

Evidence that really matters

Admissions for myocardial infarction and World Cup football: database survey

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Abstract

Objectives To examine hospital admissions for a range of diagnoses on days surrounding England's 1998 World Cup football matches.

Design Analysis of hospital admissions obtained from English hospital episode statistics.

Setting England.

Participants Population aged 15-64 years.

Main outcome measures Ratio of number of admissions for acute myocardial infarction, stroke, deliberate self harm, and road traffic injuries on the day of and five days after England's World Cup matches, compared with admissions at the same time in previous and following years and in the month preceding the tournament.

Results Risk of admission for acute myocardial infarction increased by 25% on 30 June 1998 (the day England lost to Argentina in a penalty shoot-out) and the following two days. No excess admissions occurred for other diagnoses or on the days of the other England matches. The effect was the same when only the two days after the match were treated as the exposed condition. Individual analyses of the day of and the two days after the Argentina match showed 55 extra admissions for myocardial infarctions compared with the number expected.

Conclusion The increase in admissions suggests that myocardial infarction can be triggered by emotional upset, such as watching your football team lose an important match.

Introduction

Acute myocardial infarctions have a peak incidence in the first few hours after waking, suggesting that they may be triggered by abrupt changes in psychological and behavioural status.¹⁻² Up to half of patients surviving myocardial infarction have been reported to identify triggering activities, most commonly emotional upset and physical exertion.³

More objective evidence of triggering comes from studies of the effect of catastrophic environmental events. For example, relative to corresponding days in the previous and subsequent years, the first five days after the earthquake in Athens in 1981 were associated with an excess of cardiac deaths, particularly among men.⁴ No increase was seen in deaths from cancer or other causes.⁴ Similarly, a study during the week after

the 1994 earthquake in Northridge, southern California, found a 35% increase in admissions for myocardial infarction compared with the week before the earthquake, and the proportion of coronary care units reporting increased admissions was higher in hospitals closer to the epicentre.⁵ Excesses in mortality from myocardial infarction and admissions to coronary care units have also been recorded after earthquakes in Thessaloniki⁶ and the Hanshin-Awaji district of Japan.⁷

Similar results have been found during military conflicts. The number of myocardial infarctions treated in Tel Aviv's main coronary care unit in late January 1991 (the peak of Iraqi missile attacks on Israel) was more than twice that in control periods.⁸ A Zagreb hospital recorded a much higher incidence of myocardial infarction during the height of the war in Croatia compared with periods of relative stability.⁹

It may seem inappropriate to equate the psychosocial upheaval caused by earthquakes and missile bombardments with that associated with major football tournaments. Nevertheless, an increase in mortality was reported after the quarter final between the Netherlands and France in the 1996 European cup.¹⁰ Anecdotal evidence suggests that this may not be an isolated effect. During the 2002 World Cup, the *Guardian* reported that "two South Korea fans, healthy men in their 20s, died of heart attacks during the thrilling victory over Italy. One collapsed when the co-hosts equalised in the 88th minute."¹¹

We tested the hypothesis that important football matches, particularly those in which there is a penalty shoot-out, can trigger acute cardiovascular events by analysing hospital admissions for a range of diagnoses during the 1998 World Cup. We focused on England games and assumed that any acute events precipitated by a match would be reflected in admissions for the day of and the two days after the match. The stress of watching a key game has been suggested to trigger events among people who are already at high risk, a phenomenon known as harvesting.¹² We therefore also examined admissions three to five days after the match to look for this effect.

Methods

We used data on patients attending English hospitals from the Department of Health's health episodes statistics database. From 1991 to 1999, there were about 97 million entries on the database. Each record

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Argentina goalkeeper Carlos Roa saves Paul Ince's penalty ...

in the database relates to one finished consultant episode—that is, the time an individual spends under the care of one NHS consultant. The information held includes the age and sex of the patient, area of usual residence, and reason for admission to hospital. Further information is available from the Department of Health (www.doh.gov.uk/hes).

England's matches in the 1998 World Cup were held on 15 June (England 2, Tunisia 0), 22 June (Romania 2, England 1), 26 June (Colombia 0, England 2), and 30 June (Argentina 2, England 2; Argentina won the penalty shoot-out 4-3). We extracted data on hospital admissions during this period for acute myocardial infarction (ICD-10 codes I21, I22), stroke (I61, I62, I63, I64), deliberate self harm (X60-X69, X70-X79, X80-X84), and road traffic injuries (V093, V489, V499, V799, V829, V830, V840, V850, V863) among men and women aged 15 to 64. We also extracted data for the month before the World Cup and for the same periods in 1997 and 1999 for comparison.

As the study period was short, we compared numbers of events rather than rates using Poisson and negative binomial regression (to account for possible overdispersion). We classified the day of and the two days after an index football match as exposed and the comparison days as unexposed. The results presented are the ratio of the number of admissions in each exposed condition to the number of admissions in the unexposed condition. To account for long term trends in hospital admission, we adjusted models for year of admission. As we were using data from only May, June,

and July, seasonality of hospital admission was unlikely to be an issue. Nevertheless, we adjusted models for month and average daily temperature in central England on the day of admission. These data were obtained from the British Atmospheric Data Centre. We also adjusted all models for day of week (Monday, weekend, rest of week) and sex, and restricted them to emergency admissions only. Because the matches all took place in the late evening, we examined the same associations using only the two days after the match—that is, omitting the day of the match as the exposed condition.

Results

During the period of England's World Cup matches (15 June to 1 July), 81 433 emergency admissions occurred: 1348 (2%) for myocardial infarction, 662 (1%) for stroke, 856 (1%) for road traffic injury, and 3308 (4%) for deliberate self harm. Table 1 shows the ratios of the number of emergency admissions within two days of World Cup matches compared with other days. The periods after a win and the first loss were not associated with any increased number of admissions for any of the causes examined. However, on the day of and the two days after the match against Argentina with a penalty shoot-out, admissions for acute myocardial infarction increased by 25%. No increases in admission were seen for any of the other diagnoses.

The admission ratios for myocardial infarction were slightly higher in men than women (men: 1.27, 95% confidence interval 1.08 to 1.49; women: 1.16, 0.85 to 1.59, test for interaction $P=0.53$). Estimates for the other diagnoses attenuated upwards in women and downwards in men but were not significantly different from the pooled ratios. When we re-analysed the data using only the two days after the match as the exposed condition, the results were essentially the same (ratio 1.23, 1.04 to 1.45).

We analysed daily admissions for myocardial infarction for the whole sample around the time of the Argentina match to explore possible harvesting. We fitted the same model as above but without the exposure variable and excluding the days of all the matches and the four days after. Thus, daily number of admissions for myocardial infarction was related to year and month of admission, daily temperature, day of week, and sex. We used this model to calculate expected number of admissions for myocardial infarction on each day and compared this with the actual number of admissions.

Observed admissions for myocardial infarction exceeded the expected number on the day of the Argentina match and the two following days (table 2). Apart from a modest fall on day 4, there was little evidence that the excess admissions for myocardial infarction were due to imminent and inevitable infarctions being brought forward. We also examined the hospital episode statistics for myocardial infarction for May, June, and July for the years 1995 to 1999. Of the 232 days examined, 27 (12%) days had differences at least as large as the one seen on the day after the Argentina match. This model assumed that the yearly trends seen in 1997-9 extend to 1995-6.

Discussion

We found a 25% increase in admissions for acute myocardial infarction on the day, and two days after,

Table 1 Ratios of number of emergency admissions for specific diagnoses after each of England's World Cup matches compared with non-exposed days. Results of negative binomial regression models including sex, year and month of admission, temperature on day of admission, and day of week

Admission diagnosis	Within 2 days of win	Within 2 days of 1-2 loss	Within 2 days of loss on penalty shoot-out	Not within 2 days of match	P value
Myocardial infarction	0.99 (0.89 to 1.11)	0.91 (0.78 to 1.07)	1.25 (1.08 to 1.44)	1.00	0.007
Stroke	0.87 (0.74 to 1.03)	0.97 (0.79 to 1.19)	1.00 (0.82 to 1.23)	1.00	0.42
Road traffic injury	0.99 (0.85 to 1.14)	0.96 (0.79 to 1.17)	0.85 (0.69 to 1.05)	1.00	0.51
Deliberate self harm	1.08 (1.00 to 1.16)	1.01 (0.91 to 1.12)	1.05 (0.95 to 1.16)	1.00	0.26

England lost to Argentina in a penalty shoot-out in the 1998 World Cup. No increases were seen for stroke, deliberate self harm, or road traffic injuries, and no excess admissions for any diagnosis were recorded after England's other matches. Our regression methods enabled a range of covariates to be included in the analyses, increasing the credibility of our findings. Although similar differences in numbers of admissions occurred in 12% of days in May to July during 1995 to 1999, the excess observed on the day and following two days of the match is unlikely to be due to chance.

Validity of association

We postulate that the excess admissions for myocardial infarction on the day of and the two days after the Argentina match are attributable to spectators' emotions during the very tense ending. An estimated 24 million people watched the match, making it the most watched television programme in the United Kingdom in 1998.¹³ It is difficult to see what other contemporary environmental challenge might account for the excess admissions. However, as the match started at 9 00 pm, only a short time was available for same day admissions after the match. Since we do not have data on time of admission, we cannot establish when the excess admissions occurred. A Dutch study that found excess mortality after a penalty shoot-out between the Netherlands and France in 1996 also included the day of match as exposed, although the match started slightly earlier, 6 30 pm.¹⁰ Given that matches between England and Argentina always produce intense rivalry, and the fact that it was a knock out game, football fans would have experienced a fair amount of tension before and during the match. In addition, our results were the same when we omitted the day of the match from the analysis.

In the Dutch study, the excess of deaths from myocardial infarction and stroke was seen only in men.¹⁰ We found a significant increase in hospital admissions for both sexes. The effect was slightly stronger for men than women, but there was little statistical evidence of an interaction between sex and exposure condition.

Brunekreef and Hoek recently examined mortality associated with five important Dutch international football matches between 1988 and 1994.¹⁴ In general, no excess mortality from myocardial infarction and stroke was associated with these matches. However, only one of the matches, against Denmark in the 1992 European Cup semifinal, was resolved by penalty shoot-out; the Netherlands lost. Mortality increased on the day of this match, but the increase was not significant (risk ratio 1.16, 95% confidence interval 0.93 to 1.44). Thus, the effect seems to be restricted to games that are lost in a penalty shoot-out.

Possible explanations

The triggering hypothesis considers that the emotional impact of challenging events can perturb neuroendocrine, haemodynamic, and endothelial systems, resulting in rupture of vulnerable atherosclerotic plaques; a major rupture would produce a thrombogenic focus sufficient to cause an occlusive coronary thrombosis.^{1, 2} A case study showed that contemporary viewing of the England versus Argentina match perturbed cardiovascular function.¹⁵ In addition, England supporters watching the penalty shoot-out a year later on video showed increases in blood pressure and heart rate.¹⁶

Table 2 Observed and expected numbers of emergency admissions for acute myocardial infarction on day and five days after England lost to Argentina by penalty shoot-out in 1998 World Cup

	Observed/expected* No of admissions	Actual-expected	Adjusted risk ratio†
Day of match	91/72	19.2	1.25 (0.99 to 1.57)
1 day after	88/72	16.0	1.21 (0.96 to 1.57)
2 days after	91/71	20.0	1.27 (1.01 to 1.61)
3 days after	76/74	-1.7	0.99 (0.77 to 1.27)
4 days after	71/74	-3.4	0.92 (0.71 to 1.19)
5 days after	83/72	10.9	1.13 (0.89 to 1.43)

*Predicted from a negative binomial regression model including sex, year and month of admission, temperature on day of admission, and day of week but excluding World Cup match days and five days after each match.

†Compared with days not following any World Cup match, from a negative binomial regression model including sex, year and month of admission, temperature on day of admission, day of week.

Since psychological stress and upheaval seem to increase the propensity to engage in unhealthy and risky behaviour,¹⁷ the increase in incidence of myocardial infarction might stem from binge drinking, smoking, and other acts of distracted carelessness. However, we found no effect on hospital admissions for traffic injuries and self harm, which suggests that recklessness was not an important factor. Nevertheless, episodes of deliberate self harm may be underestimated in the hospital episode statistics because hospital staff may be reluctant to code contacts under this potentially pejorative diagnosis. Furthermore, we cannot rule out more subtle effects of increased smoking and alcohol consumption on myocardial ischaemia and excitability.^{2, 18}

Since the Dutch study reported combined effects for myocardial infarction and stroke, we included hospital admissions data for stroke in our analysis. Our failure to find effects for stroke could reflect reduced power. Alternatively, triggering events may be more important in acute myocardial infarction than in stroke.

Another possible explanation for the finding is that myocardial infarctions were brought forward by two days through exposure to the penalty shoot-out—the so called harvesting effect.¹² Although we found a dip in admissions four days after the match, it was much smaller than the increase seen on the day of the match and two following days. Harvesting therefore cannot completely explain the excess admissions observed.

An artefactual explanation for these findings should also be considered. Reporting tendency has



... and England fans' hearts miss a beat

SIMON WILKINSON/EMPICS

What is already known on this topic

Physical and emotional triggers, such as environmental disasters and vigorous physical exercise, can precipitate acute myocardial infarction

An increase in cardiovascular mortality among Dutch men was associated with the 1996 European championship match between the Netherlands and France

What this study adds

Admissions for myocardial infarction increased on the day England was eliminated from the 1998 World Cup by Argentina in a penalty shoot-out and on the two subsequent days

No effect was seen on admissions for other diagnoses or after other matches

These data support the hypothesis that intense emotional reactions can trigger myocardial infarction

been shown to influence hospital admissions for cardiovascular disease.¹⁹ Some women and men may have translated their feelings of distress and disappointment at defeat by Argentina into physical symptoms. However, such an explanation is unlikely because we found no effect on admissions for conditions based on less objective criteria than myocardial infarction or for conditions with a more obvious connection to acute emotional crises.

Limitations and implications

One possible limitation of our study is that we did not examine data on sudden death. However, since sudden death is much less common than hospital admission for myocardial infarction, it would add little to the robustness of the test of the link between acute emotional upheavals and cardiac events.

Our findings support the hypothesis that major environmental events, whether physical catastrophes or cultural disappointments, are capable of triggering myocardial infarction.⁴⁻¹⁰ If the triggering hypothesis is true, preventive efforts should consider strategies for dealing with the effects of acute physical and psychosocial upheavals. Aside from issues of sporting fairness, perhaps the lottery of the penalty shoot-out should be abandoned on public health grounds.

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- 1 Kondo NI, Muller JE. Triggering of acute myocardial infarction. *J Cardiovasc Risk* 1995;2:499-504.
- 2 Muller JE, Toller GH, Stone PH. Circadian variation and triggers of onset of acute cardiovascular disease. *Circulation* 1989;79:733-43.
- 3 Toller GH, Stone PH, Maclure M, Edelman E, Davis CG, Robertson T, et al. Analysis of possible triggers of acute myocardial infarction (the MILIS study). *Am J Cardiol* 1990;66:22-7.
- 4 Trichopoulos D, Katsouyanni K, Zavitsanos X, Tzonou A, Dalla-Vorgia P. Psychological stress and fatal heart attack: the Athens (1981) earthquake natural experiment. *Lancet* 1983;321:41-4.
- 5 Lear J, Klöner. The Northridge earthquake as a trigger for acute myocardial infarction. *Am J Cardiol* 1996;77:1230-2.
- 6 Katsouyanni K, Kogevas M, Trichopoulos D. Earthquake related stress and cardiac mortality. *Int J Epidemiol* 1986;15:326-30.
- 7 Suzuki S, Sakamoto S, Miki T, Matsuo T, Hanshin-Awaji earthquake and acute myocardial infarction. *Lancet* 1995;345:981.
- 8 Meisel SR, Kutz I, Dayan KI, Pauzner H, Chetboun I, Arbel Y, et al. Effect of Iraqi missile war on incidence of acute myocardial infarction and sudden death in Israeli civilians. *Lancet* 1991;338:660-1.
- 9 Bergovec M, Mihatov S, Prpic H, Rogan S, Batarelo V, Sierobabski V. Acute myocardial infarction among civilians in the Zagreb city area. *Lancet* 1992;339:303.
- 10 Witte DR, Bots ML, Hoes AW, Grobbee DE. Cardiovascular mortality in Dutch men during 1996 European football championship: longitudinal population study. *BMJ* 2000;321:1332-4.
- 11 World Cup diary. *Guardian* 2002, June 20;Sport:11.
- 12 Zanobetti A, Schwartz J, Samoli E, Gryparis A, Touloumi G, Atkinson R, et al. The temporal pattern of mortality response to air pollution: a multicity assessment of mortality displacement. *Epidemiology* 2002;13:87-93.
- 13 Television Audience Research Information System. *UK television and video yearbook*. London: Taylor Nelson Sofres, 1999.
- 14 Brunekreef B, Hoek G. No association between major football games and cardiovascular mortality. *Epidemiology* 2002;13:491-2.
- 15 Brodtkin J. Come on, and take another piece of my heart. *Guardian* 1998, 2 July:3.
- 16 Harrison LK, Carroll D, Burns VE, Corkhill A, Harrison CM, Ring C, et al. Cardiovascular and secretory immunoglobulin A reactions to humorous, exciting, and didactic film presentations. *Biol Psychol* 2000;52:113-26.
- 17 Heslop P, Davey Smith G, Carroll D, Macleod J, Hyland F, Hart C. Perceived stress and coronary heart disease risk factors: the contribution of socio-economic position. *Br J Health Psychol* 2001;6:167-79.
- 18 Kauhanen J, Kaplan GA, Goldberg DE, Salonen JT. Beer drinking and mortality: results from the Kuopio ischaemic heart disease risk factor study, a prospective population based study. *BMJ* 1997;315:846-51.
- 19 Macleod J, Davey Smith G, Heslop P, Metcalfe C, Carroll D, Hart C. Psychological stress and cardiovascular disease: empirical demonstration of bias in a prospective observational study of Scottish men. *BMJ* 2002;324:1247-51.

Scared to death?

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Phillips et al report a “Hound of the Baskervilles effect” among Chinese-Americans and Japanese-Americans, who have abnormally high cardiac mortality on the fourth day of each month because they think the number 4 is unlucky.¹ Is it plausible that the number 4 is regarded with the same terror that the fictional Charles Baskerville felt as he was pursued in the dark by a huge hound “with its flaming jaws and blazing eyes”? We encounter the number 4 every day. Could one more 4, the fourth day of a month, be fatal?

Methods and results

A natural test is to compare deaths on the third, fourth, and fifth days of each month. A longer horizon is flawed because a systematic cycle that causes deaths to peak near day 4 may show statistical significance that reflects a bulge near the day rather than any special importance of day 4 itself.

California’s computerised mortality records include the racial status recorded on death certificates. The first section of the table shows deaths in California