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It is just a game: lack of association between watching football matches and the risk of acute cardiovascular events

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Background The role of trigger factors in acute cardiovascular events has been much studied in the past few years. A recent study analysed changes in the rates of cardiac emergencies in Bavaria (Germany) during the last Football World Cup. The authors reported a 2.7-fold increase in the incidence of cardiac emergencies in the 12 h before and after football matches involving the German team, which sparked the debate on the necessity of the introduction of *ad hoc* cardiovascular preventive measures.

Methods We studied 25 159 hospital admissions for acute myocardial infarction (AMI) among the Italian population during three international football competitions: the World Cup 2002, the European Championship 2004 and the World Cup 2006. Poisson regression was used to estimate the relative risk of hospital admission for AMI on the days when football matches involving the Italian team were disputed, compared with the other days of the three competitions. Furthermore, we reviewed the available published studies regarding the association between football matches and the risk of cardiovascular events.

Results We did not find an increase in the rates of admission for AMI on the days of football matches involving Italy in either the single competitions or the three competitions combined (relative risk 1.01; 95% confidence interval 0.98–1.05). We identified 10 studies published on this topic. With the exception of the recently published German study and two small Swiss studies, all relative risk estimates were between 0.7 and 1.3.

Conclusions The cardiovascular effects of watching football matches are likely to be, if anything, very small.

Keywords Football, acute myocardial infarction, cardiovascular triggers

Introduction

The role of trigger factors in acute cardiovascular events has been much studied in the past few years. Studies have investigated the effects of triggers acting on both the individual level, such as episodes of anger, heavy physical exertion, sexual activity and drug consumption,[1] and on a large number of people during a limited time span, from earthquakes and armed conflicts to political and sporting events.[2–4] Watching sporting events could contribute to cardiovascular risk by increases in sympathetic nervous system stimulation and circulating catecholamines induced by the emotional

involvements in the game, associated with other behaviours such as smoking, binge drinking and overeating.[4]

A recent study by Wilbert-Lampen and colleagues[5] analysed changes in the rates of cardiac emergencies in Bavaria (Germany) during the last football world cup, held in Germany in 2006. The incidence of cardiac emergencies in the population increased 2.7-fold during the 12 h before and after matches involving the German team.[5] The authors claimed that this finding has relevant public health implications, which sparked a debate on the necessity of the introduction of *ad hoc* preventive measures.[5–7]

We have investigated the association between football matches involving the Italian team in the last three international competitions and the rates of hospital admissions for acute myocardial infarction (AMI) among the Italian population (60 million inhabitants). Since the Italian team participated in the final phase of all of the last competitions, our study is based on a very large number of events and takes advantage of several repeated episodes of exposure. Furthermore, we evaluated the results of our study and that of Wilbert-Lampen and colleagues in the context of published studies on the association between football matches and the risk of cardiovascular events.

Methods

We studied daily hospital admissions for AMI in Italy during three international football competitions: the 2002 FIFA World Cup (held in South Korea and Japan between May 31 and June 30), the European Championship 2004 (held in Portugal between June 12 and July 4) and the 2006 FIFA World Cup (held in Germany between June 9 and July 9). Records of hospital admissions with a primary diagnosis of acute myocardial infarction (International Classification of Diseases, Ninth edition, Code 410) were obtained from the National Hospital Discharge Database in the form of individual anonymous records, which included age, date of admission and gender. The National Hospital Discharge Database, created in 1994, collects information on all hospitalizations recorded in Italy. The data collection has gradually improved in quality and completeness during the first 5 years and is currently regarded as highly complete.[8]

The exposure period included the days on which the Italian team played, whereas the control period included all other days of the three competitions. We used Poisson regression to estimate the relative risk of hospital admission for AMI, comparing the exposure days with the control days, for each single competition and for the three competitions combined.

Weekly variations in hospital admissions for AMI were taken into account including day of the week as a categorical variable in the models. The pooled effect estimate was obtained fitting a model including tournament as a random effect. As the comparison was made between exposed and control days within the same competition, possible confounding by long-term trends and seasonal variations in incidence of AMI were inherently taken into account. However, the control period consisted of days before and after the matches and we considered it unlikely that temperature and air pollution could change between control days and exposed days to such an extent as to introduce bias. We checked this assumption by collecting data on temperature and concentration of nitrogen dioxide for one northern Italian city (Milan), one city in central Italy (Rome) and one in southern Italy (Palermo). As reported in Table 1, average temperature and concentration of nitrogen dioxide during days when the Italian team played were very similar to figures recorded during the control days.

We also carried out secondary analyses that were limited to men aged <65 years on the assumption that football matches are viewed mostly by younger male individuals. Moreover, we also carried out analyses stratifying matches by the time of day when they were broadcasted in Italy. Finally, we conducted an analysis including only matches disputed in the final stage (knockout stage) of each competition (one match in 2002, no match in 2004 and four matches in 2006), with the assumption that these matches were watched by a larger proportion of the population and could be associated with a larger emotional involvement of the viewers.

Table 1 Descriptive statistics of temperature and concentrations of nitrogen dioxide in different Italian cities during three international football competitions (2002 FIFA World Cup, the European Championship 2004 and 2006 FIFA World Cup)

	Temperature (°C)		Nitrogen dioxide ($\mu g/m^3$)	
	When Italy played Mean (SD)	When Italy did not play Mean (SD)	When Italy played Mean (SD)	When Italy did not play Mean (SD)
Milan (northern Italy)	24.8 (3.1)[a]	25.1 (2.9)[a]	47.8 (13.6)[b]	39.8 (11.8)[b]
Rome (central Italy)	23.9 (3.0)[a]	24.6 (3.4)[a]	57.3 (14.8)[a]	57.8 (15.5)[a]
Palermo (southern Italy)	25.5 (3.6)[a]	26.1 (3.3)[a]	50.3 (14.1)[b]	48.2 (12.2)[b]

Mean values and standard deviations (SDs) are stratified by days when the Italian team played and days when the Italian team did not play.

[a]Figures are based on the measurements obtained during all three competitions.

[b]Figures are based on the measurements obtained during the 2002 FIFA World Cup and the European Championship 2004.

ref.: reference group.

To identify previously published studies on the association between football matches and cardiovascular events, we searched PubMed in December 2008 by using combinations of the following MeSH terms: Football; Soccer; Acute Coronary Syndrome; Angina; Arrhythmias, Cardiac; Coronary Disease; Myocardial Infarction; Stroke; Cardiovascular Diseases; Heart Arrest; Death, Sudden. Furthermore, we scrutinized all cited references from the retrieved articles. When studies reported both single-match and pooled estimates, we considered the summary estimate in our review. In addition, if only gender-specific estimates were reported, we calculated a pooled estimate for men and women combined.

Results

In total, 25 159 hospital admissions for AMI occurred in the Italian population during the three football competitions. Out of these, 4395 events occurred on 1 of the 14 days of matches involving the Italian team (Table 2). During the 2002 FIFA World Cup, matches involving Italy were viewed in Italy between 9 and 11 am. In the European Championship 2004, they started between 4 and 7 pm, whereas in the 2006 FIFA World Cup, they started between 4 and 9 pm. The days of the football matches were not associated with an increase in admissions for AMI in the three competitions combined [pooled relative risk (RR) 1.01; 95% confidence interval (CI) 0.98–1.05] or in each single competition. The incidence did not increase (RR 1.03; 95% CI 0.90–1.17) when Italy and France played a dramatic penalty shootout in the final match of the World Cup 2006 (data not reported in tables). Restriction of the analyses to men aged <65 years (pooled RR 1.03; 95% CI 0.97–1.09) did not substantially affect the results. Furthermore, secondary analyses were carried out stratifying matches by the time of day when they were broadcasted in Italy. No effect was observed in any of the three groups—matches of World Cup 2002 (viewed in Italy in the morning), matches disputed in the afternoon (RR 0.97; 95% CI 0.92–1.03) and matches disputed in the evening (RR 1.02; 95% CI 0.96–1.08). Finally, when we included in the analysis only matches disputed in the final stage of each competition, no increase in the rates of admissions for AMI was observed (RR 0.99; 95% CI 0.94–1.06).

Our review identified 10 published articles on the association between football matches and cardiovascular events (Table 3). There were important methodological heterogeneities among these studies that hampered a quantitative summary measure of effect. Regarding the definition of the outcome, five studies analysed mortality rates for AMI[9,10] or AMI and stroke combined,[4,11,12] two studies evaluated hospital admissions with a discharge diagnosis of either AMI or stroke,[13,14] two studies investigated the occurrence of out-of-hospital cardiac arrests and sudden cardiac death,[15,16] and one study investigated hospital admissions with a preclinical diagnosis of acute cardiovascular events (AMI, unstable angina, symptomatic cardiac arrhythmia, cardiac arrest leading to cardiopulmonary resuscitation or therapeutic discharge of an implantable cardioverter-defibrillator).[5] Regarding the definition of the exposure period, three studies evaluated the effect of a single football match,[4,9,10] whereas the studies by Bauman and colleagues,[14] Carroll and colleagues,[13] Brunekreef and Hoek[11] and Wilbert-Lampen and colleagues[5] were based on two, four, five and seven matches, respectively.

The English study by Kirkup and Merrick[12] evaluated all competitive matches played over 5 years by four local football teams to investigate whether the result of the matches (local team lost at home vs other results) was associated with cardiovascular mortality. Finally, in the two studies by Katz and colleagues,[15,16] the entire duration of the studied competitions was considered as the exposure period, regardless of whether a match involving the national team was played or not.

Figure 1 shows the results of the different studies plotted against their precision. In the absence of publication bias, the effect estimates are expected to be distributed in a triangular ('funnel') pattern, with

Table 2 Hospital admissions for acute myocardial infarction (ICD-9:410) in the Italian population during the three international football competitions

	Days of the competitions			
	When Italy played		When Italy did not play	
	Number of events (number of days)	RR[a] (95% CI)	Number of events (number of days)	RR[a]
World Cup 2006	2236 (7)	1.00 (0.95–1.05)	7377 (24)	1 (ref.)
EURO 2004	929 (3)	0.98 (0.91–1.06)	5800 (20)	1 (ref.)
World Cup 2002	1230 (4)	1.05 (0.99–1.12)	7587 (27)	1 (ref.)
Overall	4395 (14)	1.01 (0.98–1.05)	20 764 (71)	1 (ref.)

The RR of AMI on match days involving the Italian team is compared with the other days of the competitions.
[a]RR, relative risk adjusted for day of the week.

Table 3 A summary of the published studies on the association between football matches and cardiovascular events

Study	Competition	Comparison	Outcome	N	RR (95% CI)
Witte *et al.* 2000[4]	E.C. (1996)	Events during the day of the last match played by the national team vs events during preceding and following 5 days	Mortality for AMI and stroke in The Netherlands	M: 41 W: 38	M: 1.51 (1.08–2.09) W: 1.11 (0.8–1.56)
Toubiana *et al.* 2001[9]	E.C. (1996)	Events during the day of the last match played by the national team vs events during preceding and following 5 days	Mortality for AMI in France	M: 61 W: 83	M: 0.74 (0.58–1.02) W: 0.96 (0.80–1.21)
Brunekreef and Hoek 2002[11]	E.C. (1988 and 1992) W.C. (1990 and 1994)	Events during the days of five matches played by the national team in the four tournaments vs events during other days between 1986 and 1994	Mortality for AMI and stroke in The Netherlands	NA	M + W: 1.00 (0.90–1.11)[a]
Carroll *et al.* 2002[13]	W.C. (1998)	Events within 2 days after a match of the national team vs events during the other days of the tournament	Hospital admissions for AMI in England	M + W: 270 NA NA	Penalty: 1.25 (1.08–1.44)[b] Win: 0.99 (0.89–1.11)[b] Loss: 0.91 (0.78–1.07)[b]
			Hospital admissions for stroke in England	NA NA NA	Penalty: 1.00 (0.82–1.23)[b] Win: 0.87 (0.74–1.03)[b] Loss: 0.97 (0.79–1.19)[b]
Berthier and Boulay 2003[10]	W.C. (1998)	Events during the day of the final match of the national team vs events during the preceding and following 5 days	Mortality for AMI in France	M: 23 W: 18	M: 0.71 (0.55–0.98) W: 0.65 (0.45–1.16)
Kirkup and Merrick 2003[12]	E.F.T. (1994–1999)	Events on days when the local team lost at home vs events on days with any other result	Mortality for AMI and stroke in some UK health authorities	M: 220 W: 202	M: 1.28 (1.11–1.47)[c] W: 1.07 (0.93–1.24)[c]
Katz *et al.* 2005[15]	W.C. (1998)	Events during days of the tournament vs events during the preceding 33 days and following 33 days	Incidence of out-of-hospital cardiac arrests in selected provinces of Switzerland	M + W: 45 M: 37 W: 8	M + W: 2.00 (1.32–3.02) M: 2.31 (1.40–3.83) W: 1.23 (0.44–3.20)

(continued)

Table 3 Continued

Study	Competition	Comparison	Outcome	N	RR (95% CI)
Katz *et al.* 2006[16]	W.C. (2002)	Events during days of the tournament vs events during the same period in 2001	Incidence of sudden cardiac death in selected provinces of Switzerland	M + W: 38	M + W: 1.63 (1.09–2.44)
				M: 26	M: 1.77 (1.09–2.86)
				W: 12	W: 1.33 (0.63–2.82)
Bauman *et al.* 2006[14]	A.F.L (2005) W.C.Q. (2005)	Events within 2 days after the AFL final match and after the regional World Cup qualifying match vs events during the preceding 14 days and following 11 days	Hospital admissions for AMI in New South Wales (Australia)	(A.F.L.) M + W: 79	(A.F.L.) M + W: 1.21 (0.90–1.63)[c]
				(W.C.Q.) M + W: 71	(W.C.Q.) M + W: 0.81 (0.63–1.05)[c]
			Hospital admissions for stroke in New South Wales (Australia)	(A.F.L.) M + W: 38	(A.F.L.) M + W: 1.12 (0.81–1.56)[c]
				(W.C.Q.) M + W: 49	(W.C.Q.) M + W: 1.36 (0.97–1.91)[c]
Wilbert-Lampen *et al.* 2008[5]	W.C. (2006)	Events during days of matches played by the national team vs events during control days in the years 2003, 2005 and 2006[e]	Hospital admissions for acute cardiovascular events in Bavaria (Germany)	M: 216	M: 3.26 (2.78–3.84)[d]
				W: 86	W: 1.82 (1.44–2.31)[d]
				M + W: 302	M + W: 2.66 (2.33–3.04)[d]
Present study	E.C. (2004) W.C. (2002 and 2006)	Events during the day of matches played by the national team vs events during the other days of the tournaments	Hospital admissions for AMI in Italy	M + W: 4395	M + W: 1.01 (0.98–1.05)[f]

RRs refer to the numbers of cardiovascular events on days in which major football matches were played compared with events during control periods. *N*: number of events during the exposure period; E.C.: European Championship; W.C: World Cup; E.F.T: English Football Tournament; A.F.L.: Australian Football League; W.C.Q: World Cup Qualifications; M: men; W: women; M + W: both genders; Penalty: match lost by the team at penalty shootout; Win: matches won by the team; Loss: match lost by the team not at penalty shootout; NA: not available.

[a]RR adjusted for year, month, day of the week, temperature, air pollution, influenza epidemics.

[b]RR adjusted for gender, year, month, day of the week, temperature.

[c]RR adjusted for month and day of the week.

[d]RR adjusted for year, day of the week, temperature, air pollution, barometric pressure.

[e]Control days were May 1 to June 8 and July 10 to July 31 in 2006; May 1 to July 31 in 2003 and 2005.

[f]RR adjusted for competition and day of the week.

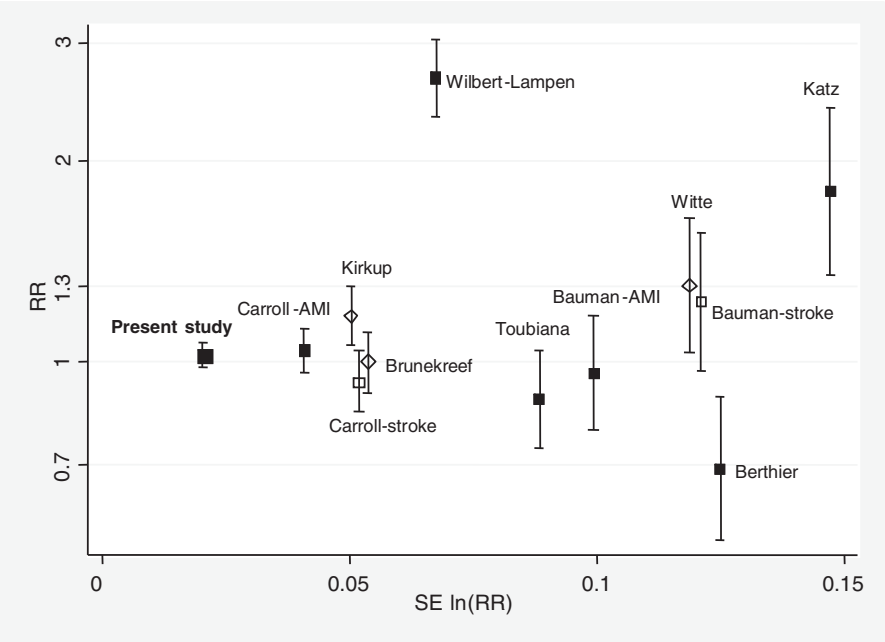

Figure 1 Funnel plot of the RRs vs their standard errors [SE ln(RR): standard error of natural logarithm of the RR] for studies on football matches and the risk of cardiovascular events. Bars represent 95% CIs. Full squares represent studies on coronary events, hollow squares studies on strokes and hollow diamonds represents studies on coronary events and strokes

less-precise studies (on the right side of the graph) randomly dispersed around the mean. The two small studies by Katz and colleagues[15,16] had the same study design and were carried out on the same population during two different competitions. For these reasons they have been pooled together. With the exception of the study by Wilbert-Lampen and colleagues[5] (RR for both genders 2.66) and the two small studies by Katz and colleagues[15,16] (pooled RR for both genders 1.8), all RR estimates were between 0.70[10] and 1.3.[4] The effect estimate found by Wilbert-Lampen and colleagues is a clear outlier, as there is no overlap between its CI and most of the CIs reported by the other authors.

Discussion

Football is the most popular sport in Italy. The final match of the World Cup 2006, when Italy beat France, was watched by more than 24 million television viewers (~40% of the population), corresponding to a share of 84% [http://it.wikipedia.org/wiki/Audience_(media)]. Nevertheless, we found no evidence of increased rates of hospital admissions for AMI associated with football matches played by the Italian national team in the three international competitions held between 2002 and 2006. Our estimates are based on large numbers of events and football matches distributed over a period of 5 years. The control period consisted of the days before and after the matches. For these reasons, it is unlikely that our results are due to the effects of unmeasured potential confounders such as temperature and pollution.

Although a fraction of patients with AMI die before they reach hospital, it is unlikely, that the proportion of deaths outside hospital increased selectively during days when the Italian team played, biasing our observed incidence rates downwards.

Our findings are consistent with most previous studies[4,9–14] that report a weak, if any, increase in cardiovascular events during the days of football matches. A remarkable exception is the recently published study by Wilbert-Lampen and colleagues, which reported a 2.7-fold increase in hospital admissions for cardiac emergencies on the days of matches involving the German team.[5] The main difference in study design between the German study and the other studies is that the former used prospectively collected information, whereas the latter studies were based on routinely collected administrative data that lack information on the exact time of the onset of the symptoms. Moreover, although Wilbert-Lampen and colleagues[5] analysed an interval of 24 h beginning at noon, the other studies used a daily interval beginning at midnight. The latter approach could introduce a certain degree of misclassification, as some of the matches were watched by European viewers at early evening; hence, some of the cardiovascular events in excess could have been admitted to the hospital after midnight and thus been counted on a control day. However, we consider it unlikely that this could explain the

differences in the results. First, watching a football match is considered to be a trigger for cardiovascular events, implying that its effects are likely to act during a short time period, typically 1–2 h.[1,5,17] Therefore, the proportion of cases admitted to hospital the day after the matches would probably be small, even in matches disputed in the evening. Secondly, we did not find an increased incidence of AMI either in the World Cup 2002, in which all matches were played in Korea and Japan and therefore watched by Italians during the morning, or in single matches disputed during afternoon in the World Cup 2006 and the European Championship 2004.

One should also consider the magnitude of the estimated RRs, which were averaged over a 24-h period in all studies, including that of Wilbert-Lampen and colleagues,[5] whereas triggers typically increase cardiovascular risk over a short time period. Assuming that the risk is increased within the first 2 h from the start of a match, the RR of 2.66 over a 24-h period found by the German study would correspond to an acute relative risk of 21 (i.e. an RR of 2.66 is the 24-h average between an RR of 1.00 during 22 h and an RR of 21 during 2 h). However, only a proportion of the population actually watches the matches (and is thus exposed). Assuming a proportion of viewers of 50% (higher than that reported in Italy during the final match of the World Cup 2006 [http://it.wikipedia.org/wiki/Audience_(media)], the corresponding acute RR among viewers would be 41 (set to 1.0 the acute RR for non-viewers). This estimate is considerably larger than that of any other cardiovascular trigger studied in case-crossover studies.[1] Indeed, with the exception of cocaine consumption, which entails an acute RR of 24,[18] sexual activity, an episode of anger, strenuous physical exercise, smoking marijuana, drinking coffee and having a heavy meal are all associated with acute RRs ranging between 2 and 7.[1] Even assuming a conservative scenario, in which the effect of watching a football match lasts for 8 h, the corresponding acute RR would still be 10. The inconsistency between the effect estimates reported by Wilbert-Lampen and the magnitude of the effects expected on the basis of previous evidence on other recognized cardiovascular triggers further suggests that the results by Wilbert-Lampen *et al*. should be regarded cautiously.

The publication of the German study stimulated intense media coverage and debate,[6,7,19–21] but neither in the scientific literature nor in the media was it mentioned that its relative risk estimate was much higher than those previously reported. This resulted in public concern over the possible harmful effects of watching sports events and in proposals to introduce *ad hoc* preventive measures, including changes in the pharmacological treatments for individuals with pre-existing coronary artery disease.[5–7] Our study and review contribute to the debate and suggest that the population cardiovascular effects of watching a football match are likely to be, if anything, very small. This is reassuring in terms of public health.

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Conflict of interest: None declared.

KEY MESSAGES

- A recent study carried out in Bavaria (Germany) during the last Football World Cup reported a 2.7-fold increase in the incidence of cardiac emergencies in the 12 h before and after football matches involving the German team.
- We investigated this issue in the entire Italian population. We found no evidence of increased rates of hospital admissions for AMI associated with football matches played by the Italian national team in three international competitions held between 2002 and 2006.
- We also reviewed the 10 published studies on the association between football matches and the risk of cardiovascular events. With the exception of the German study and two small Swiss studies, all RR estimates are spread around the null value, ranging between 0.7 and 1.3.
- Our study and review suggest that the population cardiovascular effects of watching a football match are likely to be, if anything, very small.

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Commentary: Is it safe to watch football?

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In this issue, Barone-Adesi and co-workers report on a study of the relationship between watching football games and acute cardiovascular events.[1] The study was initiated because of public concern of previous studies suggesting that the emotional stress involved in watching football games was a strong trigger for cardiovascular events.[2] The authors collected hospital admission data from throughout Italy during the football championship tournaments of 2002, 2004 and 2006. A comparison was made of cardiovascular events on days when the Italian team played, and other days of the tournament. No elevated risk was