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The impact of UEFA Euro 2020 football championship on Takotsubo Syndrome: Results of a multicenter national registry

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Objectives: The UEFA 2020 European Football Championship held in multiple cities across Europe from June 11 to July 11, 2021, was won by Italy, providing an opportunity to examine the relationship between emotional stress and the incidence of acute cardiovascular events (ACE).

Methods and results: Cardiovascular hospitalizations in the Cardiac Care Units of 49 hospital networks in Italy were assessed by emergency physicians during the UEFA Euro 2020 Football Championship. We compared the events that occurred during matches involving Italy with events that occurred during the remaining days of the championship as the control period. ACE was assessed in 1,235 patients. ACE during the UEFA Euro 2020 Football Championship semifinal and final, the most stressful matches ended with penalties and victory of the Italian team, were assessed. A significant increase in the incidence of Takotsubo Syndrome (TTS) by a factor of 11.41 (1.6–495.1, $P < 0.003$), as compared with the control period, was demonstrated during the semifinal and final, whereas no differences were found in the incidence of ACS [IRR 0.93(0.74–1.18), $P = 0.57$]. No differences in the incidence of ACS [IRR 0.98 (0.87–1.11; $P = 0.80$)] or TTS [IRR 1.66(0.80–3.4), $P = 0.14$] were found in the entire period including all matches of the UEFA Euro 2020 compared to the control period.

Conclusions: The data of this national registry demonstrated an association between the semifinal and final of UEFA Euro 2020 and TTS suggesting that it can be triggered by also positive emotions such as the victory in the European Football Championship finals.

KEYWORDS

cardiomyopathies, ACS, angina pectoris, Takotsubo, cardiovascular disease

Introduction

Football is a highly popular sport in many countries worldwide. Few updated data exist on the cardiac hospitalizations, acute coronary syndromes (ACS), and Takotsubo Syndromes (TTS) during the football championships, especially in the contemporary era, debating the association of acute cardiovascular events (ACE) with watching football matches.

The UEFA Euro 2020 Football Championship, commonly referred to as UEFA Euro 2020, was the 16th UEFA European Championship. The tournament was won by Italy, who in the final match beat England on penalties 3-2, after the 1-1 in extra time. In Italy, the emotional participation of the general population in the European football championship is robust and

this year was amplified because Italy entered the semifinals and the final.

The relationship between spectators' emotions and ACE during sporting events has been reported with conflictual results (1–5).

Accordingly, the present study aimed to assess the effect of the UEFA Euro 2020 Football Championship on hospitalizations for ACE in Italy.

Methods

ACE were assessed in an Italian Registry that included 1,235 patients admitted to 49 cardiac care units across all of Italy. The distribution of patients enrolled was geographically balanced

(North Italy 34%, Center 33%, South 32%). All patients' data were collected and reported into an electronic database.

The demographic and clinical data of the subjects along with the type of cardiovascular diseases were evaluated. Physicians made the clinical diagnosis of ACS or TTS based on the symptoms, the level of the markers of myocardial necrosis, EKG, Echocardiogram, and coronary angiography according to the current guidelines.

Italy's matches during the UEFA Euro 2020 Football Championship were 7 in total, and they were held on: 11 June (Italy vs. Turkey), 16 June (Italy vs. Switzerland), 20 June (Italy vs. Wales), 26 June (Italy vs. Austria), 2 July (Belgium vs. Italy). Semifinal and final were held on 6 July (Italy vs. Spain, Italy won the penalty shoot-out 4-2) and 11 July (Italy vs. England, Italy won the penalty shoot-out 3-2). The effect of matches was analyzed on the day that the match was played and the day after to avoid misclassification, as some of the matches were played in the evening. The control period (20 days) consisted of the days before and after 2 days of Italian team matches.

The study protocol was approved by the ethics committee of the Magna Graecia University of Catanzaro, Italy and all data were blindly analyzed. All patients provided written informed consent. The study conforms to the principles outlined in the Declaration of Helsinki.

It was not appropriate or possible to involve patients or the public in the design, or conduct, or reporting, or dissemination plans of this research.

Statistical analysis

The distribution of variables was evaluated using the Kolmogorov–Smirnov test. Continuous variables following a normal distribution were presented as mean \pm SD and compared using the unpaired-sample Student's *t*-test. Otherwise, variables that didn't follow normal distribution were presented as median (interquartile range [IQR]) and were compared with the Mann–Whitney *U* test. Categorical data were presented as numbers and percentages and compared with the chi-square test or Fisher exact tests. A *p*-value of <0.05 was considered to indicate statistical significance; all tests were two-sided.

We used Poisson regression with a time effect of 0 and +1 day to assess the effect of matches (6).

We calculated incidence ratios for the days of matches played by the Italian team and the remaining days of matches not involving the Italian team as the control period.

Statistical analyses were performed using the MedCalc Statistical Software version 14.8.1 (MedCalc Software, Ostend, Belgium).

Results

Baseline characteristics

A total of 1,235 patients admitted to Cardiac Care Units (CCUs) during the whole period of the UEFA Euro 2020 Football Championship (between 11 June and 12 July 2021) were analyzed. Of these, 499 were admitted during days of matches involving Italy, and 736 were admitted during the remaining days.

Among the patients, there were no significant differences in term of: male gender (66.7 vs. 68.7%, $P = 0.50$), mean age (66.62 ± 12.2 years vs. 67.52 ± 12.31 , $P = 0.44$), arterial hypertension (72.3 vs. 70.1%, $P = 0.44$), family history of cardiovascular disease (26.1 vs. 70.1%, $P = 0.93$), dyslipidemia (56.9 vs. 58.3%, $P = 0.66$), smoking (39.5 vs. 40.2%, $P = 0.66$), diabetes (29.1 vs. 26.2%, $P = 0.27$) and previous acute myocardial infarction (17.6 vs. 18.1%, $P = 0.88$). All the other parameters did not differ between the two groups except for body mass index (BMI) which was greater in the patients hospitalized during the control period in comparison with those hospitalized during days of matches involving Italy (29 ± 3.9 vs. 31.2 ± 3.9 , $p < 0.0001$) (Table 1).

Incidence of ACE during the UEFA Euro 2020 football championship

On the days of all matches involving the Italian team, there was no difference in the incidence of ACS [IRR 0.98 (0.87–1.11; $P = 0.80$)]. In particular, the comparative analysis of this group showed no differences in the frequency of admissions due to STEMI [IRR 1.03(0.86–1.24), $P = 0.72$], NSTEMI [IRR 0.97(0.81–1.15), $P = 0.71$], unstable angina [IRR 0.90(0.64–1.25), $P = 0.52$], and TTS [IRR 1.66(0.80–3.4), $P = 0.14$] compared to the control period (Table 2A).

Interestingly, ACE during the semifinal and final, the most stressful matches that ended with penalties and victory for the Italian team, showed a much more relevant increase in the incidence of Takotsubo Syndrome by a factor of 11.41 (1.6 – 495.1, $P < 0.003$) as compared with the control period (Figure 1). No differences were found in the incidence of ACS [IRR 0.93(0.74–1.18), $P = 0.57$] (Table 2B). In particular, we found 58 STEMI, 56 NSTEMI, 16 unstable angina, and 10 TTS (Table 4).

Characteristics of patients with Takotsubo Syndrome

Among patients with TTS on days when the Italian team played, most were female (70%) with a mean age of 60.7 ± 5.5 y.o. and BMI 24.3 ± 3.02 . The proportion with hypertension was 60%, dyslipidemia (20%), and the 30% were

TABLE 1 Baseline characteristics.

	Patients hospitalized during days of matches involving Italy (<i>n</i> = 499)	Patients hospitalized during control period (<i>n</i> = 736)	<i>p</i> -value
Male sex (<i>n</i> , %)	333, (66.7%)	506, (68.7%)	0.50
Age (<i>y</i> , ±SD)	66.95 ± 13.31	67.52 ± 12.31	0.44
STEMI (<i>n</i> , %)	205, (41.1%)	287 (39.0%)	0.49
NSTEMI (<i>n</i> , %)	213 (42.6%)	343 (46.6%)	0.18
UA (<i>n</i> , %)	63 (12.6%)	93 (12.6%)	0.93
TTS (<i>n</i> , %)	18 (3.6)	13 (1.8%)	0.07
Weight (kg, ±SD)	78.39 ± 15.91	77 ± 15.07	0.12
Height (cm, ±SD)	168.65 ± 12.68	169.04 ± 10.06	0.13
BMI (Kg/m ² , ±SD)	29 ± 3.9	31.2 ± 3.9	<0.0001
Hypertension (<i>n</i> , %)	361 (72.3%)	516 (70.1%)	0.44
Family history CVD (<i>n</i> , %)	130 (26.1%)	189 (25.7%)	0.93
Dyslipidemia (<i>n</i> , %)	284 (56.9%)	429 (58.3%)	0.66
Active smoker (<i>n</i> , %)	197 (39.5%)	296 (40.2%)	0.85
Diabetes (<i>n</i> , %)	145 (29.1%)	192 (26.1%)	0.27
Prior TIA/stroke (<i>n</i> , %)	21 (4.2%)	24 (3.3%)	0.50
Prior AMI (<i>n</i> , %)	88 (17.6%)	133 (18.1%)	0.88
Prior PCI (<i>n</i> , %)	100 (20.1%)	132 (17.9%)	0.36
Prior CABG (<i>n</i> , %)	17 (3.4%)	34 (4.6%)	0.37
CKD (<i>n</i> , %)	70 (14.1%)	96 (13.0%)	0.64
Atrial fibrillation (<i>n</i> , %)	40 (8.0%)	66 (9.0%)	0.61
COPD (<i>n</i> , %)	35 (7.0%)	45 (6.1%)	0.60
Hemoglobin (g/dl, ±SD)	13.47 ± 1.79	13.59 ± 1.91	0.27
Creatinine (mg/dl, ±SD)	1.07 ± 0.67	1.1 ± 0.80	0.49
eGFR (ml/min, ±SD)	82 ± 34.7	79 ± 34.54	0.13
LDL-Chol (mg/dl, ±SD)	113.13 ± 45.20	110.58 ± 41.09	0.30

STEMI, ST-elevation myocardial infarction; NSTEMI, No ST-elevation myocardial infarction; UA, unstable angina; TTS, Takotsubo; BMI, body mass index; CVD, cardiovascular disease; TIA, transient ischemic attack; AMI, acute myocardial infarction. Bold values indicate statistically significant results.

TABLE 2A Incidence of ACE on days during matches involving Italy, as compared with days during the control period.

	Incidence rate during days of matches involving Italy	Incidence rate during control period	Incidence rate difference	Incidence rate ratio	<i>P</i>
STEMI	0.40 (0.35–0.46)	0.39 (0.35–0.44)	0.013 (−0.06–0.08)	1.03 (0.86–1.24)	0.72
NSTEMI	0.44 (0.38–0.50)	0.45 (0.40–0.50)	−0.014 (−0.09–0.06)	0.97 (0.81–1.15)	0.71
UA	0.12 (0.09–0.16)	0.14 (0.11–0.17)	−0.01 (−0.05–0.03)	0.90 (0.64–1.25)	0.52
TTS	0.04 (0.02–0.06)	0.02 (0.01–0.03)	0.015 (0.004–0.034)	1.66 (0.80–3.48)	0.14

STEMI, ST-elevation myocardial infarction; NSTEMI, No ST-elevation myocardial infarction; UA, unstable angina; TTS, Takotsubo.

active smokers. Nobody had diabetes or known coronary artery disease. Only one suffered from chronic kidney syndrome on dialysis (Table 3).

Among patients with TTS, on days during the semifinal and final of the UEFA Euro 2020 Football Championship, 60% were admitted to centers in northern Italy, 10% to centers in central Italy, and 30% to centers in southern Italy (Figure 2).

Discussion

The major finding of the present study was the significantly increased risk of Takotsubo syndrome induced by a positive event such as the semifinal and final of the UEFA Euro 2020 Football Championship, ended with the victory of the Italian team.

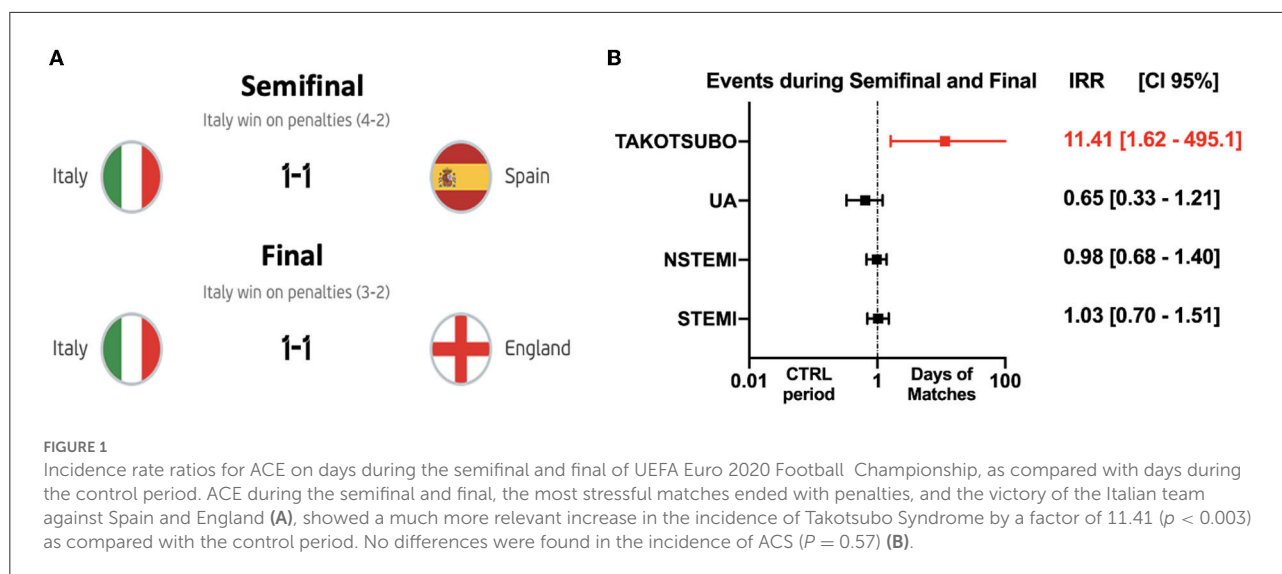


TABLE 2B Incidence of ACE on semifinal and final matches, as compared with days during the control period.

	Incidence rate during days of matches involving Italy	Incidence rate during control period	Incidence rate difference	Incidence rate ratio	P
STEMI	0.39 (0.29–0.50)	0.38 (0.29–0.48)	0.011 (–0.13–0.15)	1.03(0.70–1.51)	0.88
NSTEMI	0.42 (0.32–0.54)	0.43 (0.34–0.55)	–0.009 (–0.16–0.14)	0.98 (0.68–1.40)	0.90
UA	0.12 (0.07–0.19)	0.18 (0.12–0.26)	–0.06 (–0.15–0.02)	0.65 (0.33–1.21)	0.15
TTS	0.07 (0.03–0.13)	0.01 (0.0002–0.03)	0.06 (0.02–0.11)	11.41 (1.62–495.1)	0.0034

STEMI, ST-elevation myocardial infarction; NSTEMI, No ST-elevation myocardial infarction; UA, unstable angina; TTS, Takotsubo. Bold values indicate statistically significant results.

Since its description in 1990 (7), TTS has been defined as a syndrome precipitated by severe negative emotional stress such as pain, anger, or fear (8–10).

These precipitating causes have led to the popular definition of “broken heart syndrome” (11). It is also recognized that TTS predominantly affects postmenopausal women (12). Negative emotional stress can result in excessive or inappropriate stimulation of the sympathetic system or parasympathetic withdrawal (13).

However, TTS can be triggered by not only negative but also positive life events. Anecdotal reports (14–16) and data on the Takotsubo Registry reported that also positive emotions can trigger TTS, called the “Happy Heart Syndrome” (17).

In an international registry, the clinical presentation of patients with “happy heart syndrome” was similar to those with “broken heart syndrome” (17). Symptoms such as chest pain or electrocardiographic parameters, laboratory findings, and the 1-year outcome did not differ in the two forms (17).

The possible mechanisms of football matches induced TTS are not fully understood and might be related to an exaggerated sympathetic stimulation, especially during very stressful matches like finals. The role of the insula in the recognition of emotions such as anger and happiness through interoceptive processing

has been previously demonstrated (18). Also, genetically driven variation in the response of brain regions underlying human emotional behavior may affect the differential excitability of the amygdala to emotional stimuli (19).

Early studies have shown an association between watching football matches and an increased risk of an ACS (1, 2).

Interestingly, our study did not find an increase in the rates of ACS on the days of football matches involving Italy during the entire competition or during final and semifinal matches.

However, these findings are consistent with most previous studies (3, 4, 20).

In particular, Barone-Adesi et al. (3) did not find an increase in the rates of admission for AMI on the days of football matches involving Italy during three international football competitions. In addition, in another study watching football matches was also not associated with an increase in cardiac events (4). Conversely, the study of Wilbert-Lampen et al. (1) showed an association between watching football matches and an increased risk of an ACS in the German population during the Football World Cup 2006. The authors reported a 2.7-fold increase in cardiac emergencies in the 12 h before and after football matches involving the German team (1). However, the results of this study were not

TABLE 3 Characteristics of patients with Takotsubo during semifinal and final matches.

Age, y	66	63	54	67	52	66	59	52	59	69
Gender	F	F	F	F	F	F	F	M	M	M
Weight, kg	70	65	58	52	60	80	65	104	70	65
Height, cm	178	165	165	160	165	165	162	175	175	168
BMI	22.1	23.9	21.3	20.3	22.0	29.4	24.8	34	22.9	23.0
Hypertension	+	-	+	-	+	+	-	+	-	+
Dyslipidemia	-	+	-	-	-	-	-	-	-	+
Active smoker	-	+	-	-	-	-	-	+	+	-
Diabetes	-	-	-	-	-	-	-	-	-	-
Previous stroke or TIA	-	-	-	-	-	-	-	-	-	-
Previous AMI	-	-	-	-	-	-	-	-	-	-
Previous PCI	-	-	-	-	-	-	-	-	-	-
Previous CABG	-	-	-	-	-	-	-	-	-	-
CKD	-	-	+	-	-	-	-	-	-	-
AF	-	-	-	-	-	-	-	-	-	-
COPD	-	-	-	-	-	-	-	-	-	-
Hemoglobin, g/dl	12	13.7	11.7	12	11.3	12.9	12.5	14.3	14.9	14.3
Creatinine, mg/dl	0.86	0.77	9.34	0.8	0.64	0.69	0.68	0.8	0.93	1.10
eGFR	71	77	6	56	97	101	91	169	85	58
LDL-Chol, mg/dl	70	-	160	126	135	109	113	161	168	163
Hs-Troponin ng/ml	719	4,015	909	2,786	1,186	175	-	964	350	50
LVEF, %	50	32	35	44	37	40	30	46	56	63
Apical ballooning	+	+	+	+	+	+	+	+	+	+
sPAP, mmHg	31	57	40	34	30	-	-	-	25	-
TAPSE, mm	19	19	-	20	20	20	-	20	22	-

BMI, body mass index; CVD, cardiovascular disease; TIA, transient ischemic attack; AMI, acute myocardial infarction; LVEF, left ventricle ejection fraction; PAs, pulmonary artery pressure; TAPSE, tricuspid annular plane excursion.

confirmed by more extensive studies (3, 4, 20) and should not be generalized.

However, there are no systematic updated data available on the role of acute emotional stress induced by football championships as a trigger for Takotsubo Syndrome in the contemporary era.

We showed for the first time, in a large national registry, a significant increase in TTS incidence during stressful football matches associated with a positive event as the victory of the UEFA Euro 2020 Football Championship finals by the Italian team. Moreover, we found a TTS prevalence of 30% among male patients, while recent studies reported a prevalence of TTS approximately in 10% of the male sex (12). This data, although apparently surprising, can be explained by the fact that soccer is usually more followed by a male audience than a female one, especially in Italy as reported in a recent survey of 1,029 respondents¹

¹ Share of Italians interested in soccer in 2020. <https://www.statista.com/statistics/1127483/share-of-italians-interested-in-football-by-gender/>.

Only a few reports described a TTS after an acute emotional stress event watching football matches and were all triggered by negative events (5, 21, 22). Fijalkowski et al. described a TTS on a male after an acute emotional stress event caused by the defeat of his favorite soccer team during the Euro 2012 cup (5). Elamin et al. presented a case of a football supporter of Sheffield United who was admitted to the hospital with chest pain following a last-minute goal by the opposing team (21). Y-Hassan et al. reported a case in which a missed penalty kick triggered coronary death in the husband and TTS in the wife (22).

To date, no systematic studies or registries have shown an association between TTS and important football championships after positive emotional stress.

Limitations of the study

Our study has some limitations. First, we did not examine data on stroke, arrhythmias, and sudden death. However, sudden death is much less frequent than hospital admission for ACS.

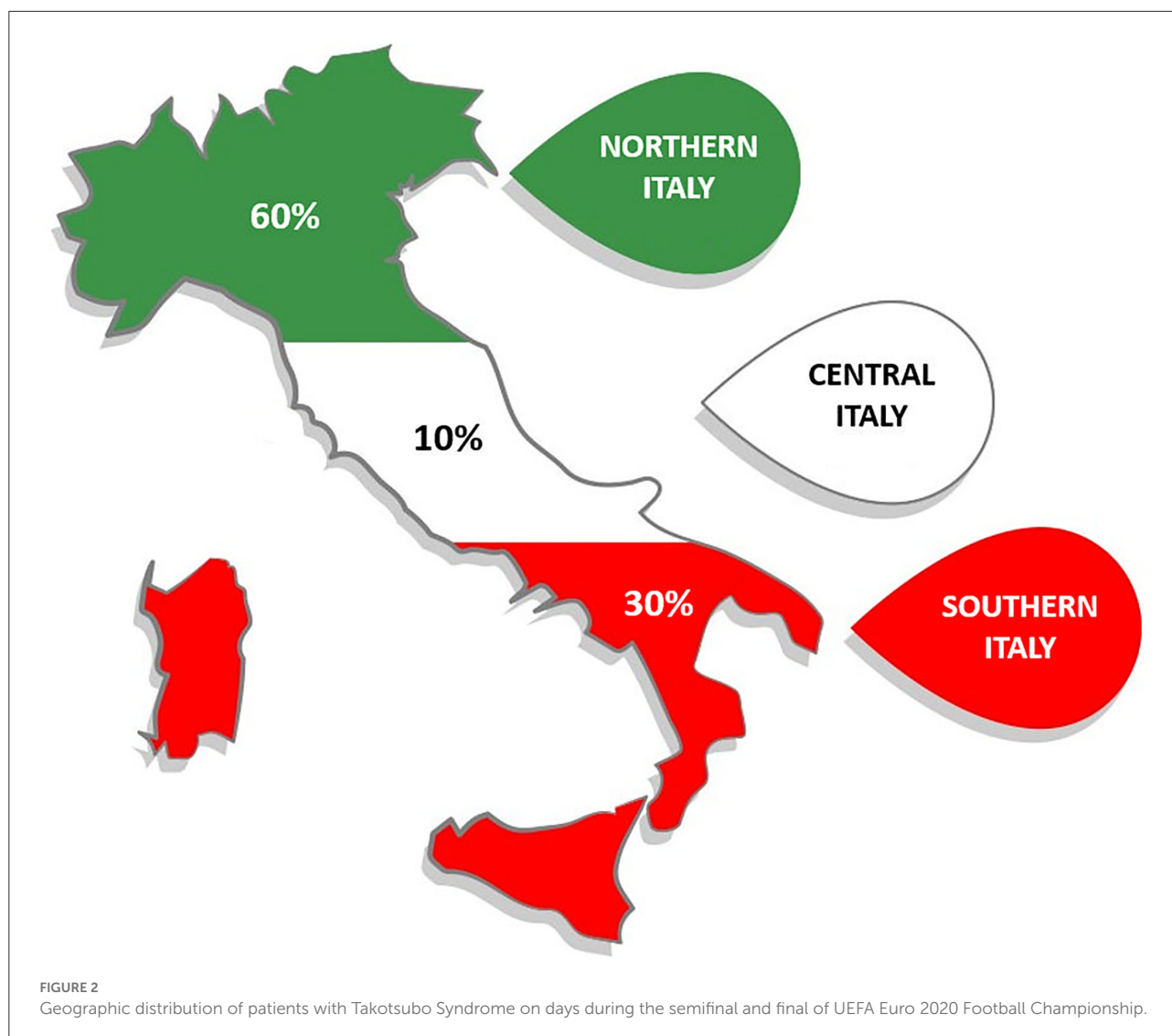


TABLE 4 ACE frequency in different periods.

	Patients hospitalized during semifinal and final matches	Patients hospitalized during other days of matches involving Italy	Patients hospitalized during control period
STEMI, n (mean/d)	58 (14.5)	147 (14.7)	287 (14.4)
NSTEMI, n (mean/d)	56 (14)	157 (15.7)	343 (17.92)
UA, n (mean/d)	16 (4)	47 (4.7)	93 (4.7)
TTS, n (mean/d)	10 (2.5)	8 (0.8)	13 (0.7)

STEMI, ST-elevation myocardial infarction; NSTEMI, No ST-elevation myocardial infarction; UA, unstable angina; TTS, Takotsubo.

Second, we assumed that patients with events on match days had indeed been watching the match. However, it is likely that the hospitalized patients have seen the matches considering the TV share over 21 million views during the finals in Italy.

Third, we do not have any information on the time of the onset of symptoms. However, by analyzing the effect of

matches on the day of the match and the day after we avoided a misclassification, as some of the matches were watched in the evening and thus were miscounted on a control day.

Fourth, we have no data about recent (or concomitant) COVID-19 infection. Moreover, we have not performed a

comparison with the previous year to avoid confounders related to the pandemic.

Fifth, we do not have any data on coronary angiography, CMR, IVUS or OCT findings and long-term follow-up.

Moreover, since the control period consisted of the days before and after the matches, it is unlikely that our results are due to the effects of unmeasured potential confounders such as temperature and pollution that were similar during the entire tournament.

Conclusions

The data of this national Registry demonstrated an association between the semifinal and final of the UEFA Euro 2020 Football Championship and TTS suggesting that it can be triggered by also positive emotions. Conversely, no differences were found in the incidence of ACS. Further prospective studies should be planned to assess the relative association risk of football matches and TTS.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by the Ethics Committee of the Magna Graecia University of Catanzaro, Italy. The patients/participants provided their written informed consent to participate in this study.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fcvm.2022.951882/full#supplementary-material>

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