The Impact of World and European Football Cups on Stroke in the Population of Dijon, France: A Longitudinal Study from 1986 to 2006

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Background: Acute stress may trigger vascular events. We aimed to investigate whether important football competitions involving the French football team increased the occurrence of stroke. *Methods:* We retrospectively retrieved data of fatal and nonfatal stroke during 4 World Football Cups (1986, 1998, 2002, and 2006) and 4 European Championships (1992, 1996, 2000, and 2004), based on data from the population-based Stroke Registry of Dijon, France. One period of exposure was analyzed: the period of competition extended to 15 days before and after the competitions. The number of strokes was compared between exposed and unexposed corresponding periods of preceding and following years using Poisson regression. *Results:* A total of 175 strokes were observed during the exposed periods compared with 192 and 217 strokes in the unexposed preceding and following periods. Multivariate regression analyses showed an overall 30% significant decrease in stroke numbers between periods of competition and unexposed periods of following year (risk ratio (RR) = 1.3; 95% confidence interval [CI] = 1.0-1.6; $P = .029$) but not with that of preceding year (RR = 1.1; 95% CI = .9-1.3; $P = .367$). This was mostly explained by a 40% decrease in stroke numbers during European Championships, compared with the unexposed following periods (RR = 1.4; 95% CI = 1.0-1.9; $P = .044$) in stratified analyses by football competitions. *Conclusions:* Watching European football competitions had a positive impact in the city of Dijon with a decrease of stroke numbers. European championship is possibly associated with higher television audience and long-lasting euphoria although other factors may be involved. Further studies using nationwide data are recommended to validate these findings. **Key Words:** Stroke—football—soccer—trigger—risk factors—registry—epidemiology.

Introduction

Acute stress may trigger cardiac events,[1-4] sudden death,[5] or stroke,[5-9] as has been demonstrated during wars[10] or after earthquakes.[11] This phenomenon is also possible immediately after stressful national and international sporting events,[4] and football is the best-known

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cause of acute stress, excitation, and anger.[3,4,12-14] Football World Cups have been blamed for increased cardiac deaths,[15,16] stroke and myocardial infarctions,[5] and hospital admissions for cardiovascular causes.[4,5]

The Fédération Internationale de Football Association World and European Cups provided the opportunity to investigate the relationship between emotional stress experienced in a predefined population during football matches and fatal and nonfatal stroke.

In the population of the city of Dijon, France, we assessed the occurrence of stroke during the 8 European and World Cups from 1986 to 2006, when France Team was qualified. Our hypothesis was that in the population of Dijon, where football is popular, World and European matches involving the national team might be a strong enough trigger to induce an increase in the number of strokes.

Materials and Methods

Study Setting

This was a retrospective study based on data from the population-based stroke registry of Dijon, France, the methodology of which has been described elsewhere.[17] The Dijon Stroke Registry prospectively collects all stroke cases occurring in the city of Dijon since 1985 (2011 census: 152,110). Briefly, the case collection procedure relies on multiple overlapping sources of information to identify fatal and nonfatal, hospitalized and nonhospitalized stroke patients. Data were obtained from: (1) a review of medical records from the emergency rooms and all the clinical and radiological departments of Dijon University Hospital, with a diagnosis of stroke made by one of the neurologists of the department of neurology, where the Stroke Registry is located; (2) a review of medical records from the emergency rooms and all the clinical departments of the 3 private hospitals of the city and its suburbs, with diagnosis made by neurologists working in these establishments; (3) a review of computerized hospital diagnostic codes of Dijon University Hospital. The *International Classification of Diseases, Tenth Revision*, was used. The following codes are initially searched for I60 (subarachnoid hemorrhage), I61 (intracerebral hemorrhage), I62 (nontraumatic intracranial hemorrhage), I63 (ischemic stroke), I64 (nondetermined stroke), G45 (vascular syndromes), G46 (transient ischemic attack), and G81 (hemiplegia). Study investigators then consulted the medical records of identified patients to confirm or not the reported diagnosis or to reclassify the patients if a misclassification was noted; (4) a review of computerized hospital diagnostic codes of the private hospitals with the same procedure as described earlier; (5) collaboration with the general practitioners to identify stroke patients managed at home or in nursing homes, with the diagnosis assessed by public or private neurologists from outpatient clinics; (6) a review of the medical records of patients identified from a computer-generated list of all requests for imaging to the private radiological and Doppler ultrasound centers of the city and its suburbs; and (7) regular checking of death certificates obtained from the local Social Security Bureau that is responsible for the registration of deaths in the community particularly fatal strokes outside hospital. The quality and the completeness of the registry are certified every 4 years by an audit from the National Institutes for Health and Medical Research and the National Public Health Institute.

Study Population

We retrieved from the Dijon Stroke Registry, abstracts of patients aged 18 years and older and diagnosed for stroke during 4 World Football Cups (1986, 1998, 2002, and 2006) and 4 European Championships (1992, 1996, 2000, and 2004). Stroke was defined according to the World Health Organization recommendations. The diagnosis of stroke subtype was always performed on clinical, cerebral imaging, and complementary exams to distinguish between ischemic and hemorrhagic (intracerebral hemorrhage or subarachnoid hemorrhage) stroke. Only first-ever symptomatic stroke was considered for this study.

Exposure Time Periods

We used a symmetrical bidirectional approach to analyze potential exposure to emotional stress that could be faced by spectators during football competitions and evaluate the impact of precompetition uncertainty and postcompetition outcome on stroke events. For each tournament, an exposure period of 15 days before the beginning and after the end of the tournament was considered and compared with the corresponding periods in the previous and following years of the tournament considered as unexposed periods 1 and 2.

We did not calculate incidence rates (by omitting the offset term from the Poisson regression model) because the population of Dijon at risk of being a spectator for each competition was unknown. We assumed that this population at risk was large relative to the daily number of stroke and that the composition and size of the population did not covary with the exposure of interest.[18]

Variables Recorded

Several baseline characteristics were recorded at stroke onset: demographics, vascular risk factors including history of known hypertension (blood pressure $\geq$ 140 mm Hg and/or 90 mm Hg, antihypertensive medication), diabetes (glucose level $\geq$ 7.8 mmol/L, treatment with insulin or oral hypoglycemic agents), and hypercholesterolemia (total cholesterol $\geq$ 5.7 mmol/L or lipid-lowering therapy). A history of prestroke transient ischemic attack, prior antiplatelet agents, anticoagulants, and antihypertensive drugs was also recorded. We also analyzed the

mean monthly temperature (°C) to control the excess mortality related to potential heat wave in France particularly in August 2003 and July 2006.[19]

Statistical Analyses

Baseline characteristics were compared between exposed and unexposed periods using the chi-square test for proportions and the *t* test for means. We performed a Poisson regression model with a log link to compare the mean number of stroke events between exposed and unexposed periods. Several variables were included in multivariate models to account for possible confounding such as age, stroke subtypes, years of admission, and other baseline characteristics with *P* values less than .20 in bivariate analyses. We calculated ratios of the number of stroke diagnosis in the unexposed period to the exposed periods (risk ratios, RR) with 95% confidence intervals (CIs) and *P* values. In case of overdispersion of the Poisson regression model, the dispersion parameter was estimated using the ratio of the deviance statistic to its associated degrees of freedom.

P values less than .05 were considered statistically significant. SAS 9.2 (SAS Institute Inc, Cary, NC) was used for statistical analyses.

Ethics

The Dijon Stroke Registry was approved by the Comité National des Registres (French National Committee of Registers) and the French Institute for Public Health Surveillance. Authorization of the Commission Nationale de l'Informatique et des Libertés was obtained for the protection of the privacy of electronic data.

Results

Extended exposure periods to 15 days before the beginning and after the end of the tournament showed a total of 175 stroke events that occurred in the city of Dijon. In comparison, 192 and 217 stroke events occurred during unexposed periods 1 and 2 (Table 1). The average age was 75 years and more than half of the patients were men (52.0%). Baseline characteristics were similar apart from a lower temperature (15.2 ± .7 C) compared with unexposed periods 1 (16.1 ± 1.0 C; $P < .0001$) and 2 (15.5 ± .8; $P = .0005$) and a higher frequency of patients with diabetes during the football competitions compared with unexposed periods (n = 34 [19.4%] versus n = 27 [12.0%]; $P = .049$).

Stratified analyses by Football Cups showed no differences except a lesser use of antiplatelet agents in patients with a stroke during European Championship, compared with the unexposed period 2 (13 versus 28; *P* for Poisson = .022; Table 2).

Using a multivariate Poisson regression, the number of strokes significantly decreased by 30% during the football competitions as a whole compared with the unexposed period 2 (adjusted RR = 1.3; 95% CI = 1.0-1.6; $P = .029$; Table 3). This was only explained by the 40% decrease of stroke number during the European Championship (adjusted RR = 1.4; 95% CI = 1.0-1.9; $P = .044$). No such difference was observed during World Football Cups.

Discussion

This is the first population-based study to investigate from 1986 to 2006 the impact of emotional stress induced by watching 8 World Football Cups and European Championship on the occurrence of stroke in the city of Dijon. The main finding was a decrease of 40% of the number of strokes related to European Championship compared with the unexposed period of following year, when the period of competition was extended to 15 days before the beginning and after the end of the tournament.

It is difficult to compare our findings with those reported in other studies because they were inconsistent.[3] Two studies showed a rise in vascular and cardiovascular events during football tournaments.[20,21] Another reported an excess of admissions for myocardial infarction but not for stroke in England on the day and the 2 days after the loss of the national team against Argentina by penalty shoot-out.[4] Two concluded to no increase in vascular[22,23] and cardiovascular[24] events. Only 1 study assessed the impact of euphoria after victory of France at home against Brazil in the final of World Cup Football 1998. The authors found a lower number of deaths from myocardial infarction compared with the mean number on the preceding and following 5 days.[25]

It has been suggested that football may be considered a trigger of vascular events. A trigger can be defined as a stimulus to pathophysiological changes, leading directly to disease. Stress hormones may directly affect endothelial, monocytic, and platelet functions.[2,5,13,14] A nonvulnerable atherosclerotic plaque can be transformed into a plaque susceptible to disruption by acute increased sympathetic nervous activity and increased coagulability.[2,5,13] A recent study found that both testosterone and cortisol concentrations were, respectively, 29% and 52% higher in 50 Spanish fans who watched the final of 2010 World Cup between the Netherlands and Spain compared with the control day.[26] The match was engaging and the Spanish team scored the winning goal at the end of the extra time. This sporting event beat all records of viewers in television history with around 15.61 million people (86% of all television spectators) in Spain.

One issue concerns the impact of the delay between the sporting event and the vascular process. Extension of 2 weeks before and after the periods of competition was associated with a lower number of stroke events during European Championship compared with unexposed periods of following years contrary to results of others studies.[4,20,21] Differences in the periods studied may

Table 1. *Baseline characteristics according to exposed and unexposed months of competition for all football cups from 1986 to 2006*

	Comparison between month of competition and corresponding month of preceding year			Comparison between periods of competition and corresponding periods of following year	
	Month of preceding year	Month of competition	*P* value	Month of following year	*P* value
Overall	192	175	.375	217	**.034**
Age, y					
<50	12	7	.257	15	.096
50-68	40	38	.821	45	.443
≥69	140	130	.543	157	.112
Gender					
Men	95	91	.769	105	.318
Women	97	84	.334	112	**.046**
Stroke subtypes					
Hemorrhagic stroke	21	22	.879	29	.329
Ischemic stroke	171	153	.318	188	.059
Vascular risk factors					
Hypertension	123	112	.473	133	.180
Diabetes	23	34	.148	27	.371
Hypercholesterolemia	43	41	.827	52	.255
Atrial fibrillation	50	37	.165	44	.437
Prestroke TIA	25	24	.886	25	.886
Prestroke medication					
Antiplatelet agents	43	37	.503	53	.093
Anticoagulants	11	15	.435	14	.853
Antihypertensive drugs	88	82	.646	94	.366
Temperature (mean ± SD)	16.1 ± 1.0	15.2 ± .7	**<.0001**	15.5 ± .8	**.0005**

The numbers of strokes were compared according to unadjusted models of Poisson. Significant results ($P < .05$) are in bold.

explain the controversies. Whereas the study of Witte et al[20] compared the index day to the 5 days before and after the event, Carroll et al[4] studied the months before and after the event, but Wilbert-Lampen et al[14] compared the 3 months before and after the event. All 3 observed an increase in the number of vascular events during the index period.

Some observations highlight the role of the event itself whatever the results of the match as the intense strain and excitement induced by the viewing of a dramatic moment such as a penalty shoot-out. On days when the German team played during the Football World Cup in June 2006, the incidence of cardiac emergencies was 2.66 times that during control period (95% CI = 2.33-3.04; $P < .001$).[14] Among patients with coronary events, the proportion with known coronary heart disease was 47% as compared with 29.1% during the control period. The interest of this study was that the incidence of cardiovascular events increased during the hours before the match, reaching a peak 2 hours before the match and remaining high for several hours after the end of the match.[14]

Conversely, other observations highlight the role of the results of the match. Cardiovascular and stroke mortality increased only in men in the Dutch population aged 45 years and older in June 1996 on the day of the final match (relative risk 1.51, 95% CI = 1.08-2.09) during the Dutch football championship.[18] In England, the risk of admission for acute myocardial infarction increased by 25% on June 30, 1998, when England lost to Argentina and remained high over the following 2 days. No excess admissions occurred for other diagnoses.[4] Therefore, the fact that the national football team loses an important match may trigger an emotional upset able to induce vascular stress.

In our study, the results of the game may partly explain the decrease of the number of strokes because we extended the exposure period to 15 days before and after the competitions. We think that several factors such as the stress induced by the "preparation" of the competition, the hopes, and good or bad surprises after the games altogether may have an impact. It seems that positive effects after the games reported as euphoria by Berthier and Boulay could be predominant lasting after competitions and may be associated with the lower number of strokes in the period of competitions compared with unexposed periods.[25] However, we need to be cautious because it is difficult to disentangle the relative contribution of each factor.

Table 2. *Stratified analyses of stroke number according to World Football Cups and European Football Championship*

	World football cups (1986, 1998, 2002, and 2006)					European football championship (1992, 1996, 2000, and 2004)				
	Comparison between period of competition and period of preceding year			Comparison between period of competition and period of following year		Comparison between period of competition and period of preceding year			Comparison between period of competition and period of following year	
	Unexposed period 1	Period of competition	*P* value	Unexposed period 2	*P* value	Exposed period 1	Period of competition	*P* value	Unexposed period 2	*P* value
Overall	114	94	.166	114	.166	78	81	.812	103	.106
Age, y										
<50	8	3	.147	8	.147	4	4	1.000	7	.372
50-68	21	22	.879	27	.476	19	16	.613	18	.732
≥69	85	69	.198	79	.411	55	61	.578	78	.150
Gender										
Men	63	44	.068	47	.753	32	47	.094	58	.284
Women	51	50	.921	67	.117	46	34	.181	45	.217
Stroke subtypes										
Hemorrhagic stroke	11	10	.827	20	.074	10	12	.670	9	.514
Ischemic stroke	103	84	.165	94	.454	68	69	.932	94	.051
Vascular risk factors										
Hypertension	75	67	.502	70	.798	48	45	.756	63	.085
Diabetes	15	22	.253	14	.186	8	12	.374	13	.842
Hypercholesterolemia	24	26	.777	28	.786	19	15	.494	24	.153
Atrial fibrillation	32	22	.176	18	.528	18	15	.602	26	.090
Prestroke TIA	16	18	.732	14	.481	9	6	.442	11	.232
Prestroke medication										
Antiplatelet agents	27	24	.675	25	.886	16	13	.578	28	**.022**
Anticoagulants	7	8	.796	7	.796	4	7	.372	7	1.000
Antihypertensive drugs	59	44	.141	41	.745	29	38	.273	53	.118

The numbers of strokes were compared using unadjusted Poisson regression.

Table 3. *Adjusted ratios (RRs) of stroke occurrence during football competitions as compared with unexposed periods*

Groups	Comparison between months of competition and corresponding months of preceding year			Comparison between months of competition and corresponding months of following year		
	RR	95% CI	*P* value	RR	95% CI	*P* value
Overall	1.1*	.9-1.3	.367	1.3*	1.0-1.6	**.029**
World football cups	1.2†	.9-1.6	.180	1.1†	.9-1.5	.347
European Football Championship	.9‡	.6-1.3	.594	1.4‡	1.0-1.9	**.044**

Abbreviation: CI, confidence interval; RR, risk ratio.

Significant results ($P < .05$) are in bold.

*Adjusted for age, years of admission, stroke subtypes, diabetes, atrial fibrillation, transient ischemic attack, antiplatelet agents, hypercholesterolemia, and temperature.

†Adjusted for age, years of admission, stroke subtypes, diabetes, atrial fibrillation, transient ischemic attack, hypertension, hypercholesterolemia, anticoagulants, and temperature.

‡Adjusted for age, years of admission, stroke subtypes, diabetes, atrial fibrillation, transient ischemic attack, hypertension, and temperature.

We can postulate that competitions particularly European Championship were probably more engaging for spectators because of football matches broadcasted during the day leading to a higher television audience. In contrast, World Cup matches hosted in Brazil in 1996, United States in 1994, and South Korea and Japan in 2006 were broadcasted at night for French TV spectators. Nigh-time activities may be a concern for elderly TV spectators who are more at risk of stroke. The proportion of people older than 65 years (25%) in the city of Dijon is greater than that in the global French population.[27] The profile we observed in patients with stroke in the different periods of exposure was characterized by a higher proportion of old women, ischemic stroke, diabetes, and treatment with antiplatelets and antihypertension drugs.

Our study has limitations. First, a lack of sleep, overeating, heavy alcohol consumption and smoking, excitement, and failure to comply with medical regimens in patients with vascular risk factors were not taken into account in multivariate analyses. Moreover, the results of several competitions were pooled together although they could have heterogeneous impact because of victory and defeat on the occurrence of stroke that may have biased the estimates toward the null. Lastly, the lack of statistical power prevented us to stratify by football competitions and to include additional confounding factors in models such as comorbid conditions (eg, myocardial infarction, heart failure) or environmental factors (weather data, particulate matter).

The strength of our study was that is was the first to report the 21-year impact of 8 football competition on the occurrence of stroke. Thus, we avoided selection biases observed in studies that were based on only 1 or 2 matches.[3,20,23] Finally, we did not use incidence rates because of an unknown population at risk of spectators at Dijon limiting a possible underestimation of the true effect of football that would have been observed with use of incidence rates.

Conclusion

Our population-based study showed that only European Championship had a positive impact with a lower number of strokes in the city of Dijon during extended periods of 15 days before and after competitions. These results may be explained by higher television audience and long-lasting euphoria after victory. Further studies using nationwide data are recommended to validate these findings.

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