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RESEARCH ARTICLE

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ABSTRACT

Objectives: Christmas holidays have been associated with the highest incidence of myocardial infarction (MI). We wanted to assess possible triggers of MI during Christmas. *Design:* A nationwide, retrospective postal survey with case-control design. All individuals suffering an MI during the Christmas holidays 2018 and 2019 in Sweden were identified through the SWEDEHEART registry and a control group matched in age and gender with chronic coronary syndrome who did not seek medical attention during Christmas were asked for participation. Subjects completed a questionnaire asking them to rate 27 potential MI-triggers as having occurred more or less than usual. *Results:* A total of 189 patients suffering an MI on Christmas Eve, Christmas Day, or Boxing Day, and 157 patients in the control group responded to the questionnaire, representing response rates of 66% and 62%, respectively. Patients with MI on Christmas experienced more stress (37% vs. 21%, $p = .002$), depression (21% vs. 11%, $p = .024$), and worry (26% vs. 10%, $p < .001$) compared to the control group. The food and sweets consumption was increased in both groups, but to a greater extent in the control group (33% vs. 50%, $p = .002$ and 32% vs. 43%, $p = .031$). There were no increases in quarrels, anger, economic worries, or reduced compliance with medication. *Conclusions:* Patients suffering MI on Christmas holiday experienced higher levels of stress and emotional distress compared to patients with chronic coronary syndrome, possibly contributing to the phenomenon of holiday heart attack. Understanding what factors increase the number of MI on Christmas may help reduce the excess number of MIs and cardiovascular burden.

Introduction

The annual peak in myocardial infarction (MI) incidence coinciding with Christmas and New Year holidays has been well described. The day with the highest incidence has been reported to be Christmas Eve, with a 37% higher risk of MI than during a defined control period [1]. Christmas in Sweden is the main holiday of the year and is celebrated with close family, mainly on Christmas Eve, 24 December, but festivities continue through Christmas Day and Boxing Day. Many family members travel some distance to reunite. Culinary traditions include an abundant smorgasbord, which offers a mixture of hot and cold dishes as a buffet. The holiday is traditionally associated with happiness and joy, but, from a public health standpoint, often involves high mortality and morbidity [1]. Hypotheses concerning the source of this phenomenon include overeating, alcohol, anxiety, a decline in medication adherence, depression, and limited access to health care [1–3].

We conducted a nationwide survey to identify the primary triggers of MI during Christmas, hypothesising that an increased incidence of MI during the Christmas holidays is triggered by emotional stressors, physical activity, and excessive food and alcohol consumption. The hazard trigger period was defined as 24 h before the onset of MI.

Methods

Study population

We used the nationwide Swedish Web System for Enhancement and Development of Evidence-based care in Heart disease Evaluated According to Recommended Therapies (SWEDEHEART) registry to identify MI cases in Sweden over the Christmas holidays 2018 and 2019. The SWEDEHEART registry includes all patients with symptoms of acute coronary syndrome admitted to a coronary care unit in Sweden, and collects information on background characteristics such as age, sex, body mass index, smoking status, and electrocardiographic findings as well as data of other examinations, interventions, complications, laboratory measures, discharge medications, and diagnoses [4]. Combining the SWEDEHEART MI data with data from the National Population Registry, we included all surviving patients who were diagnosed with type I MI showing symptom onset from 24 through 26 December 2018 and 2019. We selected a control group consisting of an age- and sex-

matched group diagnosed with stable angina and treated with percutaneous coronary intervention within the five years prior to inclusion who did not seek medical attention during Christmas 2018 and 2019.

Study design

In this retrospective case-control study with postal questionnaires, each subject was asked to answer questions about the presence of potential triggers compared to what the subject usually experiences. In addition, a control group was used to characterize the experience of Christmas in a population diagnosed with chronic coronary artery disease. The MI-Christmas participants were asked to report the occurrence of the factors in the 24 h before the onset of symptoms, while the control group evaluated their occurrence on 24–26 Dec. Possible responses were *not at all/not applicable*, *much less than usual*, *a little less than usual*, *as usual*, *a little more than usual*, and *much more than usual*. We distributed a postal questionnaire (Supplemental material) with a cover letter and an informed consent form to potential participants. Questions covered 27 topics in three sections. *Activity* contained questions regarding outdoor activities, snow shovelling, traveling, cooking, cleaning, sexual activity, and sleep disturbances. A second section consisted of questions related to *emotions*: joy, stress, exhilaration, anxiety, depression, sadness, worry, quarrelling, and others. The third section included questions regarding the consumption of fatty foods, sweets, and alcohol. Additional questions dealt with social gatherings, usual level of physical activity according to a simplified Frändin/Grimby scale [5], presence of symptoms, and an open question regarding potential stress inducers. Prior to data collection, the questionnaire was tested in a smaller group of patients with MI, designed and coded to obtain validity and reliability [6]. To increase the response rate, a lottery ticket, stamped returned envelope, and a reminder letter were used [7]. Demographic data were obtained from the SWEDEHEART registry. Sampling was conducted from October 2019 through March 2020. Participants relating to Christmas 2018 received the questionnaire in October 2019, and those from Christmas 2019 received the questionnaire in February 2020.

Statistical and content analysis

The collected data were encoded and analysed using SPSS version 26. Baseline demographics of the groups are presented as mean and standard deviation for continuous variables and as counts and percentages for categorical data. Descriptive polar diagrams are showing patient perception of an increased presence of the hypothetical trigger from both groups. Missing data ranged from 2 to 5% (Supplementary Tables 1–3). Comparison between the proportions of those who stated increased experience of triggers in MI-Christmas and control group were made using chi-square test. If the number of observations was too few, Fischer's exact test was used. A *p*-value of $\leq .05$ was considered statistically significant.

The questionnaire provided space to freely formulate causes of any increased stress. The free text answers were analysed only by summarizing the content described and divided into themes, a simpler form of summative content analysis [8]. This gave five areas illustrated with a pie chart with absolute frequencies.

Results

Patient characteristics

A total of 542 patients, 287 with MI during Christmas 2018 and 2019 and 255 in the matched control group, were identified in the SWEDEHEART registry and contacted by mail. The response rate was 64%. In the MI-Christmas group, 189 (66%) completed the questionnaire and the corresponding rate was 157 (62%) in the control group. The responders in the MI-Christmas group were more often male, non-smokers, with less comorbidity than non-responders. The control group responders were more often male, non-smokers, and with less diabetes than non-responders but virtually no difference in another medical history. Baseline demographic data of participants and non-responders are presented in Table 1.

Emotions

The emotions, reported a little more or much more than usual, that were more prevalent among MI Christmas group than in the control group were stress (37% vs. 21%, *p* = .002), depression (21% vs. 11%, *p* = .024) and worry (26% vs. 10%, *p* < .001) (Figure 1). Other non-significant frequent emotions were joy (27% vs. 30%, *p* = .401), exhilaration (19% vs. 16%, *p* = .411), happiness (19% vs. 23%, *p* = .581), troubles (19% vs. 13%, *p* = .187), anxiety (18% vs. 11%, *p* = .058), sadness (13% vs. 15%, *p* = .514) and loneliness (11% vs. 12%, *p* = .687) (Figure 1).

Activities

Reporting a little more or much more than usual of cleaning activities (9% vs. 21%, *p* = .001) and outdoor activity (5% vs. 12%, *p* = .038) were more common in the control group. Other frequent activities, reported as little more or much more prevalent than usual were insomnia (21% vs. 16%, *p* = .303), cooking (20% vs. 25%, *p* = .257), physical activity (11% vs. 8%, *p* = .346), and long-distance travel (11% vs. 8%, *p* = .466) (Figure 1). One-fourth (25%) of the respondents in the MI-Christmas group stated less physical activity and less outdoor activity than usual with similar findings in the control group (31% and 27%) (Supplementary Table 1).

Food, alcohol consumption and symptoms

Food (33% vs. 50%, *p* = .002) and sweets (32% vs. 43%, *p* = .031) consumption a little more or much more than usual, was more prevalent in the control group compared with the MI-Christmas group (Figure 1). No differences were seen in

Table 1. Baseline demographics of study groups.

	MI-Christmas		Control group	
Characteristics	Responders	Non-responders	Responders	Non-responders
Number (%)	189 (65.9)	98 (34.1)	157 (61.6)	98 (38.4)
Mean (SD) age (years)	72.8 (10.3)	72.3 (12.3)	73.3 (9.5)	72.4 (12.6)
Male	130 (68.8)	64 (65.3)	110 (70.0)	67 (68.4)
Mean (SD) BMI	27.3 (4.6)	27.1 (4.9)	27.1 (4.1)	27.6 (4.4)
Current smoker	28 (14.8)	24 (24.5)	11 (7.0)	9 (9.2)
Medical history				
Diabetes	46 (24.3)	36 (36.7)	23 (14.6)	22 (22.4)
Hypertension	117 (61.9)	74 (75.5)	131 (83.4)	82 (83.7)
Myocardial infarction	53 (28.0)	41 (41.8)	55 (35.0)	34 (34.7)
PCI	38 (20.1)	29 (29.6)	66 (42.0)	38 (38.8)
CABG	19 (10.1)	8 (8.2)	15 (9.6)	12 (12.2)
Chronic heart failure	11 (5.8)	11 (11.2)		
Stroke	9 (4.8)	4 (4.1)		

Responders and non-responders. Values are numbers and percentages unless stated otherwise. No baseline data in control group regarding CHF and stroke are available.
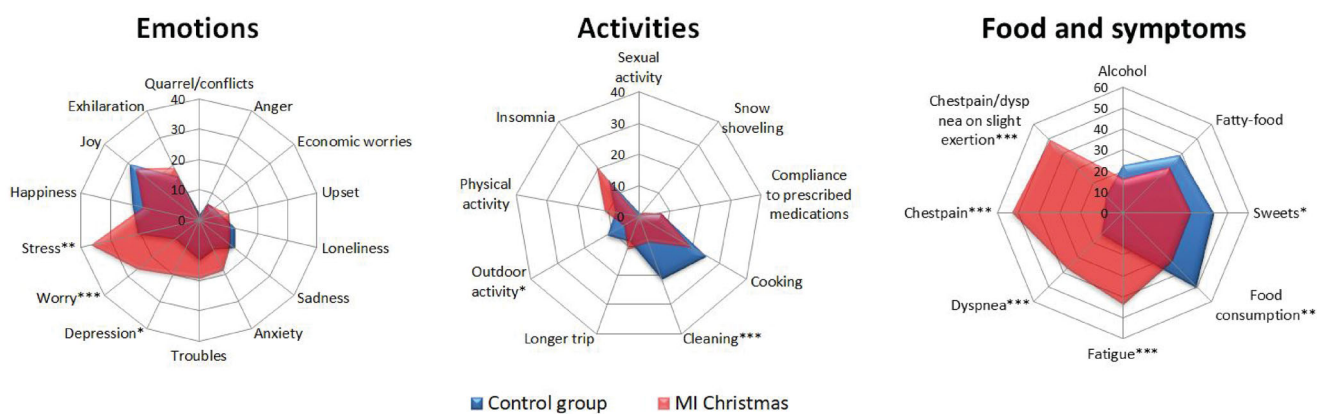
Figure 1. Report of a little more or much more of emotions, activities, food, alcohol, and symptoms than usual in the 24 h pre-MI or 24–26 Dec in the control-group. Values represent the percentage of responders. *$p < .05$, **$p < .01$, ***$p < .001$.

fatty-food (31% vs. 39%, $p = .129$) and alcohol consumption (16% vs. 23%, $p = 0,135$). 50% in the MI group consumed no alcohol 24 h prior to symptom onset. (Supplementary Table 3). In the MI-Christmas group, 53% experienced increased chest pain compared to 8.6% in the control group ($p < .001$), 44% fatigue (vs. 16%, $p < .001$), and 38% dyspnea (vs. 15%, $p < .001$) during the 24 h preceding MI (Figure 1).
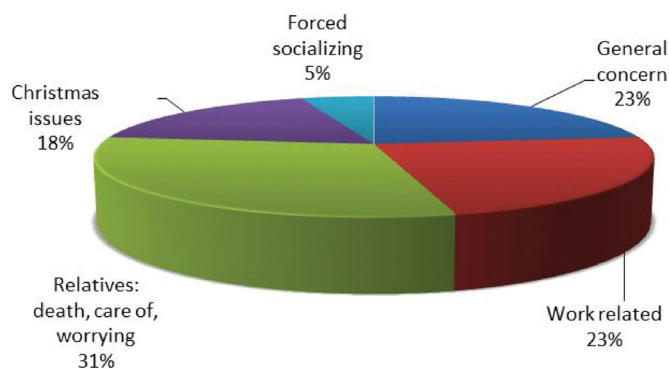
Described causes of stress

Participants had the opportunity to describe any possible trigger or stress inducer in their own words (Figure 2 and Supplementary Table 4.). Of the 39 responses from the MI-Christmas group, 12 participants (31%) declared worries regarding family and relatives. Stress at work was described by nine responders (23%) and as many stated Christmas issues and forced socializing as stressful.

Discussion

Patients with MI at Christmas reported stress, depression, and worry to a greater extent than the control group. Both groups reported altered diet habits even if consumption of food and sweets was more common in the control group. No differences were seen in alcohol and fatty food consumption. The frequency of quarrels, anger and financial worries did not differ

Figure 2. Stated reasons for stress from MI-Christmas responders. Categories of responder descriptions. Values in percent.

markedly. About half of the patients with MI at Christmas experienced warning signs such as chest pain.

Emotions

Emotional stress has been reported in earlier studies to precede cardiac events [9–11]. This was confirmed in our study. Although only 7% stated that they were alone over the Christmas holidays pre-MI (Figure 3), a much higher

Socializing 24 h pre-MI
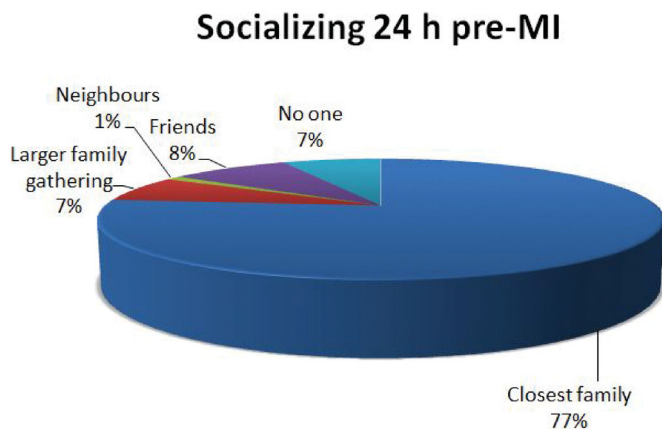
Figure 3. Socializing in the 24 h pre-MI in the MI-Christmas group. Values represent percentages of responders.

proportion reported greater than usual emotional distress. Of the MI-Christmas group, 52% expressed higher levels than usual of at least one of the following negative feelings: anxiety, depression, loneliness, sadness, worry, troubles, financial worries, and stress. Subjective emotional illness is multifaceted, and assessment of stress is a challenge, as no standard methodology exists. The free wording descriptions of stressors provide insight into both short- and long-term emotional stress with several responses relating to the loss of family members. Loss of loved ones has been associated with a 21-fold increase in MI incidence rate in the initial 24 h, declining in the following days [12]. Work-related stress has likewise been documented to trigger MI [10,13].

Our group [1] has earlier observed that the risk of MI during the Christmas holiday period was greater in older individuals with comorbidities, suggesting that vulnerable patients may be more susceptible to triggers associated with the Christmas holidays. In the present study, the mean age was considerably higher than in many other trials assessing triggers of MI [14]. A previous study stated that wellbeing likely plays a protective role in health maintenance [15]. Steptoe et al. [15]shows that the elderly population in Western countries experiences lower levels of stress, worry, and anger than do middle-aged individuals. The close relationship of impaired psychological wellbeing and physical health is supported by the study, indicating compromised emotional health preceding MI.

Food and alcohol

More than one-third of MI-Christmas responders described consuming more food than usual in the 24 h pre-MI. Associations with MI have been observed in the hours following ingestion of a heavy meal because of endothelial dysfunction, excessive gastric distention, and increased blood pressure [16,17]. Approximately 8% of MIs are considered to follow meal ingestion [9]. In addition, about one-third of the MI Christmas group reported increased consumption of sweets. Elevated insulin and hyperglycaemia can influence blood vessels through inflammation, endothelial dysfunction, and increased platelet adhesiveness; hence, a short-term trigger effect similar to overeating is likely [18]. Increased

consumption of food and sweets was more prevalent in the control group than in the MI group contradicting the expected relationship between increased food intake and MI during Christmas. The fact that the control group reported variables over 3 days, compared to 24 h for the MI group could be a reason, in addition, pre-symptoms and reduced psychological well-being in the MI group reduced appetite could influence. Moderate alcohol consumption has been associated with an increased risk of cardiovascular disease in the first 24 h after consumption [19]. Overall alcohol consumption was low in this study, 50% consumed no alcohol (Supplementary Table 3), and it does not seem to be the main factor in the increased number of MIs at Christmas.

Activity

Except for cooking and cleaning, reduced physical and outdoor activity was common in our study, with one in four responders in the Christmas-MI group reporting less physical activity than usual. This was also true of almost one-third of the group of patients in the control group. Although our results did not indicate it as a major trigger of MI during the Christmas holidays, physical exertion as a trigger of MI has been well described [16,18], and one patient in the MI-Christmas group was skiing when MI symptoms developed. We also asked about poor compliance with prescribed medication, which has been speculated to be associated with increased cardiac events during holidays. Only three responders (2%) admitted to lower than usual compliance in the MI-Christmas group. Drug adherence can however be quite challenging to measure and self-reported answers have limitations [20]. About half of the MI-Christmas patients experienced chest pain, fatigue, or dyspnea in the 24 h pre-MI which may have been a warning sign.

Strengths and limitations

The main limitation of this study is recall bias [21], compounded by the increased likelihood of reporting retrospective psychological illness when trying to find a reason for a physical disorder. The experience could be remembered as more intense or more proximate to the MI than it was. An earlier study has although shown that, on average, positive emotions were retrospectively overestimated, whereas negative emotions were recalled more accurately [21]. However, we used a common design in patient-reported outcomes, and it is difficult to investigate this topic prospectively. In addition, we used 24 h as a hazard period to identify triggers, while most previous studies have used one to two hours. Our main objective was to obtain the patient view of the time pre-MI to understand the mechanisms behind the higher heart attack rate during Christmas.

As no validated questionnaire was available, we constructed our own by using standard instruments in combination with our survey questionnaire [22]. The responders were instructed to value any possible action, feeling, or food consumption relative to "as usual." The interpretation of this was left to the responders and objective scales were not used for most topics. This design has limitations even as it

reduces differences in patient perception. Despite the lag time from the MI event to answering the questionnaire, most of the responders remember the circumstances. The first-year results and the response rates were almost identical to those of the second year, and the same conclusions could be drawn. A final limitation could be that this study assessed only triggers of Christmas MI in surviving patients. This study benefits from many strengths including being a nationwide survey study with high response rates assessing a large number of potential MI triggers.

Conclusions

The main findings in this nationwide survey are increased stress and impaired psychological wellbeing as potential triggers to Christmas-MI. Awareness of impaired psychological wellbeing preceding the myocardial infarction is important to deal with in the secondary prevention care. Other potential reasons for Christmas-MI, like food, sweets, quarrel, or economic worries are not shown to be major triggers in this study.

Ethical approval

This study was approved by Swedish Ethical Review Authority (2019/01586).

Author contributors

All authors were involved in the study design, data analysis, and revision of the manuscript and read and approved the final manuscript. DE is the guarantor. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Data availability statement

The data that support the findings of this study are available from the corresponding author, [DE], upon reasonable request.

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