Medium-Term Effects of a Train Derailment on the Physical and Psychological Health of Men

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Abstract

In July 2013, the derailment of a train caused the death of 47 people and the destruction of Lac-Mégantic's downtown area (Canada). Three years after this event, a population survey was conducted among a representative sample of 800 adults, including 282 men. Several significant differences were observed among respondents of a survey based on their level of exposure to this tragedy, including their physical (changes in physical health) and psychological health (post-traumatic stress disorder, mood and anxiety disorders, psychological distress, signs of depression, consultation of social workers and psychologists) as well as their use of prescribed (anxiolytics and antidepressants) and nonprescribed drugs. Such results can be explained by the nature, magnitude, and cause of the event.

In the past two decades, many countries and populations have faced technological disasters that have caused death, disrupted the lives of thousands of people, and forced public authorities to declare a state of emergency. Among these disasters, the derailment of a train filled with crude oil has caused major trauma to people living in the community of Lac-Mégantic and surrounding areas, part of the MRC du Granit (Quebec, Canada).

On July 6, 2013, in the middle of the night, a train of 72 tank wagons carrying crude oil derailed in the downtown area of Lac-Mégantic. This derailment sparked a series of explosions, burned 5.7 hectares of the city, killed 47 people, and destroyed many buildings, including 5 private residences, 66 apartments, and 44 businesses. This disaster forced the evacuation of more than 2,000 people, including 169 who were never able to return to their homes. More than five million tons of crude oil was released into the environment.

The human consequences of this tragedy were still tangible 3.5 years after this event and still are even today. The magnitude of the primary and secondary stressors associated with such an event is likely to have medium-term repercussions for exposed individuals. Given the extent of this event, it is relevant to examine the state of men's health in both the short and long term.

Although some scientific works state that women exposed to disaster are at greater risk of developing post-traumatic stress disorder (PTSD) than men are (Goldmann & Galea 2014; Musa et al., 2014), it is not always the case. Galea, Nandi, and Vlahov (2005) established that in some studies, gender does not matter in risk factors related to the presence of PTSD. They also suggest that mediating factors, including social support, may alter the results of the gendered analysis of this disorder. A

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meta-analysis focusing on the consequences of 220 natural or technological disasters highlighted that, compared to women, men are less inclined to believe in a just world after experiencing a technological catastrophe (Riaz et al., 2015). Given that the concept of a just world is a moderator of resilience, this could explain, among other things, why some men find it difficult to adapt after a technological disaster (Riaz et al., 2015). In general, men also display little compassion for themselves, while a high level of compassion reduces the onset of psychological health problems following exposure to a stressful or traumatic event (Leary, Tate, Adams, Batts Allen, & Hancock, 2007; Reilly, Rochlen, & Awad, 2014). According to Labra, Maltais, and Tremblay (2017), during a disaster, men combine several risk factors related to psychological distress, such as socioeconomic difficulties, material precariousness, and family difficulties. Added to this is the fact that men do not express their pain and the various feelings they may feel after a natural disaster. In this context, it seems appropriate to capture the state of men's health after exposure to a technological disaster, as they would be less likely to consult with mental health professionals, seek help from their loved ones, and recognize their problems compared to women (American Psychiatric Association, 2000).

Literature Review

Research on natural or technological disasters reported that this type of event is associated, after several months, with the presence of mental health problems including PTSD, with signs of depression, anxiety, and somatization as well as memory disorders (Anderson, Sortwell, Wolf Craig, & Ziedonis, 2016; Arnberg, Eriksson, Hultman, & Lundin, 2011; Chung, Farmer, Werrett, Easthope, & Chung, 2001; Chung, Easthope, Farmer, Werrett, & Chung, 2003; Engelhard, van den Hout, Arntz, & McNally, 2002). A significant number of individuals also experience other symptoms affecting their quality of life, including disturbing thoughts, difficulty falling asleep, and frequent nightmares. Victims exposed to a disaster may exhibit several adverse behaviors, such as the use of alcohol, substances, and medication (Fullerton & Ursano, 2005; Warsini et al., 2014).

Residents living in areas where a train derailment occurs would suffer more physical and mental health problems than those further away from it (Chung et al., 2003). With respect to explosions and fires in recreational facilities or factories, the medium- and long-term effects studies come to similar conclusions. Residents affected by fires following accidental explosions in factories would have two to three times more problems with depression, anxiety, and sleep difficulties, 18 and 24 months after their exposure, than a control group (Grievink et al., 2007). Again, 47% of workers, living near or away from a factory that

was seriously damaged by explosions (Toulouse, France, 2000), were still suffering from psychological distress 2 years after this event and the frequency of symptoms of depression and anxiety was higher in women than in men (Cohidon et al., 2009). The presence of psychological symptoms, including despair and sleep and concentration difficulties, would also be significantly associated with the distance between the location of the explosion and where exposed people live (Diène, Agrinier, Santin, Cohidon, & Schwoebel, 2007). Being evacuated as a result of severe fires would also be related to the presence of PTSD (Elklit, 2007). The presence of post-traumatic stress symptoms 15 months after exposure to an industrial incident would be a good indication that these symptoms are not likely to fade over the years (Bui et al., 2010). According to Rivière et al. (2008), Nandi et al. (2004), Cerdá et al. (2013), and Ghaffari-Nejad, Ahmadi-Mousavi, Gandomkar, and Reihani-Kermani (2007), the presence of psychological health problems several months after exposure to a disaster would be associated with three broad types of factors: (a) individual vulnerability factors (e.g., older age, low socioeconomic status, history of mental health problems, use of avoidance strategies), (b) factors related to disaster exposure (e.g., loss of a child or loved one, destruction of home, injuries, relocation, relief to victims), as well as (c) post-traumatic factors (e.g., period of unemployment, loss of resources and income, deterioration of working conditions, inconvenience related to the closure of public services, subsequent financial hardships, loss, and low social support). Studies reveal that adults exposed to a disaster may experience different stressors or adjustment difficulties that usually manifest themselves in changes in their general living conditions (Aldrich & Benson, 2008; Lamb, O'Brien, & Fenza, 2008; Maltais, Lachance, Brassard, & Picard, 2002).

Yokoyama et al. (2014) mentioned that men facing postdisaster economic problems are more likely to develop mental health problems than women. In this sense, there is an association between home-related damage and psychological distress among men over the age of 40 years (Lavenda, Hoffman, Grossman, & Ben-Ezra, 2017). Physical losses, such as the severity of home damage, increase the risk of major depression (Cerdá et al., 2013). For their part, following the floods in England, Akerkar and Fordham (2017) proposed that the main indicators promoting the recovery of men's mental health are the degree of perceived control, the perception of their ability to cope, and the implementation of concrete actions to improve their situation. Research in social sciences suggests that the gap between men's and women's health is only slightly accentuated by physiological factors and is more likely to be the result of socialization (Tremblay & Déry, 2010). Men are reported to be significantly less likely to use help and support services for their

mental health (Addis & Hoffman, 2017), even following an exposure to a disaster (Elhai & Ford, 2009; Labra et al., 2017). The desire to conform to the traditional norms of masculinity is no stranger to this underutilization of health and social services (Yousaf, Popat, & Hunter, 2015). Men would use help services mostly when they are in a state of crisis (Oliffe, Ogrodniczuk, Bottorff, Johnson, & Hoyak, 2012; Tremblay & Déry, 2010; Yousaf et al., 2015). It should be noted that many of them seem to have the perception that time will solve their health difficulties, although this vision does not seem to be successful with respect to the remission of certain mental health disorders such as PTSD (Labra et al., 2017; Morina, Wicherts, Lobbrecht, & Priebe, 2014).

Several researchers have examined the vulnerability of adults following a disaster without stratifying analysis by gender of participants. This leads to a lack of information on the difficulties faced by men and the impacts of their exposure to a technological disaster. This article focuses specifically on the postdisaster physical and psychological health of men affected by a train derailment.

Methodology

Setting

The Eastern Townships region includes a mix of urban, semiurban, and rural areas. It is located in the southeastern part of the province of Quebec (Canada) and extends to Vermont, New Hampshire, and Maine, along the American border. Its population is approximately 500,000 people, one third of whom live in the area's main city, Sherbrooke (Quebec's 6th largest city). The town of Lac-Mégantic has a population of approximately 6,000 citizens. It is the seat of the Granit area (population of 20,000 residents), which is one out of the nine administrative areas in the Eastern Townships. Lac-Mégantic is located on the shores of the Lake Mégantic.

Participant Recruitment Process

The data presented in this article are taken from a quantitative study on the effects of the Lac-Mégantic tragedy, for which ethical certification was obtained from the Centre intégré universitaire de santé et de services sociaux de l'Estrie-Centre hospitalier universitaire de Sherbrooke (reference number: 92017-544). From October to November 2016, a professional polling firm recruited, from randomly generated telephone numbers, 800 adults aged 18 years and over living in the regional county municipality (MRC) du Granit, 387 of whom lived in Lac-Mégantic and 413 in the other municipalities of this MRC. Of these 800 people, 282 were men. Randomly selected individuals were asked to complete,

on the phone or online, a close-ended questionnaire. The maximum duration of telephone conversations was 30 min and response rates were 47.8% for residents living in Lac-Mégantic and 50.1% for other municipalities in the MRC du Granit. At the beginning of their telephone exchanges, the interviewers provided information on the objectives of this study and its modalities. The participants then received information on the researchers and organizations responsible for this study (Université de Québec à Chicoutimi and Direction de santé publique de l'Estrie-CHUS) and the maximum duration of the questionnaire (30 min). Participants were also informed that their participation was voluntary and that all their responses would be kept confidential. This study posed no risk to the physical or psychological health of respondents. Each participant was given a number by the polling firm. At the beginning of the telephone interview, the interviewers made sure of the willingness of the people to participate in the survey. No constraints were placed on the respondents. They were given the opportunity not to answer some of the questions or to end the telephone interview at any time without inconvenience. For the survey to begin, people had to give their verbal consent and the interviewers had to indicate in the database whether participants agreed to or refused to participate in this study. The survey firm that collected the data had conducted the same type of population survey over the previous 2 years with more than 8,000 adults residing in the territory covered by Direction de la santé publique de l'Estrie-CHUS.

Data Collection Tool and Variables Under Study

To survey the participants, a questionnaire was developed based on existing tests with good psychometric properties and measures previously validated in various studies on the consequences of technological disasters (Armenian et al., 2002; Chung et al., 2001, 2003; Engelhard et al., 2002; Rhebergen et al., 2011; Rivière et al., 2010). The purpose of this questionnaire was to assess the intensity of exposure of respondents to the train derailment and to provide a portrait of their physical and psychological health and their use of alcohol, antianxiety drugs, antidepressants, and nonprescription drugs. The questionnaire contained 62 dichotomous or multiple-choice questions, including seven scales validated in other similar studies.

The questions to distinguish the level of exposure to the train derailment related to various events and losses experienced during this disaster. Respondents were asked whether they experienced the following situations when the train derailed: fear for their own lives or that of a family member (immediate family members, extended family members, or significant others), to be without news of a

loved one for a few hours or a few days, to suffer personal injury or to find that a loved one was injured, to experience the loss of a loved one (members of one's immediate family, extended family, or a significant other), and to suffer damage or the total loss of one's home and be temporarily or permanently relocated.

Based on the participants' responses, it was possible to classify these in three categories: those who were highly exposed (21.6%, *n* = 61), moderately exposed (54.6%, *n* = 154), and unexposed to the tragedy (23.7%, *n* = 67). Respondents who were highly exposed have experienced human losses (fear for their life or that of a loved one, loss of a loved one, or injury) and material damage (relocation or damage to their home) and consider that the train derailment was a stressful event that had negative impacts on their lives (subjective perception of the tragedy). In contrast, moderately exposed respondents experienced two of the three types of losses mentioned earlier (human, material, or subjective), while unexposed respondents experienced none of these three types of losses.

Closed dichotomous or multiple-choice questions were used to gather information on the sociodemographic characteristics of respondents. For example, information on the place of residence, gender, age, marital status, level of education and family income, and the number of children under the age of 18 years living with the participants was obtained.

The original version of Horowitz's Impact of Event Scale (Horowitz, Wilner, & Alvarez, 1979) was used to measure the presence or not of PTSD. This tool includes 15 items and for each of them, respondents must indicate the frequency of these symptoms over the past week (Alexander & Klein, 2001; Maltais et al., 2005). The score of this instrument ranges from 0 to 75 points. The higher the score, the more post-traumatic stress symptoms respondents show. A score greater than 25 indicates the presence of PTSD (Ticehurst, Webster, Carr, & Lewin, 1996). This data was used as a dichotomous variable. In this study, the alpha coefficient is .93 for the overall score.

The six-items Kessler Psychological Distress Scale (K6) was used to assess psychological distress (Kessler, Andrews, Colpe, & Hiripi, 2002; Orpana, Lemyre, & Gravel, 2009). This scale, validated in various population surveys, deals with feelings of nervousness, hopelessness, agitation, depression, discouragement, and uselessness felt during the past month. Each item is evaluated on a 4-point scale, for a total score ranging from 0 to 24. The higher the score, the greater the psychological distress. According to the Institut de la statistique du Québec (Baulne & Courtemanche, 2016), people who score 7 or more are considered to be suffering from psychological distress. This data was used as a dichotomous variable. The alpha of this test is .86.

The presence of depressive symptoms was assessed by two questions indicating whether, over a consecutive period of 2 weeks or more in the past 12 months, respondents were sad, melancholic, or depressed and had experienced a loss of interest in the things they usually liked. Respondents also had to answer two questions asking them (a) whether they had a mood disorder, such as depression, bipolar disorder, mania, or dysthymia, and (b) whether they had an anxiety disorder, such as a phobia, obsessive compulsive disorder, or panic disorder. These questions were used previously in two population surveys, conducted in 2014 and 2015 by Eastern Townships Public Health Department (Généreux et al., 2016).

The respondents' consumption patterns were listed based on questions relating to their use or not of tranquilizers, sedatives, or antidepressants prescribed by a doctor, and the consumption frequency of five glasses or more of alcohol during one single occasion in the past 12 months. According to the Association pour la santé publique du Québec (2015), this type of alcohol consumption is referred to as "binge drinking." Respondents also had to estimate whether their frequency of alcohol consumption had remained stable, decreased, or increased over the past 3 years (i.e., since the train tragedy).

Finally, in order to identify positive or negative impacts in various aspects of their lives, respondents had to consider if there were any changes over the past 3 years prior to data collection in their personal life (mood, outlook on life, and future), marital life (relationship with a partner or spouse), family life (relationship with children, siblings, and extended family), and social life (frequency and quality of contact with family members, frequency of leisure activities with at least one other person, outings, and activities). Depending on the items investigated, respondents could answer that their situation had improved, deteriorated, or remained stable or that the number or frequency of these had increased, decreased, or remained stable.

Data Analysis

This study aims to compare respondents according to their level of exposure to the disaster on all variables under study. Pearson's chi-squared tests were used for nominal or ordinal data. When significant differences were identified, a posteriori comparative tests were conducted using the Bonferroni correction. The results on the scales, measuring the presence of post-traumatic stress and psychological distress, were analyzed in dichotomous categories (presenting or not these symptoms) based on the cutting score suggested in the scientific literature. Analysis of variance (ANOVA) was also used to

compare the averages of these two variables. Given the significant differences between the three age groups and the presence of children under the age of 18 years at home, logistic regression analyzes were also conducted to verify whether significant differences between respondents were maintained for all dependent variables. The significance threshold was established at 0.05 for all the analyses.

Results

Sociodemographic Characteristics of Respondents by Level of Exposure

The majority of highly exposed respondents live in Lac-Mégantic (82.0%, $n = 50$), while those moderately exposed (57.1%, $n = 88$) or not exposed (83.6%, $n = 56$) reside in other municipalities located in the Lac-Mégantic vicinity ($p < .001$). Highly exposed respondents had the lowest percentage of participants aged 65 years or older (11.5%, $n = 7$) and the highest percentage of men aged 50 to 64 years (50.8%, $n = 31$; $p < .001$). More highly exposed respondents (31.1%, $n = 19$) had children aged 18 years and under living at home than those unexposed (11.9%, $n = 8$; $p < .05$). There was no significant difference between the three groups with respect to the percentages of respondents aged 18–49 years, living alone, marital status, economic conditions, and education level (Table 1).

Exposure to the Disaster

The majority of highly exposed men said they feared for their life (56.1%, $n = 32$) or that of a loved one (78.9%, $n = 45$). In addition, more than half (54.1%, $n = 33$) of the 61 men who were highly exposed to the disaster lost a relative or friend during the tragedy, while 41.6% ($n = 90$) of the moderately exposed also lost a loved one. As for material losses, 27.9% ($n = 17$) of those highly exposed have experienced home damage or complete destruction of it, while only 3.2% ($n = 5$) of those moderately exposed were in the same situation ($p < .001$). The majority of highly exposed individuals lost their jobs (41.0%, $n = 25$) either temporarily or permanently, while 6.5% ($n = 10$) of moderately exposed individuals experienced job losses ($p < .001$). In addition, most highly exposed individuals (82.0%, $n = 50$) experienced temporary or permanent relocation following the train derailment, compared to 16.9% ($n = 26$) of moderately exposed individuals. Finally, the majority of the highly exposed (82.0%, $n = 50$) and slightly less than half of the moderately exposed (49.4%, $n = 76$) were, at the time of data collection, daily confronted with the sight of the downtown area destroyed by the train derailment.

Perceived Physical and Psychological Health of Respondents by Level of Exposure

Three years after the tragedy, the majority of men, regardless of their level of exposure to the train derailment, rate their physical health as excellent or very good (see Table 2). Moreover, significantly more men who were not exposed (76.1%, $n = 51$) to the tragedy compared to the highly exposed (45.9%, $n = 28$) group feel that their health has stayed stable the past 3 years ($p < .01$). On the other hand, the highly exposed respondents (39.3%, $n = 24$) are the more likely ones to consider that their health status has deteriorated than the nonexposed (19.4%, $n = 13$). The majority of highly exposed men (72.1%, $n = 44$) also showed signs of PTSD during the data collection and a quarter presented mood disorders (23.0%, $n = 14$). These percentages are significantly higher ($p < .001$) than those identified in moderately exposed individuals and in those not exposed to the tragedy. Also, highly and moderately exposed men are significantly more likely than the nonexposed men to have experienced anxiety ($p < .001$), psychological distress ($p < .001$), and depressive episodes ($p < .001$) in the past 12 months. This study also found that those who were highly exposed are significantly more likely to have consulted a social worker (24.6%, $n = 15$) over the past year than the other two groups of respondents ($p < .001$), while consulting a psychologist varied according to the level of exposure to the tragedy (highly exposed: 16.4%, $n = 10$, moderately exposed: 9.1%, $n = 14$, nonexposed: 3.0%, $n = 2$; $p < .05$).

Consumption Patterns of Alcohol, Antianxiety, Antidepressant, and Nonprescription Drugs by Level of Exposure

Highly exposed men (29.5%, $n = 18$) are significantly more likely than others to report the use of anxiolytics ($p < .01$). Highly (18.0%, $n = 11$) and moderately (9.2%, $n = 14$) exposed men are significantly more likely than the nonexposed men (0%, $n = 0$) to have taken antidepressants ($p < .01$) in the 12 months prior to data collection. Highly exposed men are also more (16.4%, $n = 10$) likely to estimate that their use of over-the-counter medications has increased over the same period more than that of nonexposed respondents (1.5%, $n = 1$; $p < .05$) (Table 3).

Personal, Family, and Professional Lives of Respondents

Men who were highly (31.1%, $n = 19$) and moderately (20.1%, $n = 31$) exposed to the train derailment are more likely to feel that most of their days are quite or extremely stressful ($p < .001$) and to notice a mood deterioration (highly exposed: 32.8%, $n = 20$,

Table 1. Sociodemographic Characteristics of Men (%).

Variables	Highly exposed (n = 61)		Moderately exposed (n = 154)		Not exposed (n = 67)		χ^2	p
	N	%	N	%	N	%		
Territory							56.07	.000***
Lac-Mégantic	50	82,0[a]	66	42.9[b]	11	16.4[c]		
Elsewhere in MCR du Granit	11	18.0[a]	88	57.1[b]	56	83.6[c]		
Age							15.66	.004**
18–49 years old	23	37.7[a]	43	28.5[a]	21	31.8[a]		
50–64 years old	31	50.8[a]	59	39.1[ab]	18	27.3[b]		
65 years old and over	7	11.5[a]	49	32.5[b]	27	40.9[b]		
Live alone							3.23	.198
Yes	23	37.7[a]	42	27.5[a]	25	37.3[a]		
No	38	62.3[a]	111	72.5[a]	42	62.7[a]		
Marital status							8.13	.228
Married/free union	35	57.4[a]	96	62.3[a]	35	52.2[a]		
Single	15	24.6[ab]	28	18.2[b]	23	34.3[a]		
Separated/divorced	10	16.4[a]	23	14.9[a]	7	10.4[a]		
Widowed	1	1.6[a]	7	4.5[a]	2	3.0[a]		
Presence of children under 18 years							7.42	.025*
Yes	19	31.1[a]	30	19.5[ab]	8	11.9[b]		
No	42	68.9[a]	124	80.5[ab]	59	88.1[b]		
Source of income							10.60	.101
Full-time worker	34	55.7[a]	66	43.4[a]	27	40.3[a]		
Part-time worker	8	13.1[a]	11	7.2[a]	6	9.0[a]		
Retired	12	19.7[a]	63	41.4[b]	26	38.8[ab]		
Other	7	11.5[a]	12	7.9[a]	8	11.9[a]		
Highest level of education completed							6.92	.733
Less than High school	11	18.0[a]	32	20.8[a]	15	22.4[a]		
Vocational diploma	23	8.2[a]	39	9.1[a]	24	7.5[a]		
High school	5	37.7[a]	14	25.3[a]	5	35.8[a]		
College	10	16.4[a]	31	20.1[a]	12	17.9[a]		
University	11	18.0[a]	33	21.4[a]	11	16.4[a]		
Others	1	1.6[a]	5	3.2[a]	0	0.0[a]		
Annual household income							5.34	.254
Less than $30,000	20	33.9[a]	46	30.9[a]	22	34.9[a]		
Between $30,000 and $79,999	27	45.8[a]	73	49.0[a]	36	57.1[a]		
$80,000 or over	12	20.3[a]	30	20.1[a]	5	7.9[a]		

Note. [a,b]Each superscript letter denotes a sub-category whose proportions do not differ significantly at the .05 level.
*$p < .05$. **$p < .01$.

moderately exposed: 18.2%, $n = 28$; $p < .001$). Nonexposed men are more likely to consider no change in their perception of the future (70.1%, $n = 47$; $p < .05$), and highly exposed men (37.7%, $n = 23$) report more sleep difficulties than the nonexposed men (9.0%, $n = 6$; $p < .001$). Men with high exposure also reported more often (23.0%, $n = 14$) a negative perception of life in general since the train derailment than nonexposed men (6.0%, $n = 4$; $p < .01$) (Table 4).

Men with high exposure are also significantly more likely than moderately exposed or nonexposed ones to notice over the past 3 years a change (either deterioration or improvement) in the relationship with their partner or spouse ($p < .001$) and their children ($p < .01$), as well as a decrease in the relationship with their siblings ($p < .001$). At the professional level, experiencing high exposure to the train derailment had negative impacts on respondents' motivation (34.0%, $n = 17$; $p < .05$) and job performance (22.9%, $n = 11$) compared to nonexposed men ($p < .05$). The level of stress at work in the past 3 years ($p < .001$) is also more important for highly exposed men (36.1%, $n = 22$) than it is for the other two groups, and the moderately exposed (17.5%, $n = 27$) are in the same position compared to nonexposed men (1.5%, $n = 1$).

Table 2. Perception of Physical and Psychological Health Status of Men (%).

Variables	Highly exposed (n = 61)		Moderately exposed (n = 154)		Not exposed (n = 67)		χ^2	p
	N	%	N	%	N	%		
Physical health status								
Perception of health status							2.86	.239
Excellent to very good	48	78.7[a]	130	84.4[a]	60	89.6[a]		
Fair to poor	13	21.3[a]	24	15.6[a]	7	10.4[a]		
Change in health status							14.96	.005**
Improved	9	14.8[a]	9	5.8[a]	3	4.5[a]		
Remained stable	28	45.9[a]	102	66.2[b]	51	76.1[b]		
Deteriorated	24	39.3[a]	43	27.9[ab]	13	19.4[b]		
Consulting a family doctor							4.26	.119
Yes	48	78.7[a]	125	81.2[a]	46	68.7[a]		
No	13	21.3[a]	29	18.8[a]	21	31.3[a]		
Consulting a specialist							6.61	.037*
Yes	24	39.3[ab]	72	46.8[b]	19	28.4[a]		
No	37	60.7[ab]	82	53.2[b]	48	71.6[a]		
Psychological health status								
Post-traumatic stress disorder							55.62	.000***
Yes	44	72.1[a]	53	34.4[b]	6	9.0[c]	F = 26,80[1]	.000***
No	17	27.9[a]	101	65.6[b]	61	91.0[c]		
Average		38,11		22,93		7,94		
Mood disorder							16.46	.000***
Yes	14	23.0[a]	14	9.1[b]	1	1.5[b]		
No	47	77.0[a]	140	90.9[b]	66	98.5[b]		
Anxiety disorder							19.35	.000***
Yes	16	26.2[a]	21	13.6[a]	0	0.0[b]		
No	45	73.8[a]	133	86.4[a]	67	100.0[b]		
High psychological distress							20.97	.000***
Yes	26	42.6[a]	41	26.6[a]	5	7.5[b]	F = 114,33[1]	.000***
No	35	57.4[a]	113	73.4[a]	62	92.5[b]		
Average		7,11		4,62		3,03		
Depressive episode							14.57	.001**
Yes	28	45.9[a]	47	30.5[a]	10	14.9[b]		
No	33	54.1[a]	107	69.5[a]	57	85.1[b]		
Consulting a psychologist							6.86	.032*
Yes	10	16.4[a]	14	9.1[ab]	2	3.0[b]		
No	51	83.6[a]	140	90.9[ab]	65	97.0[b]		
Consulting a social worker							17.40	.000***
Yes	15	24.6[a]	13	8.4[b]	2	3.0[b]		
No	46	75.4[a]	141	91.6[b]	65	97.0[b]		

Note. [a, b, c]Each superscript letter denotes a sub-category whose proportions do not differ significantly at the .05 level. [1]An analysis of variance (ANOVA) was performed to compare the average of the groups.
*p < .05. **p < .01. ***p < .001.

Multivariate Analyzes With Adjustment for Age and Presence of Children Under 18 Years at Home

Since all three groups of respondents differed in terms of age and presence of children aged 18 years or younger at home, logistic regression analyzes were conducted to determine whether differences between respondents remained after controlling the effect of these two variables. The results of these analyzes indicate that all the differences found between respondents remain significant. Due to limitations, the results of these logistic regression analyses were not presented in additional tables.

Table 3. Consumption Patterns of Alcohol and Medication (%).

Variables	Highly exposed (n = 61)		Moderately exposed (n = 154)		Not exposed (n = 67)		χ^2	p
	N	%	N	%	N	%		
Binge drinking							2.24	.326
Yes	13	21.3[a]	23	14.9[a]	8	11.9[a]		
No	48	78.7[a]	131	85.1[a]	59	88.1[a]		
Alcohol consumption							7.31	.120
Has increased	10	16.4[a]	11	7.1[a]	3	4.5[a]		
Remained stable	42	68.9[a]	111	72.1[a]	52	77.6[a]		
Has decreased	9	14.8[a]	32	20.8[a]	12	17.9[a]		
Use of nonprescribed medications							11.64	.020*
Has increased	10	16.4[a]	10	6.5[ab]	1	1.5[b]		
Remained stable	46	75.4[a]	135	87.7[a]	60	89.6[a]		
Has decreased	5	8.2[a]	9	5.8[a]	6	9.0[a]		
Use of anxiolytics							12.27	.002**
Yes	18	29.5[a]	29	12.7[b]	6	9.0[b]		
No	43	70.5[a]	131	87.3[b]	61	91.0[b]		
Use of antidepressants							12.80	.002**
Yes	11	18.0[a]	14	9.2[a]	0	0.0[b]		
No	50	82.0[a]	138	90.8[a]	67	100.0[b]		

Note. [a, b]Each superscript letter denotes a sub-category whose proportions do not differ significantly at the .05 level.
*p < .05. **p < .01.

Discussion

This study demonstrates that men with high exposure to a train derailment present several significant differences from moderately and nonexposed respondents that seem to persist over time. Highly exposed men experience more difficulties than their counterparts in terms of physical and psychological health, as well as their medication consumption. As reported in other studies, this research indicates that men who have been highly exposed to a train derailment are more likely to exhibit PTSD (Mong, Noguchi, & Ladner, 2012; Rivière et al., 2010). Highly exposed men present psychological distress (Cohidon et al., 2009) and mood or anxiety disorders (Grievink et al., 2007), more than 3 years after the traumatic event.

Unlike other studies conducted in contexts of natural or technological disasters, the data in this study do not suggest differences between the three types of exposure in terms of sociodemographic characteristics except for age (He et al., 2014; Lie, Chow, Shi, & Chan, 2015; Kristensen, Weisaeth, & Heir, 2012; Newson). The sociodemographic characteristics of the respondents cannot therefore explain the presence of significant differences between them concerning the perception of physical health status, the presence of several symptoms of distress, and the deterioration of several aspects of personal, family, social, and professional life.

During the 3 years preceding the investigation, the population of Lac-Mégantic was also confronted with various secondary stressors such as the maintenance of train traffic within the downtown area, the decontamination of the grounds, the destruction of several homes located in the area affected by the oil spill, a class action, the reduction of psychosocial services specially established after the tragedy and by a trial against the train drivers. All of these events have likely contributed to delaying the recovery process for men and the general population affected by the tragedy.

In terms of age, of the 215 men exposed to the train derailment, 41.4% are between the ages of 35 and 64 years, a period described by experts as middle of life (Carr, 2009). In times of disasters, this period represents another challenge that can make them vulnerable in different spheres of their lives. For example, physically, men in the middle of life face a decrease in their faculties and must cope with physiological changes during this period (Willis & Reid, 1999). Scientific literature indicates that men between the ages of 51 and 60 are more anxious, less resilient, and have lower self-esteem compared to men in other age groups, which may not have facilitated the recovery process for men exposed to the train derailment (Beutel, Glaesmer, Wiltink, Marian, & Brahler, 2010; Beutel, Wiltink, Schwarz, Weidner, & Brähler, 2002).

Table 4. Personal, Family, and professional Life of Men (%).

Variables	Highly exposed (n = 61)		Moderately exposed (n = 154)		Not exposed (n = 67)		χ²	p
	N	%	N	%	N	%		
Personal life								
Stressful days							33.35	.000***
Not very stressful	12	19.7ᵃ	62	40.3ᵇ	45	67.2ᶜ		
A little stressful	30	49.2ᵃ	61	39.6ᵃᵇ	19	28.4ᵇ		
Somewhat stressful	19	31.1ᵃ	31	20.1ᵃ	3	4.5ᵇ		
Sleeping difficulties							20.25	.000***
Increased	23	37.7ᵃ	34	22.1ᵃᵇ	6	9.0ᵇ		
Remained stable	32	52.5ᵃ	112	72.7ᵇ	59	88.1ᶜ		
Decreased	6	9.8ᵃ	8	5.2ᵃ	2	3.0ᵃ		
Mood							20.35	.000***
Improved	6	9.8ᵃ	12	7.8ᵃ	6	9.0ᵃ		
Remained stable	35	57.4ᵃ	114	74.0ᵃᵇ	59	88.1ᵇ		
Deteriorated	20	32.8ᵃ	28	18.2ᵃ	2	3.0ᵇ		
Perception of the future							9.57	.048*
More positive	17	27.9ᵃ	44	28.6ᵃ	12	17.9ᵃ		
Remains the same	28	45.9ᵃ	80	51.9ᵃ	47	70.1ᵇ		
More negative	16	26.2ᵃ	30	19.5ᵃ	8	11.9ᵃ		
Conception of life							13.77	.008**
More positive	24	39.3ᵃ	43	27.9ᵃ	18	26.9ᵃ		
Remains the same	23	37.7ᵃ	88	57.1ᵇ	45	67.2ᵇ		
More negative	14	23.0ᵃ	23	14.9ᵃᵇ	4	6.0ᵇ		
Family life								
Relation with spouse		(n = 45)		(n = 130)		(n = 47)	10.67	.030*
Improved	7	15.6ᵃ	11	8.5ᵃ	3	6.4ᵃ		
Remained stable	27	60.0ᵃ	103	79.2ᵇ	41	87.2ᵇ		
Deteriorated	11	24.4ᵃ	16	12.3ᵃᵇ	3	6.4ᵇ		
Relation with your children		(n = 45)		(n = 116)		(n = 47)	9.81	.044*
Improved	10	22.2ᵃ	26	22.4ᵃ	6	12.8ᵃ		
Remained stable	31	68.9ᵃ	89	76.7ᵃ	40	85.1ᵃ		
Deteriorated	4	8.9ᵃ	1	0.9ᵇ	1	2.1ᵃᵇ		
Relation with your brothers, sisters, father, or mother		(n = 58)		(n = 148)		(n = 65)	7.96	.093
Improved	12	20.7ᵃ	15	10.1ᵃ	7	10.8ᵃ		
Remained stable	42	72.4ᵃ	121	81.8ᵃ	57	87.7ᵃ		
Deteriorated	4	6.9ᵃ	12	8.1ᵃ	1	1.5ᵃ		
Relation with your relatives		(n = 57)		(n = 149)		(n = 66)	7.91	.095
Improved	4	7.0ᵃ	9	6.0ᵃ	4	6.1ᵃ		
Remained stable	48	84.2ᵃ	136	91.3ᵃ	62	93.9ᵃ		
Deteriorated	5	8.8ᵃ	4	2.7ᵃᵇ	0	0.0ᵇ		
Professional life								
Relations with other employees		(n = 47)		(n = 93)		(n = 43)	11.23	.024*
Improved	8	17.0ᵃ	13	14.0ᵃ	3	7.0ᵃ		
Remained stable	31	66.0ᵃ	75	80.6ᵃᵇ	39	90.7ᵇ		
Deteriorated	8	17.0ᵃ	5	5.4ᵃ	1	2.3ᵃ		
Relations with the employer		(n = 43)		(n = 84)		(n = 38)	6.09	.192
Improved	5	11.6ᵃ	14	16.7ᵃ	3	7.9ᵃ		
Remained stable	30	69.8ᵃ	62	73.8ᵃ	33	86.8ᵃ		
Deteriorated	8	18.6ᵃ	8	9.5ᵃ	2	5.3ᵃ		
Performance		(n = 48)		(n = 97)		(n = 46)	9.76	.045*
Improved	8	16.7ᵃ	13	13.4ᵃ	8	17.4ᵃ		

Table 4. (continued)

Variables	Highly exposed (n = 61)		Moderately exposed (n = 154)		Not exposed (n = 67)		χ^2	p
	N	%	N	%	N	%		
Remained stable	29	60.4[a]	75	77.3[a]	36	78.3[a]		
Decreased	11	22.9[a]	9	9.3[ab]	2	4.3[b]		
Motivation		(n = 50)		(n = 99)		(n = 49)	10.14	.038*
Increased	5	10.0[a]	16	16.2[a]	9	18.4[a]		
Stable	28	56.0[a]	60	60.6[a]	36	73.5[a]		
Decreased	17	34.0[a]	23	23.2[ab]	4	8.2[b]		
Number of days of sick leave							9.31	.054
Increased	11	18.0[a]	14	9.1[ab]	2	3.0[b]		
Stable	48	78.7[a]	129	83.8[a]	61	91.0[a]		
Decreased	2	3.3[a]	11	7.1[a]	4	6.0[a]		
Level of stress at work							31.72***	.000***
Increased	22	36.1[a]	27	17.5[b]	1	1.5[c]		
Stable	29	47.5[a]	114	74.0[b]	59	88.1[b]		
Decreased	10	16.4[a]	13	8.4[a]	7	10.4[a]		

Note. [a,b,c]Each superscript letter denotes a sub-category whose proportions do not differ significantly at the .05 level.
*p < .05. **p < .01. ***p < .001.

The scientific literature also mentions that men have limited access to psychosocial services (Smith, Tran, & Thompson, 2008, Vogel, Heimerdinger-Edwards, Hammer, & Hubbard, 2011), which is also identified in this study, as less than a quarter of those exposed to the train derailment consulted a mental health professional in the 12 months prior to the survey, despite the fact that 72.1% had PTSD and 42.6% had psychological distress. This low use of psychosocial support services can, among other things, be explained by living in a small municipality where it is more difficult for service seekers to maintain their anonymity. The image socially conveyed to users of mental health services often hinders men's consultation (Corrigan, 2004), as they are more affected by social stigma compared to women (Vogel, Wade, & Hackler, 2006). In rural areas, men are inhabited by the false impression that they will overcome the hardships they encounter (Alston, 2006), which leads them to consult later (Tremblay & Déry, 2010).

In this study, the most heavily exposed victims feared for their lives or that of a loved one during the explosions and fires that followed the train tragedy, and nearly one out of two lost a loved one during the train derailment. Dealing with the grief of losing a loved one in conditions where the death is violent, unexpected, and out of the ordinary, as was the case in Lac-Mégantic, is likely to hinder the recovery process of individuals. Scientific literature reported that technological disasters are generally associated with more serious consequences than natural disasters for a similar extent of loss and damage to the property of individuals and their communities (Morgan & Bhugra,

2010). This phenomenon is due to persistent concerns that individuals may have about their own health and that of their loved ones in the months or years following this type of tragedy (Bromet, Havenaar, & Guey, 2011).

In such a context, it is not surprising to find that men who were highly exposed to the train derailment are significantly more likely than moderately and or nonexposed ones to have consumed anxiolytics and antidepressants in the 12 months prior to the data collection. These results converge with findings from other studies, which indicate that psychological symptoms following a disaster can lead to an increase in the number of psychotropic prescriptions (Boscarino, Galea, Ahern, Resnick, & Vlahov, 2003; DiMaggio, Galea, & Madrid, 2007; Rossi, Maggio, Riccardi, Allegrini, & Stratta, 2011). Unlike other studies conducted about alcohol consumption after a disaster, the results of the present research do not support a correlation between the level of exposure to the disaster and heavy drinking on a weekly basis and increase in alcohol consumption among men (Boscarino, Adams, & Galea 2006; Nordlokken, Pape, & Heir, 2016). Studies of disaster victims indicate that men tend to increase their consumption of alcoholic beverages (Zara, Parkinson, Duncan, & Joyce, 2016). It goes without saying that, in this study, only the perception of respondents was investigated. These differences can probably be explained by the bias of social desirability. The men interviewed did not dare to reveal their real consumption of alcoholic beverages to avoid being judged.

Although previous research has already highlighted the negative impacts of a disaster on men's health, it is, to our

knowledge, one of the few studies that has measured the impact of such an event on various aspects of life of these people. As disasters become more frequent, it will be interesting for future studies on this topic to continue to incorporate new variables. Most studies on the effects of a disaster on the health of individuals have focused on the adverse effects of the disaster (Bonnano, Brewin, Kaniasty, & La Greca, 2010). There is now evidence that a disaster can also lead to positive changes in different life aspects of victims. The addition of variables to measure these changes is a strength of this study. Few researchers have focused on technological disasters compared to natural disasters. The incidence of this first type of disaster has been increasing steadily for the past two decades.

Study Limitations

Although the results support the importance of integrating diverse variables to portray the impact of disasters on the overall health of men, they cannot be generalized to all those exposed to train derailments or other types of disasters. In fact, it is possible that men who refused to complete the telephone survey had sociodemographic characteristics and a more or less precarious state of health than those who volunteered. It is also possible that some men were not completely honest when it was time to answer some questions about their mental health, especially those experiencing mood disorder, anxiety, or depression since it involved asking them if they had been diagnosed by a health professional for these mental health problems. The use of validated tests would have been preferable, but since the data collection method was through a telephone survey, some questions had to be prioritized over others. It would have been interesting to know whether social workers or psychologists were consulted earlier, namely, within 2 years of the derailment of the train, as well as the reasons for consultation or not of this type of professional. The high number of respondents in the three groups of participants is, however, a positive factor in the internal validity of the results.

Conclusion

These results display the importance, for health and social service workers, of identifying and paying special attention to men suffering from their exposure to a technological disaster. Different efforts must be made to ensure that men with psychological health problems can access services that meet their needs and adapt to their beliefs and their habits of consultation with health and social services. Indeed, their habits generally differ from those of women.

It is important to develop various types of interventions, both individually and collectively, allowing men to normalize their feelings about exposure to a traumatic event and the health problems they must overcome throughout their adaptation and recovery process, which can take from several months to years. Health and social service professionals as well as public and community authorities must therefore remain alert regarding the physical and psychological health status of men and consider the postdisaster recovery period as an opportunity to modify their professional practices according to the real and sustained needs of men affected by their exposure to natural or manmade disasters.

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