the 2 neighboring odd-numbered and tournament-free years. Finally, we focused on the most recent tournament, WC 2018, by comparing match days with non-match days.

Combined analysis A mean number of 65.49 acute cardiovascular events (12.1 cases of I21, 1.64 of I46, and 51.75 of I47–I49) per week per 100 000 men were reported during the exposure period, in close parallel to the mean number of 63.76 events (11.49 cases of I21, 1.51 of I46, and 50.76 of I47–I49) observed during the reference period.

No significant differences were found in the incidence of acute cardiovascular events between the exposure and reference periods, with RR consistently oscillating around the null value: RR = 1.05 (95% CI, 0.97–1.14; P = 0.2) for AMI, RR = 1.08 (95% CI, 0.87–1.35; P = 0.47) for SCA, and RR = 1.02 (95% CI, 0.98–1.06; P = 0.32) for SAs. The results of the combined analysis are presented in TABLE 1. They were consistent among all age groups.

Individual tournaments Events that occurred during the individual tournaments compared with the respective reference periods (the corresponding dates in the years before and after the tournament) are presented in TABLE 2 and in Supplementary material, *Tables S1* and *S2*. No EC tournament was associated with a significant difference in the frequency of AMI or SCA among Polish men. The association between football spectatorship and SA occurrence was more inconsistent, with a small yet significant

TABLE 3 Frequency of selected acute cardiovascular events per 100 000 men in Poland during 2018 World Cup on Polish national team match days and the following days compared with the days before and after the games (continued on the next page)

Game	Diagnosis	Age, y	Days before and after the games	Match day and the following day	RR (95% CI)	*P* value
June 19, 2018: Poland–Senegal, 1:2	Acute myocardial infarction	35–49	27	22	0.81 (0.46–1.43)	0.48
		50–64	113	113	1 (0.77–1.3)	>0.99
		65–79	114	109	0.96 (0.74–1.24)	0.74
		80+	26	27	1.04 (0.61–1.78)	0.89
		35+	281	271	0.96 (0.82–1.14)	0.67
	Sudden cardiac arrest	35–49	1	3	3 (0.31–28.84)	0.34
		50–64	9	8	0.89 (0.34–2.3)	0.81
		65–79	11	9	0.82 (0.34–1.97)	0.66
		80+	5	5	1 (0.29–3.45)	>0.99
		35+	26	25	0.96 (0.56–1.66)	0.89
	Sudden arrhythmias	35–49	65	65	1 (0.71–1.41)	>0.99
		50–64	324	308	0.95 (0.81–1.11)	0.52
		65–79	638	641	1 (0.9–1.12)	0.93
		80+	237	226	0.95 (0.79–1.14)	0.61
		35+	1264	1239	0.98 (0.91–1.06)	0.62

TABLE 3 Frequency of selected acute cardiovascular events per 100 000 men in Poland during 2018 World Cup on Polish national team match days and the following days compared with the days before and after the games (continued from the previous page)

Game	Diagnosis	Age, y	Days before and after the games	Match day and the following day	RR (95% CI)	*P* value
June 24, 2018: Poland–Colombia, 0:3	Acute myocardial infarction	35–49	22	19	0.86 (0.47–1.6)	0.64
		50–64	95	97	1.02 (0.77–1.35)	0.89
		65–79	86	89	1.03 (0.77–1.39)	0.82
		80+	26	21	0.81 (0.45–1.44)	0.47
		35+	230	225	0.98 (0.81–1.18)	0.81
	Sudden cardiac arrest	35–49	4	4	1 (0.25–4)	>0.99
		50–64	9	12	1.33 (0.56–3.16)	0.51
		65–79	11	14	1.27 (0.58–2.8)	0.55
		80+	6	2	0.33 (0.07–1.65)	0.18
		35+	30	31	1.03 (0.63–1.71)	0.9
	Sudden arrhythmias	35–49	41	43	1.05 (0.68–1.61)	0.83
		50–64	178	181	1.02 (0.83–1.25)	0.87
		65–79	326	331	1.02 (0.87–1.18)	0.84
		80+	112	111	0.99 (0.76–1.29)	0.95
		35+	658	666	1.01 (0.91–1.13)	0.83
June 28, 2018: Poland–Japan, 1:0	Acute myocardial infarction	35–49	24	28	1.17 (0.68–2.01)	0.58
		50–64	112	113	1.01 (0.78–1.31)	0.95
		65–79	101	103	1.02 (0.78–1.34)	0.89
		80+	27	27	1 (0.59–1.7)	>0.99
		35+	264	271	1.03 (0.87–1.22)	0.76
	Sudden cardiac arrest	35–49	3	1	0.33 (0.03–3.2)	0.34
		50–64	11	7	0.64 (0.25–1.64)	0.35
		65–79	9	9	1 (0.4–2.52)	>0.99
		80+	7	6	0.86 (0.29–2.55)	0.78
		35+	30	23	0.77 (0.45–1.32)	0.34
	Sudden arrhythmias	35–49	56	44	0.79 (0.53–1.17)	0.23
		50–64	249	251	1.01 (0.85–1.2)	0.93
		65–79	498	472	0.95 (0.84–1.07)	0.4
		80+	172	175	1.02 (0.82–1.26)	0.87
		35+	975	941	0.97 (0.88–1.06)	0.44

Abbreviations: see TABLE 1

TABLE 4 Average outdoor temperature and air pollution during the tournament (exposure period) and tournament-free (reference period) years in Poland

Variable	Year							
	2011	2012 (European Championship)	2013	2015	2016 (European Championship)	2017	2018 (World Cup)	2019
Outdoor temperature, °C	18.2 (2.1)	17.7 (2)	17.7 (1.9)	18 (2.2)	19 (2.7)	18.1 (2.2)	19.8 (3)	20.3 (3.1)
Nitric dioxide, μg/m^3	12.2 (3.2)	10.4 (2.5)	11.3 (2.8)	10.1 (1.4)	15.8 (3.8)	11.4 (3.2)	12.6 (3.9)	9.9 (2.7)

Data are presented as mean (SD).

increase (RR = 1.05; 95% CI, 1.01–1.08; P = 0.02) and decrease (RR = 0.95; 95% CI, 0.91–0.99; P = 0.02) in its incidence during 2016 and 2012 EC tournaments, respectively.

For WC 2018, we reported a higher incidence of AMI (RR = 1.2; 95% CI, 1.12–1.3; P <0.001). This was mainly driven by the higher rate of hospitalization for AMI in men aged 50 to 79 years during the tournament period. No differences in the incidence of SCA or SAs were found during that tournament compared with the reference periods in 2017 and 2019.

Per-match day analysis Finally, we performed a day-by-day analysis for WC 2018 (TABLE 3). Despite a highly significant increase in the incidence of AMI during the whole WC tournament, no significant differences were observed in the incidence of AMI, SCA, or SAs between match and match-free days.

Data on outdoor temperature and air pollution are presented in TABLE 4.

DISCUSSION

The mechanism coupling emotional stress and the onset of cardiovascular diseases can be elucidated in 2 ways. First, behavioral mechanisms are at play, as emotional stress impairs health decision-making. Consequently, behaviors such as smoking, binge drinking, poor dietary compliance, physical inactivity, and poor adherence to the medical regimen stand in lieu of health-promoting behaviors.[31] Second, direct pathophysiological mechanisms, though not fully understood, can be cogently characterized as follows: emotional stress stimulates the sympathetic nervous system, which results in increased heart rate, blood pressure, and cardiac contractility, thereby raising myocardial oxygen demand.[32] Myocardial perfusion becomes impaired owing to increased coronary vascular tone and failure of the coronary microvasculature to dilate. Collectively, these events promote myocardial ischemia and atherosclerotic plaque rupture. Besides changes in sympathetic tone, emotional stress increases the levels of circulating catecholamines, which reduces myocardial electrical stability and, thus, expedites arrhythmogenesis.[33,34] Stress hormones may also directly alter endothelial and monocytic function.[19,35] Finally, prothrombotic changes in the hemostatic system and hematologic indices are observed, namely, increased levels of procoagulant activity markers,[36] increased platelet aggregability, decreased fibrinolytic activity[7,37] as well as increased hematocrit values[38] and blood viscosity.[39] Interestingly, a recent study has shown that cardiovascular diseases were a more common cause of death among elite Polish football players than in the general male population.[40]

As holds for many other European nations, football is the most popular sport in Poland. In addition, the FIFA World Cup—a quadrennial football tournament organized by the global governing body—is the biggest single-sport international sporting event in the world. Like the WC, the UEFA EC is a major quadrennial international football tournament held in Europe. According to Nielsen Audience Measurements, the average number of spectators in Poland for the analyzed tournaments approximated 4 million people, with around 30 million people watching at least a minute of a game during a single tournament. Matches played by the Polish national football team attracted most attention and were watched by approximately 8 to 17 million spectators on television, depending mainly on the significance of the game: 8 million people watched the Poland–Japan match during the already-lost WC 2018 compared with 17 million people who watched the Poland–Portugal quarterfinal during EC 2016, which was the highest achievement of the Polish national team during the analyzed tournaments. In 2 out of the 3 analyzed tournaments—during EC 2012 co-hosted with Ukraine and during WC 2018—the Polish national team was eliminated in the group phase, whereas it reached the quarterfinals during EC 2016. However, expectations were high during all 3 tournaments, owing to both abundant press coverage and success in the elimination phases.

Our combined analysis provided no evidence for increased rates of hospitalization for AMI, SCA, or SAs associated with the 3 football tournaments. Similarly, day-by-day analysis of WC 2018 showed no increased risk of AMI, SCA, or SAs associated with football matches played by the Polish national team. The only remarkable results were as follows: a) fluctuating differences in the incidence of SAs during the 2 EC tournaments, which could thus be regarded as a chance finding; and b) a higher incidence of AMI during WC 2018, which needs further clarification, especially in light of the negative findings reported for the day-by-day analysis of the same tournament. We posit that the higher incidence of AMI during WC 2018 must have been provoked by factors other than match spectatorship, as the most decisive, high-stakes games of the Polish national team had already been held and lost without increasing the rate of admissions due to AMI. This postulate is founded on studies that have shown that the outcome of a game may impact the frequency of acute cardiovascular events, with lost games posing the highest risk.[16,23,26] Although we cannot firmly determine which factors were at play, weather analyses revealed that outdoor temperatures were much higher in 2018 and 2019 than in 2017, which could have influenced the results, as 2017 was part of the reference period.[41] In consequence, the results became insignificant (data not shown) after excluding the year 2017 from the reference period.

An extensive clinical assessment would be necessary to determine other potential causes of acute events.[42]

Our study was the first of this kind performed in East-Central Europe. The estimates are based on a very large study group comprising the whole male population of Poland over 35 years of age (more than 10 million people), included football events held over a period of 7 years, and were checked for weather condition linearity. Unlike numerous previous studies limited to the analysis of selected events, we included a broad spectrum of cardiovascular diagnoses.[18,26] Of note, almost all studies reporting a significant association between football spectatorship and acute cardiovascular diseases, responsible for shifting the association found in the meta-analysis towards significance, were based on selected populations such as those of provinces of Switzerland or regions of Bavaria as well as on single events. Meanwhile, broader, nation-wide analyses and/or analyses of more tournaments, like our study, consistently demonstrated lack of a significant association.[26] Furthermore, some studies did not include days of the week as a potential confounder by systemizing data on a weekly rather than tournament period basis.[17,19] In our study (like in other reports),[28,29] a peak of hospital admissions due to acute cardiovascular events occurred from Mondays to Wednesdays, which, if not adjusted for, could influence the results (Supplementary material, *Figure S1*).

Obviously, while no association was detected at the population level, our results cannot eliminate the possibility of individual football spectatorship–induced cardiovascular events. Our findings should also be considered in view of potential regional and social differences in the emotional engagement elicited by football spectatorship. Furthermore, the Polish national team lost qualification games and early matches for many consecutive tournaments since the time of its peak performance (during WCs in 1974 and 1982, winning bronze medals). This might have been accompanied by changes in spectator attitudes that curtailed emotional engagement. It is also possible that, unlike in other regions of the world or in selected environments, football spectatorship is not conducive to emotional responses robust enough to trigger or precipitate acute cardiovascular events at the population level in Poland.[16,43]

Limitations Our study was limited to the male population of Poland, although it may be expected that emotional stress accompanying football spectatorship is greater in men than in women. Therefore, if no consistent significant differences were found in men, it is unlikely that such differences would be present in the Polish female population. The use of hospital admission codes was another study limitation, as it could have led to underreporting or misreporting and our study may thus include a fraction of misclassified patients.

Conclusions In conclusion, we posit that emotional stress evoked by football spectatorship is insufficiently potent to precipitate the onset of selected acute cardiovascular events at the population level. Our findings are consistent with previous studies that shift the association between football spectatorship and the incidence of acute cardiovascular events towards the null hypothesis.

SUPPLEMENTARY MATERIAL

Supplementary material is available at www.mp.pl/kardiologiapolska.

ARTICLE INFORMATION

CONFLICT OF INTEREST None declared.

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REFERENCES

1 Mensah GA, Roth GA, Fuster V. The global burden of cardiovascular diseases and risk factors. J Am Coll Cardiol. 2019; 74: 2529-2532.

2 Tofler GH, Muller JE. Triggering of acute cardiovascular disease and potential preventive strategies. Circulation. 2006; 114: 1863-1872.

3 Dimsdale JE. Psychological stress and cardiovascular disease. J Am Coll Cardiol. 2008; 51: 1237-1246.

4 Mittleman MA, Maclure M, Tofler GH, et al. Triggering of acute myocardial infarction by heavy physical exertion – protection against triggering by regular exertion. N Engl J Med. 1993; 329: 1677-1683.

5 Moller J. Sexual activity as a trigger of myocardial infarction. A case-crossover analysis in the Stockholm Heart Epidemiology Programme (SHEEP). Heart. 2001; 86: 387-390.

6 Obrastzo VP, Strazhesko ND. The symptomatology and diagnosis of coronary thrombosis. In: Vorobeva VA, Konchalovski MP, eds. Works of the First Congress of Russian Therapists. Comradeship Typography of AE Mamontov; 1910: 26-43.

7 Willich SN. Circadian variation and triggering of cardiovascular events. Vasc Med. 1999; 4: 41-49.

8 Tofler GH, Stone PH, Maclure M, et al. Analysis of possible triggers of acute myocardial infarction (the MILIS study). Am J Cardiol. 1990; 66: 22-27.

9 Behar S, Halabi M, Reicher-Reiss H, et al. Circadian variation and possible external triggers of onset of myocardial infarction. Am J Med. 1993; 94: 395-400.

10 Meisel SR, Dayan KI, Pauzner H, et al. Effect of Iraqi missile war on incidence of acute myocardial infarction and sudden death in Israeli civilians. Lancet. 1991; 338: 660-661.

11 Rumboldt Z, Miric D, Bozic I, et al. War-stress-induced medical emergencies in south Croatia. Lancet. 1993; 341: 965-966.

12 Aoki T, Fukumoto Y, Yasuda S, et al. The great East Japan earthquake disaster and cardiovascular diseases. Eur Heart J. 2012; 33: 2796-2803.

13 Leor J, Poole WK, Kloner RA. Sudden cardiac death triggered by an earthquake. N Engl J Med.1996; 334: 413-419.

14 Leor J, Kloner RA. The Northridge earthquake as a trigger for acute myocardial infarction. Am J Cardiol. 1996; 77: 1230-1232.

15 Niederseer D, Thaler CW, Egger A, et al. Watching soccer is not associated with an increase in cardiac events. Int J Cardiol. 2013; 170: 189-194.

16 Kirkup W, Merrick DW. A matter of life and death: population mortality and football results. J Epidemiol Community Health. 2003; 57: 429-432.

17 Katz E, Metzger J-T, Marazzi A, et al. Increase of sudden cardiac deaths in Switzerland during the 2002 FIFA World Cup. Int J Cardiol. 2006; 107: 132-133.

18 Barone-Adesi F, Vizzini L, Merletti F, et al. It is just a game: lack of association between watching football matches and the risk of acute cardiovascular events. Int J Epidemiol. 2010; 39: 1006-1013.

19 Wilbert-Lampen U, Leistner D, Greven S, et al. Cardiovascular events during World Cup soccer. N Engl J Med. 2008; 358: 475-483.

20 Jauss M, Sitzer M, Stolz E, et al. Lack of increase of cerebrovascular events during German World Cup soccer games in 2006. J Neurol. 2009; 256: 863-866.

21 Carroll D. Admissions for myocardial infarction and World Cup football: database survey. BMJ. 2002; 325: 1439-1442.

22 Berthier F. Lower myocardial infarction mortality in French men the day France won the 1998 World Cup of football. Heart. 2003; 89: 555-556.

23 Witte DR, Bots ML, Hoes AW, et al. Cardiovascular mortality in Dutch men during 1996 European football championship: longitudinal population study. BMJ. 2000; 321: 1552-1554.

24 Zimmerman FH, Fass AE, Katz DR, et al. Safety of spectator sports: blood pressure and heart rate responses in baseball and football fans. Am J Hypertens. 2010; 12: 816-817.

25 Kloner RA, McDonald S, Leeka J, et al. Comparison of total and cardiovascular death rates in the same city during a losing versus winning Super Bowl Championship. Am J Cardiol. 2009; 103: 1647-1650.

26 Lin LL, Gu HY, Yao YY, et al. The association between watching football matches and the risk of cardiovascular events: a meta-analysis. J Sport Sci. 2019; 37: 2826-2834.

27 May M, McCarron P, Stansfeld S, et al. Does psychological distress predict the risk of ischemic stroke and transient ischemic attack? Stroke. 2002; 33: 7-12.

28 Turin TC, Kita Y, Rumana N, et al. Incidence, admission and case-fatality of acute myocardial infarction: weekend versus weekday in a Japanese population: 16-year results from Takashima AMI Registry (1988–2003). Eur J Epidemiol. 2008; 24: 93-100.

29 Barnett AG. Excess in cardiovascular events on Mondays: a meta-analysis and prospective study. J Epidemiol Community Health. 2005; 59: 109-114.

30 Altman DG, ed. Practical Statistics for Medical Research. London: Chapman and Hall; 1991.

31 Ferrer RA, Mendes WB. Emotion, health decision making, and health behaviour. Psychol Health. 2017; 33: 1-16.

32 Chi JS. Stress and myocardial infarction. Heart. 2003; 89: 475-476.

33 Lown B, Verrier R, Corbalan R. Psychologic stress and threshold for repetitive ventricular response. Science. 1973; 182: 834-836.

34 Brodsky MA. Ventricular tachyarrhythmia associated with psychological stress. JAMA 1987; 257: 2064-2067.

35 Wilbert-Lampen U, Trapp A, Modrzik M, et al. Effects of corticotropin--releasing hormone (CRH) on endothelin-1 and NO release, mediated by CRH receptor subtype R2: a potential link between stress and endothelial dysfunction? J Psychosom Res. 2006; 61: 453-460.

36 Matsuo T, Suzuki S, Kodama K, et al. Hemostatic activation and cardiac events after the 1995 Hanshin-Awaji earthquake. Int J Hematol. 1998; 67: 123-129.

37 von Känel R, Mills PJ, Fainman C, et al. Effects of psychological stress and psychiatric disorders on blood coagulation and fibrinolysis: a biobehavioral pathway to coronary artery disease? Psychosom Med. 2001; 63: 531-544.

38 Patterson SM, Krantz DS, Gottdiener JS, et al. Prothrombotic effects of environmental stress. Psychosom Med. 1995; 57: 592-599.

39 Lowe GDO, Lee AJ, Rumley A, et al. Blood viscosity and risk of cardiovascular events: The Edinburgh Artery Study. Br J Haematol. 1997; 96: 168-173.

40 Gajda J, Śmigielski W, Śmigielski J, et al. Longevity and cardiovascular mortality of Polish elite football players. Kardiol Pol. 2018; 76: 1705-1711.

41 Sun Z, Chen C, Xu D, et al. Effects of ambient temperature on myocardial infarction: a systematic review and meta-analysis. Environ Pollut. 2018; 241: 1106-1114.

42 Stępień-Wojno M, Ponińska J, Rydzanicz M, et al. Sudden cardiac arrest in patients without overt heart disease: a limited value of next generation sequencing. Pol Arch Intern Med. 2018; 128: 721-730.

43 Borges DG, Monteiro RA, Schmidt A, et al. World soccer cup as a trigger of cardiovascular events. Arq Bras Cardiol. 2013; 100: 546-552.