



Emerging Evidence

Matters of the Heart: Case-Crossover Analysis of Myocardial Infarction on Valentine's Day

Nathalie Auger, MD, MSc, FRCPC,^{a,b,c,d} Marianne Bilodeau-Bertrand, MSc,^b

Aimina Ayoub, MSc,^{a,b} and Brian J. Potter, MD, SM, FRCPC^{a,e}

^a University of Montreal Hospital Research Centre, Montreal, Quebec, Canada

^b Quebec National Institute of Public Health, Montreal, Quebec, Canada

^c Department of Epidemiology, Biostatistics, and Occupational Health, McGill University, Montreal, Quebec, Canada

^d Department of Social and Preventive Medicine, School of Public Health, University of Montreal, Montreal, Quebec, Canada

^e Division of Cardiology, Department of Medicine, University of Montreal Hospital Centre, Montreal, Quebec, Canada

ABSTRACT

We studied the risk of myocardial infarction on Valentine's Day. We conducted a case-crossover study of 51,450 adults with myocardial infarctions in February, 1989-2019. The exposure was Valentine's Day, and the 2 days before and after Valentine's Day. We estimated odds ratios (OR) to compare days when myocardial infarction occurred with neighboring control days. Compared with other days, Valentine's Day was associated with lower odds of myocardial infarction the following day for men (OR 0.91, 95% confidence interval 0.85-0.98), but not for men and women combined (OR 0.95, 95% confidence interval 0.91-1.01). Risk of myocardial infarction in men is lower the day after Valentine's Day.

RÉSUMÉ

Nous avons étudié le risque de subir un infarctus du myocarde le jour de la Saint-Valentin. Nous avons réalisé une étude selon la méthode cas-croisé portant sur 51 450 adultes ayant subi un infarctus du myocarde en février entre 1989 et 2019. La période d'exposition était le jour de la Saint-Valentin ainsi que les 2 jours précédant et suivant celui-ci. Nous avons estimé les rapports de cotes (RC) pour comparer les jours où étaient survenus des infarctus du myocarde et les jours témoins voisins de cette date. Comparativement aux autres jours, le jour de la Saint-Valentin était associé à une probabilité plus faible d'infarctus du myocarde le lendemain chez les hommes (RC 0,91, intervalle de confiance à 95 % : de 0,85 à 0,98), mais pas chez les hommes et les femmes analysés ensemble (RC 0,95, intervalle de confiance à 95 % : de 0,91 à 1,01). Le risque d'infarctus du myocarde chez les hommes est plus faible le lendemain de la Saint-Valentin.

Holidays are a neglected determinant of health, and their potential cardiovascular impact is frequently overlooked. Valentine's Day is a popular holiday associated with love, affection, romantic dinners, chocolate, and other indulgences. There is evidence that other holidays may be associated with the risk of myocardial infarction.¹⁻³ Both Christmas and New Year's Eve are associated with a higher rate of myocardial infarction in Sweden.¹ Similarly, the number of myocardial infarction hospitalizations appears to be greater during Islamic holidays,² and researchers have observed an excess of deaths due to myocardial infarction on Chinese holidays.³ The relationship of myocardial infarction with Valentine's Day,

however, has not been studied. Ischemic heart disease is a leading cause of death, and excessive food and alcohol, or stress associated with holidays, may influence the risk of acute myocardial infarction.⁴ We hypothesized that the risk of myocardial infarction differed immediately after Valentine's Day compared with other nearby days. We focused on the risk of myocardial infarction the day after Valentine's Day, as celebrations that evening would most likely lead to events at night and official hospital admissions the following day.

Materials and Methods

We designed a case-crossover study of 31,505 men and 19,945 women with acute myocardial infarction in February, between 1989 and 2019, in Quebec, Canada. We identified all hospitalizations for acute myocardial infarction from the Maintenance and Use of Data for the Study of Hospital Clientele Registry using diagnostic codes in the International Classification of Diseases (ICD; ICD-9 410; ICD-10 I21-I22). Case-crossover studies are suitable for transient

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Ethics Statement: We complied with Tri-Council Policy requirements for ethical research in Canada. The Institutional Review Board of the University of Montreal Hospital Centre waived ethics review.

Corresponding author: Dr Nathalie Auger, 190 Cremazie Blvd E, Montreal, Quebec H2P 1E2, Canada. Tel.: 1-514-864-1600 ext. 3717; fax: 1-514-864-1616.

E-mail: nathalie.auger@inspq.qc.ca

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Table 1. Association of Valentine's Day with myocardial infarction, Quebec, 1989-2019*

Date in February	Total			Men			Women		
	Case days	OR (95% CI)	P	Case days	OR (95% CI)	P	Case days	OR (95% CI)	P
12	1846	1.03 (0.98-1.09)	0.25	1120	1.03 (0.96-1.10)	0.42	726	1.04 (0.95-1.13)	0.39
13	1836	1.03 (0.97-1.08)	0.32	1155	1.05 (0.98-1.12)	0.20	681	1.00 (0.92-1.09)	0.97
14 (Valentine's Day)	1806	1.03 (0.98-1.09)	0.21	1132	1.06 (0.99-1.13)	0.12	674	1.00 (0.92-1.09)	0.98
15	1815	0.95 (0.91-1.01)	0.08	1069	0.91 (0.85-0.98)	0.01	746	1.02 (0.94-1.10)	0.70
16	1839	0.97 (0.92-1.03)	0.97	1139	0.99 (0.93-1.06)	0.75	700	0.95 (0.87-1.04)	0.25

CI, confidence interval; OR, odds ratio.

*Exposed days are compared with unexposed days. For example, February 12 (exposed) is compared with February 5, 19, and 26 (unexposed).

exposures such as Valentine's Day, and for acute outcomes, such as myocardial infarction.⁵⁻⁷

The case-crossover study is a variant of the case-control study.^{8,9} In a case-crossover study, the day of the event is matched with other nearby days, and the characteristics of case days are compared with those of control days. In our study, case days were the date of hospital admission for acute myocardial infarction. We identified all case days in February between 1989 and 2019. We matched each case day with 3-4 control days from the same day of the week from the other weeks of February in each calendar year. Thus, cases reflected days when myocardial infarction occurred, matched with nearby control days when myocardial infarction did not occur. For example, a case day on February 9 was matched with control days on February 2, 16, and 23 of the same year.

The exposure was Valentine's Day (February 14), including the 2 days before (February 12 and 13) and the 2 days after (February 15 and 16). We included February 12 and February 16 for comparative purposes, as the risk of myocardial infarction on these days should not be influenced by Valentine's Day. Case days could be either exposed or unexposed to Valentine's Day. Similarly, control days could be exposed or unexposed.

We estimated odds ratios (ORs) and 95% confidence intervals (CIs) using conditional logistic regression, comparing the odds of exposure on case days with the odds of exposure on control days. We stratified the analysis by age and sex. As patients were self-matched, confounding due to lifestyle factors such as smoking was accounted for.⁸ In sensitivity analyses, we excluded the region of Quebec City that celebrates the Carnaval de Quebec, an event that coincides with Valentine's Day.

We performed the analysis using SAS version 9.4 software (SAS Institute Inc, Cary, NC). We complied with the Tri-Council Policy requirements for ethical research in Canada. The Institutional Review Board of the University of Montreal Hospital Centre waived ethics review.

Results

There were 1815 myocardial infarctions on February 15, of which 58.9% were in men (Table 1). About 40% of myocardial infarctions occurred in men aged < 65 years. In women, the majority of myocardial infarctions occurred at age ≥ 75 years (59.7%; 445 of 746). The day after Valentine's Day appeared to be protective against myocardial infarction. For men, Valentine's Day was associated with 0.91 times lower odds of infarction the following day (95% CI 0.85-0.98; $P = 0.01$) compared with no exposure. This association was not apparent for Valentine's Day itself (OR 1.06, 95% CI 0.99-1.13; $P = 0.12$) or for other surrounding days. There was no noticeable association for women or for the 2 sexes combined.

The protective association of the day after Valentine's Day was greatest for men aged < 65 years (OR 0.87, 95% CI 0.78-0.97; $P = 0.01$; Fig. 1). A trend toward lower odds was also present for women aged < 65 years (OR 0.85, 95% CI 0.70-1.03; $P = 0.11$). Excluding Quebec City did not change the study findings.

Discussion

This case-crossover analysis of more than 50,000 patients suggests that Valentine's Day may be associated with a lower risk of myocardial infarction the following day, especially in young men and possibly even young

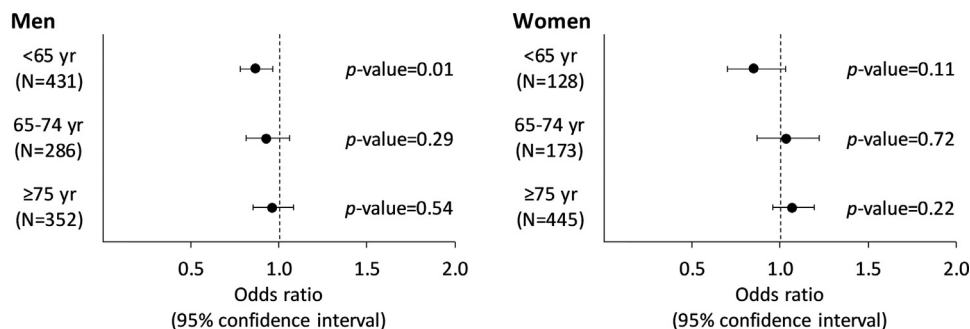


Figure 1. Likelihood of myocardial infarction the day after Valentine's Day, according to age, Quebec, 1989-2019. Odds ratios are for the comparison of the day after Valentine's Day (February 15) with unexposed days (February 1, 8, and 22).

women. We could not rule out the possibility of spurious results, although the presence of an association only the day after Valentine's Day reinforces the hypothesis, as an association on Valentine's Day itself would be due to other morning or daytime exposures.

Although this study is the first to assess the relationship between Valentine's Day and the risk of myocardial infarction, there is evidence to suggest that other holidays may be associated with cardiovascular outcomes.¹⁻³ A study of 283,014 patients in Sweden found that rates of myocardial infarction were elevated during Christmas, New Year's, and the Midsummer holiday.¹ Many of these associations are thought to relate to consumption of alcohol and heavy meals, potential triggers of myocardial infarction.^{1,4} Although couples may consume more food and alcohol on Valentine's Day, our findings do not suggest a harmful association. We found a protective effect the day after Valentine's Day. It may be that excess consumption on Valentine's Day is mild compared with that on other holidays. However, the lower risk in men right after Valentine's Day suggests that other mechanisms might be at play.

The protective association was more prominent among younger men, and possibly women, who may be more likely to have newer relationships and celebrate Valentine's Day most earnestly. Romantic emotions during Valentine's Day have the potential to reduce stress and be cardioprotective. Chocolate, a popular gift on Valentine's Day, may also help lower blood pressure.¹⁰ Finally, a protective effect of sexual activity, which may be more common the night of Valentine's Day, must be considered.¹¹

It is possible that the absence of a cardioprotective effect of Valentine's Day in older patients is due to other factors. Negative consequences of excessive food and alcohol consumption, or stress associated with Valentine's Day, might disproportionately affect older individuals. It is also possible that Valentine's Day carries less importance in older men and women and is not as intensely celebrated. Elderly individuals may also be single or have lost a committed partner.

Although it is possible that an increase in myocardial infarction events on Valentine's Day was offset by reduced presentation the night of Valentine's Day, the number of cases did not increase in the days that followed, as one would expect if patients had indeed delayed an emergency visit. Thus, it appears unlikely that the absence of an association on Valentine's Day and the lower risk of myocardial infarction the day after Valentine's Day are due to reduced presentation.

We used a large dataset of more than 50,000 cases, with a study design that could not be affected by ecologic bias, as we analyzed individual rather than aggregated data. This study, however, has limitations. Valentine's Day and other holidays are not celebrated by everyone. Because the exposure may be misclassified for patients who did not celebrate Valentine's Day, differences between groups may be attenuated and therefore underestimated. We cannot confirm the exact pathways linking Valentine's Day with myocardial infarction.

Cases of myocardial infarction may be missed or misclassified. The lower incidence of myocardial infarction at young ages may have prevented us from detecting

associations for women. We could not distinguish between incident and prevalent cases, although we expect that the majority of myocardial infarction hospitalizations will be for acute events. We investigated patients with myocardial infarction, but we could not study cardiovascular events with subacute onset. Although the case-crossover design accounted for potential confounders, we did not have information on the exact time and subtype of myocardial infarction, or on changes in food and alcohol intake. Lack of data on relationship status limited our ability to explain the sex-specific associations. Future research is warranted to confirm the findings in other locations where Valentine's Day is celebrated.

Conclusions

Valentine's Day may be associated with a lower risk of myocardial infarction in men and possibly women the following day, despite indulgence in food and/or alcohol. The results suggest a potential beneficial impact of Valentine's Day on the cardiovascular system, particularly for younger individuals. Although the reasons for the protective effect remain to be elucidated, the results support the notion that romance and affection have an influence on the heart. The findings call for better documentation of the implications of holidays for cardiovascular health.

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Disclosures

The authors have no conflicts of interest to disclose.

References

1. Mohammad MA, Karlsson S, Haddad J, et al. Christmas, national holidays, sport events, and time factors as triggers of acute myocardial infarction: SWEDHEART observational study 1998-2013. *BMJ* 2018;363:k4811.
2. Zubaid M, Thalib L, Suresh CG. Incidence of acute myocardial infarction during Islamic holiday seasons. *Eur J Epidemiol* 2006;21:191-5.
3. Lin X, Green JC, Xian H, et al. Holiday and weekend effects on mortality for acute myocardial infarction in Shanxi, China: a cross-sectional study. *Int J Public Health* 2020;65:847-57.
4. Nawrot TS, Perez L, Künzli N, Munters E, Nemery B. Public health importance of triggers of myocardial infarction: a comparative risk assessment. *Lancet* 2011;377:732-40.
5. Polcaro-Pichet S, Kosatsky T, Potter BJ, Bilodeau-Bertrand M, Auger N. Effects of cold temperature and snowfall on stroke mortality: a case-crossover analysis. *Environ Int* 2019;126:89-95.

6. Levy D, Lumley T, Sheppard L, Kaufman J, Checkoway H. Referent selection in case-crossover analyses of acute health effects of air pollution. *Epidemiology* 2001;12:186–92.
7. Janes H, Sheppard L, Lumley T. Case-crossover analyses of air pollution exposure data: referent selection strategies and their implications for bias. *Epidemiology* 2005;16:717–26.
8. Maclure M, Mittleman MA. Should we use a case-crossover design? *Annu Rev Public Health* 2000;21:193–221.
9. Redelmeier DA, Tibshirani RJ. Interpretation and bias in case-crossover studies. *J Clin Epidemiol* 1997;50:1281–7.
10. Larsson SC, Åkesson A, Gigante B, Wolk A. Chocolate consumption and risk of myocardial infarction: a prospective study and meta-analysis. *Heart* 2016;102:1017–22.
11. Dahabreh IJ, Paulus JK. Association of episodic physical and sexual activity with triggering of acute cardiac events: systematic review and meta-analysis. *JAMA* 2011;305:1225–33.