World Soccer Cup as a Trigger of Cardiovascular Events

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Abstract

Background: **Acute coronary syndromes are the major cause of death in Brazil and in the world. External stimuli, known also as triggers, such as emotional state and activity, may generate physiopathological changes that can trigger acute coronary syndromes. Among the studied triggers, the impact of stressful events, such as soccer championships, are controversial in literature and there is no effective data on the Brazilian population.**

Objective: **To evaluate the acute effects of environmental stress induced by soccer games of the World Soccer Cup on increased incidence of cardiovascular diseases in Brazil.**

Methods: **Public data were obtained from the Unified Health System (Sistema Único de Saúde), regarding hospital admissions that had the International Code Disease of acute coronary syndromes from May to August, in 1998, 2002, 2006 and 2010 (155,992 admissions). Analysis was restricted to patients older than 35 years and admitted by clinical specialties. The incidence of myocardial infarction, angina and mortality were compared among days without World Cup soccer games (Group I: 144,166; 61.7 ± 12.3; 59.4% males); on days when there were no Brazil's soccer team matches (Group II: 9,768; 61.8±12.3; 60.0% males); and days when there were Brazil's soccer team matches (Group III; 2,058; 61.6±12.6; 57.8% males). Logistic regression was used to adjust to age, gender, population density and number of medical assistance units.**

Results: **The incidence of myocardial infarction increased during the period of World Cup soccer games (1.09; 95%CI = 1.05-1.15) and days when there were Brazil's matches (1.16; 95%CI = 1.06-1.27). There was no impact on mortality during the Cup (1.00; CI95% = 0.93-1.08) and Brazil's matches (1.04; 95%CI = 0.93-1.22).**

Conclusion: **World Cup soccer games and, specially, Brazil's matches have an impact on the incidence of myocardial infarction, but not on in-hospital mortality. (Arq Bras Cardiol. 2013;100(6):546-552)**

Keywords: **Cardiovascular Diseases; Acute Coronary Syndrome; Myocardial Infarction; Sports, Athletes; Soccer.**

Introduction

Atherosclerosis is the major cause of morbidity and mortality in the western world, with Acute Coronary Syndrome (ACS) being one of its main manifestations. Although many risk factors have already been well-established, triggering factors are still debatable, i.e., those factors that imply that ACS is triggered at a specific moment in time. These factors are known as "triggers" and can be defined as an external stimulus, emotional state or activity that produces physiopathological changes leading to a vascular event[1]. Situations such as acute exposure to pollutants, cold and wet weather, behavioral factors and exposure to stressful situations have been investigated[2-7].

Among the events assessed as potential triggers of emotional stress, sports matches are interesting objects of study, considering their broad population impact. Reported associations between soccer matches and rates of illness and death from cardiac causes have been controversial[8-18].

It is assumed that in a country such as Brazil, where soccer is particularly popular, World Cup matches involving the Brazilian team could be a strong enough trigger to increase the incidence of cardiovascular emergencies.

Methods

This is a descriptive, observational study and data were obtained from the Hospital Information Systems of the Unified Health System (SIH/SUS), managed by the Ministry of Health and available at the internet with free access.

Data on hospitalizations and in-hospital deaths were obtained from Hospitalization Admission Authorization (HAA) records, which contain information on treatment, with the diagnosis at admission and discharge (coded according to ICD 10), data on the individual's characteristics (age and gender), time and place (origin of the patient) of hospitalizations, procedures performed, amounts paid

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Manuscript December 11, 2012, revised January 23, 2013, accepted February 15, 2013.

DOI: 10.5935/abc.20130105

and registration data from health facilities, among others, which allow their use for epidemiological purposes. As the number of HAA can be repeated according to the year (single numerical series issued annually by ministerial order), possible duplicates were discarded, keeping the HAA of which there was only one per year of birth, year of hospital admission and hospital identification number (CGC) (Figure 1).

The analysis units were hospitalizations and in-hospital deaths aggregated by year of occurrence of the event, from May 1 to August 31 of the years 1998-2010, in order to cover approximately one month before and one month after the completion of the World Soccer Cup, held every four years between June and July, and also to ensure the same weather conditions. The analysis was restricted to ACS that culminated in hospital admission or in-hospital death and that were diagnosed as angina and acute myocardial infarction (AMI), corresponding to chapters I20, I21 and I22 of ICD-10.

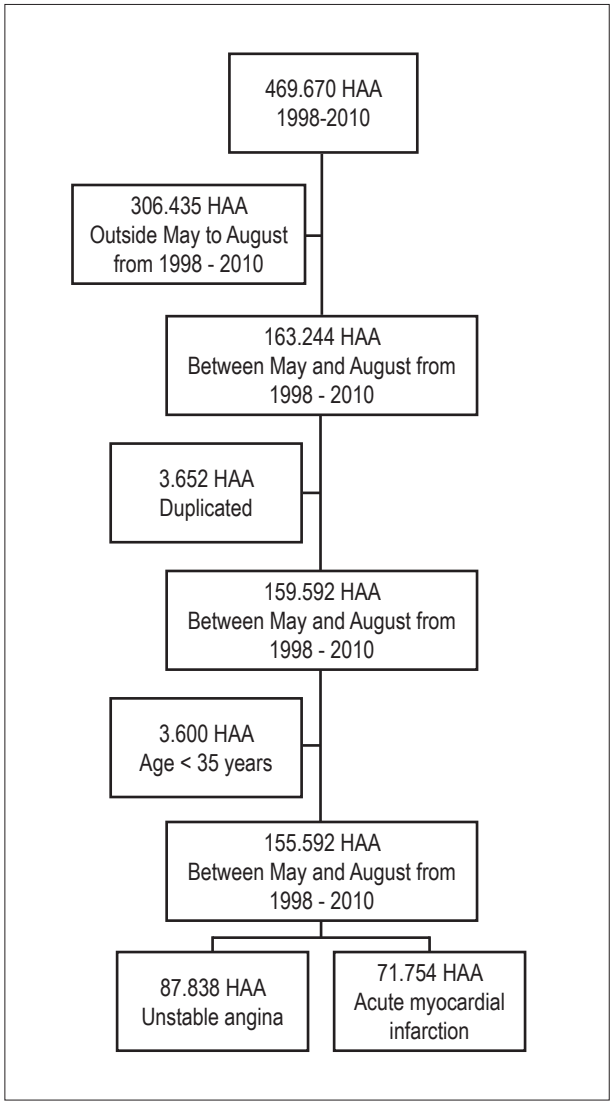

Figure 1 - *Selection criteria used to define the study population. HAA: Hospital Admission Authorization.*

The years 1998, 2002, 2006 and 2010 were defined as exposure periods to World Soccer Cup and the respective dates of Brazil's matches (Group 3) were compared with days without World Cup games (Group 1) and without Brazil's matches as control (Group 2). This variable was used in both models continuously, assuming a constant increment of the trigger as categorical variable, to explore multiplicative impact.

All statistical analyses were performed using the STATA package, release 10. Categorical variables were expressed as percentages, using the Chi-square test for differences between groups. Analysis of variance (ANOVA) was used for comparison of continuous variables. Logistic regression analysis was used to correct for age, gender, population density and total population of the state of São Paulo the association between exposure (days on which there were World Soccer Cup games) and the outcomes (death and AMI), according to Table 1.

The number of events per day of infarctions and deaths was used as the outcome for the Poisson regression analysis, correcting the association with exposure for gender and age, in relation to the population of the state of São Paulo estimated for each year (obtained from official sources available at the internet), as shown in Table 2. Sensitivity analysis to assess data consistency was performed in two different ways. For logistic regression, we used stratification by gender for comparison with some findings in the literature (Table 1). The second strategy was to disregard the years when there was no World Cup and recalculate the estimates (Tables 1 and 2). In a third strategy, we included one variable for each year of occurrence of the event, due to the fact that an increased incidence of myocardial infarction and death was observed throughout the study period (Figure 2). Finally, we calculated the values for each Cup year alone. For all tests, a p value < 0.05 was considered statistically significant and the 95% confidence intervals were also shown, whenever possible.

The study was approved by the Ethics Committee in Research of Hospital das Clínicas da Faculdade de Medicina de Ribeirão Preto da Universidade de São Paulo (HCFMRP-USP process # 4.308/2010; CAAE 0121.0.004.000-10). Considering that the study used publicly available information from SUS and the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística - IBGE), therefore not directly involving subjects' confidential data, the signing of the free and informed consent form was not necessary. This study received funding from the Institutional Program for Scientific Initiation Scholarships (PIBIC) of the National Council for Scientific and Technological Development (CNPq).

Results

A total of 469,679 admissions from ICD related to ACS between 1998 and 2010, the study population consisted of 155,592 individuals (33.1%), after considering those that

Table 1 - Odds ratio and confidence interval (95%) for myocardial infarction and death for the total population and years in which there were World Cup soccer games

		Infarction			Death		
		Total*	Men**	Women	Total***	Men****	Women
Population 1998 to 2010							
Continuous		1 .08 (1.05;1.12)	1.08 (1.04;1.13)	1.08 (1.03;1.14)	1.01 (0.95;1.07)	1.00 (0.93;1.08)	1.09 (1.00;1.19)
Categorical	Ref	-			-		
	No Brazil's matches	1.09 (1.05;1.15)	1.09 (1.03;1.15)	1.09 (1.02;1.17)	1.00 (0.93;1.08)	0.96 (0.86;1.07)	1.14 (1.02;1.27)
	Brazil's matches	1.16 (1.06;1.27)	1.16 (1.03;1.31)	1.16 (1.02;1.17)	1.04 (0.93;1.08)	1.14 (0.92;1.41)	1.09 (0.86;1.38)
Population for World Cup years (1998, 2002, 2006, 2010)*****							
Continuous		1.04 (1.01;1.08)	1.04 (1.00;1.08)	1.04 (1.00;1.10)	1.038 (0.97;1.10)	1.01 (0.93;1.10)	1.07 (0.99;1.17)
Categorical	Ref						
	Not Brazil's game	1.03 (0.99;1.08)	1.03 (0.97;1.09)	1.04 (0.97;1.12)	1.03 (0.95;1.13)	0.93 (0.86;1.28)	1.13 (1.00;1.28)
	Brazil's game	1.10 (1.01;1.21)	1.11 (1.00;1.26)	1.15 (1.00;1.32)	1.07 (0.91;1.26)	1.09 (0.88;1.36)	1.02 (0.88;1.30)

** The regression model included acute myocardial infarction as outcome, adjusting for the exposure variable (0 - days with no game 1 - game day without Brazil's matches and 2 - game day with Brazil's matches) and confounding factors: age (years), gender, population density of the city of origin and population of the State of São Paulo. The model used the exposure variable in both continuous and categorical form; ** the same analysis of (1) was performed stratified by gender, but this analysis is also corrected for the year of the event (see Table 3) ; *** the same analysis of (1) using death as endpoint; **** the same analysis (3) was performed stratified by gender; ***** were calculated using the same models described from 1-4, but in this analysis, the year of the event was also corrected (see Table 3).*

Table 2 - Number and percentage of patients with acute myocardial infarction, incidence rate per 100,000 inhabitants and odds ratio obtained by the model (5) according to the World Cup year. The year 2002 was used as a reference for having the lowest percentage of infarction in the selected population

Year	Number AMI (%)	AMI rate (/100,000 inhabitants)	Odds ratio - (year 2002 used as reference)
1998	3.444 (45,6)	9.8	1.21 (1.14;1.29)
2002	4.558 (41,4)	11.9	Ref
2006	6.181 (47,6)	15.1	1.26 (1.19;1.33)
2010	7.455 (49,7)	17.5	1.35 (1.29;1.42)

AMI: acute myocardial infarction.

occurred between May and August of each year, discarding potential duplicates (3,652) and inadequate codes (3,600), as shown in Figure 1. Of the resulting population, 71,754 HAA were identified as AMI (45.0%) and 13,181 (8.4%) died in the hospital.

In the univariate analysis, 996 (48.4%) of hospital admissions were diagnosed as AMI and 190 (9.2%) died on the days when Brazil's matches were held. This number of hospitalizations with AMI diagnosis significantly different from the other groups; when compared to the total population, it was significant ($p < 0.01$) and showed a trend when the analysis was restricted to the World Cup years ($p = 0.06$). There was no difference in mortality from ACS (Table 3).

This difference in the number of infarctions among the groups persisted after correcting for possible confounding factors and resisted the sensitivity analysis, in which the analysis was restricted to the World Cup years (Table 1). The same pattern was maintained when the analysis was stratified by gender. Considering that increased rates of incidence and mortality were observed throughout the study years, the variable "year" was included in the adjusted models (Figure 2 and Table 2). When calculating the impact for each year of World Cup alone, significance was observed only for the year 2006 (1.13 - 1.06; 1.21), whereas the same was not observed the same for the other years - 1998 (1.07 – 0.99; 1.16); 2002 (0.99 – 0.93; 1.03) and 2010 (1.01 – 0.95; 1.07).

Regarding the increase in the number of events as the outcome of Poisson analysis, the same finding was observed for the increased incidence of myocardial infarction, although, when the "World Cup" variable was used as categorical variable, there was only a trend toward the increase on days of Brazil's matches (Table 4). In relation to the increased incidence of in-hospital deaths, there was no difference between the groups.

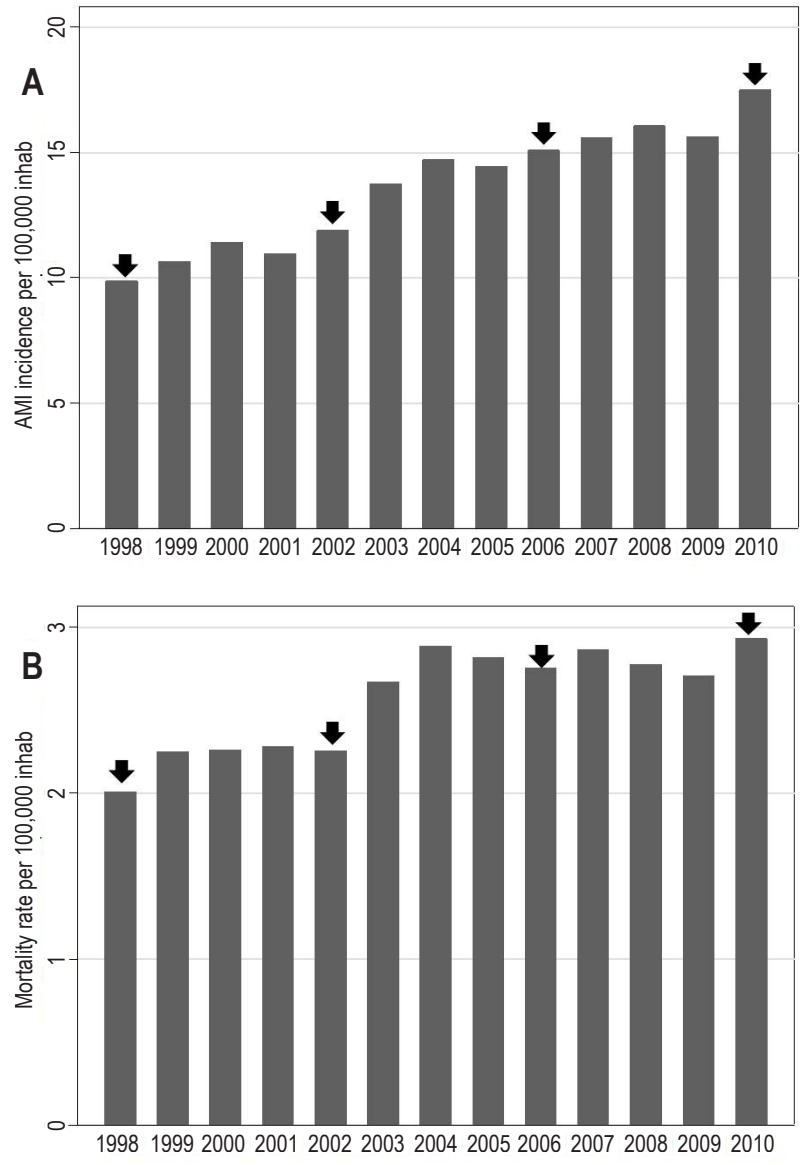

Figure 2 - *Incidence rate (A) and in-hospital mortality (B) of acute coronary syndromes (per 100,000 inhabitants) according to the year. The arrows show the years when the World Cup was held. AMI: acute myocardial infarction.*

Discussion

World Cup games are associated with an increased occurrence of AMI among Brazilians, ranging between 4 and 8%, depending on the stringency of the criteria used in the analysis. When using the variable "World Cup" as a distinct category, these estimates may increase to 9-16% for general and 0-10% for more careful analysis. Regarding the occurrence of in-hospital mortality, no consistent behavioral difference was observed between the groups.

Sports events as cardiovascular event triggers have been studied for over a decade, with controversial results. Some studies have found increased incidence of infarctions, at much higher numbers than those shown in this study[10,11,13,15,16]. Particularly, Spitters[15] showed an odds ratio of 2.66, but even the other studies that showed an association demonstrated higher numbers than those found herein, being around 25%. A single study showed a decrease in the occurrence of events during the games, being attributed to the fact that the country of the study won the World Cup[14]. Finally, other studies did not show any association[8,9,12,18]. A noteworthy point is that two studies showed controversial results, using a population exposed to the same international event, but held in different countries[12,13].

An important point that differentiates between studies is the outcome used. This study was able to show that the chance

Table 3 - Variables of interest, according to the study group and the reference population

	Group I – no games (n = 144,166)	Group II – game days, but no Brazil's matches (n = 9,708)	Group III – game days, with Brazil's matches (n = 2,058)	p
Population 1998 to 2010				
Age (years) - mean (SD)	61.7 (12.3)	61.8 (12.3)	61.6 (12.6)	0.289
Male gender (%)	85.731 (59.4)	5.867 (60.0)	1.190 (57.8)	0.155
Diagnosis of infarction at admission (%)	64.622 (44.8)	4.607 (47.1)	996 (48.4)	< 0.01
In-hospital death (%)	12.133 (8.4)	858 (8.8)	190 (9.2)	0.197
Population for World Cup years (1998, 2002, 2006, 2010)				
	Group I – no games (n = 34,681)	**Group II – game days, but no Brazil's matches (n = 9,759)**	**Group III – game days, with Brazil's matches (n = 2,058)**	**p**
Age (years) - mean (SD)	61.7 (12.3)	61.8 (12.3)	61.6 (12.6)	0.289
Male gender (%)	20.777 (59.9)	5.867 (60.0)	1.190 (57.8)	0.154
Diagnosis of infarction at admission (%)	16.041 (46.2)	4.607 (47.1)	996 (48.4)	0.06
In-hospital death (%)	2.894 (8.3)	858 (8.8)	190 (9.2)	0.197

Table 4 - Incidence rate calculated by Poisson regression using the number of events (myocardial infarction or death) as the outcome and adjusting for exposure (0 - no games; 1 - no Brazil's matches; 2 – Brazil's matches) and confounding factors (age, gender, city's population). At the analysis restricted to the population in World Cup years, the year variable was used in the regression model

		Infarction	Death
Population from 1998 to 2010			
Continuous		1.01 (0.99;1.03)	1.01 (0.95;1.06)
Categorical	Ref		
	No Brazil's matches	1.01 (0.98;1.04)	1.04 (0.97;1.12)
	Brazil's matches	1.03 (0.97;1.09)	1.03 (0.90;1.19)
Population for World Cup years (1998, 2002, 2006, 2010)			
Overall		1 .03 (1.00;1.06)	1.04 (0.97;1.11)
Categorical	Ref		
	No Brazil's matches	1.05 (1.00;1.09)	1.10 (1.01;1.20)
	Brazil's matches	1.03 (0.95;1.11)	0.97 (0.81;1.16)

of a patient with chest pain having an AMI when admitted to the hospital was higher on the World Cup game days, especially if they were Brazil's matches, but there was no difference in in-hospital mortality. In this sense, the data from this study are comparable to those of Carroll et al[10], with similar design, albeit with a smaller magnitude. Regarding the magnitude of the effect, the estimates from this study seem to be more comparable to other studies, with the exception of the one by Katz et al[16] and Wilbert-Lampen et al[8].

Unlike other studies, the occurrence of ACS was observed in four world events. This may be the explanation of a more robust estimate than that observed in isolated events. When the events are studied separately, a significant increase in the number of events was observed only in 2006, which may partly explain the variation observed in other studies.

Even separately, there was no protective effect in the 2002 World Cup, when Brazil became five-time world champion, which is in disagreement with data from Berthier et al[14]. Another noteworthy point is that the obtained estimates resisted the sensitivity analysis with more specific criteria, with no differences regarding gender and after being corrected by the estimated population for each year.

Data of the present study on mortality are restricted to in-hospital death. Thus, it does not seem strange that the sports event will not work as a trigger after hospital admission, which is an environment where the patient is

better protected. This may explain the differences found in other studies that observed increased prehospital mortality[8,11-13]. Perhaps the same limitations might explain the fact that there were no differences between genders in this study.

A limiting factor in all studies, including the present one, was the fact that they start from the premise that an event can have an impact on the entire population, even though the exposure may not be homogenous (part of the population may not be watching the game). This limitation would only be possible to circumvent with studies such as the one by Sierra Grima et al[17] that studied the occurrence of infarction, cardiovascular emergencies and cardiac arrest directly in the stadiums during the season of Barcelona games in 2000-2001, verifying a risk of 0.0056 episodes per 100,000 person-hours. Considering the 1990 infarction rate, which was 165 per 100,000 (world's) and 278 per 100,000 inhabitants (developed countries) and that the occurrence was homogeneous as a function of time, the authors hypothesized that the occurrence should have been much lower. Likewise, prospective prehospital data would be interesting in future events.

Taking into account dissimilar data, considering that sports events are associated with increased incidence of cardiovascular events, probably similar to other emotional triggers, and that these events occur in distinct populations and constitute the best available evidence, it seems reasonable to increment the public policy of defibrillation and population training[19]. In two years, Brazil will host a World Cup and our health care conditions are precarious. The trigger effect of sports events is expected to be maximized, as the Cup will be held in Brazil and it would be neglectful if our stadiums were not prepared to deal with such situations of high population concentration[20,21].

As previously mentioned, this study has several limitations. This is a retrospective study, based on data of which verification is limited by the preservation of individual confidentiality and, additionally, other triggers may have an impact on the studied outcomes, which were not evaluated. Another factor may be the day of event notification, as, due to administrative problems, they are often made on working days only and the matches are held on holidays or weekends. Although the strategy of restricting the analysis to a single period of the year sought to correct environmental triggers, the increased incidence of myocardial infarction and the absence of objective data on the level of pollution in the state of São Paulo are limitations that cannot be corrected.

Conclusion

In summary, the World Cup soccer games can act as triggers to generate AMI in Brazil, but there were no differences regarding gender or in-hospital mortality. Additional prospective studies are needed, but, considering the risk to which the population may be exposed when Brazil hosts the World Cup in 2014, training and structural measures should be implemented in stadiums for basic life support.

Author contributions

Conception and design of the research, Statistical analysis and Critical revision of the manuscript for intellectual content: Borges DGS, Schmidt A, Pazin-Filho A; Acquisition of data, Analysis and interpretation of the data and Writing of the manuscript: Borges DGS, Monteiro RA, Pazin-Filho A.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

Sources of Funding

This study was partially funded by PIBIC of CNPq.

Study Association

This article is part of the thesis of research iniciation submitted by Daniel Guilherme Suzuki Borges, from Faculdade de Medicina de Ribeirão Preto.

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