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Comparing life satisfaction and functioning 15 years after September 11, 2001 among survivors with and without injuries: a mixed-method study

Lisa M. Gargano[1] · Ho Ki Mok[1] · Melanie H. Jacobson[1] · Patricia Frazier[2] · Sascha K. Garrey[1] · Lysa J. Petrsoric[1] · Robert M. Brackbill[1]

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Abstract

Purpose This study compares life satisfaction and limited activity days among 9/11 survivors with and without physical injuries using quantitative and qualitative approaches.

Methods The study population included World Trade Center Health Registry enrollees who reported being injured on 9/11 in 2003–2004 and a sample of non-injured enrollees who participated in a cross-sectional substudy. We used multivariable logistic regression to examine differences in life satisfaction and number of limited activity days in the last 30 days between those with and without injuries. The free-response section of the survey was analyzed qualitatively to compare themes of those with and without injuries.

Results The final sample consisted of 2821 adult enrollees. Compared to those who were not injured, those who were injured on 9/11 were more likely to report being unsatisfied with their life (adjusted odds ratio (AOR): 1.5, 95% confidence intervals (CI) 1.1–2.0) and have 14 or more limited activity days in the last 30 days (AOR: 1.4, 95% CI 1.0–1.9). Among those who were injured, being partially or completely prevented from working increased the odds of being unsatisfied with life and having 14 or more limited activity days. In qualitative analysis, the emotional trauma experienced from 9/11 was a major and common theme, regardless of injury status. Those with injuries were more likely to express anger/lack of recognition/appreciation, describe substance use/abuse, and have financial/health care access issues.

Conclusions More than 15 years after 9/11, those who were injured continue to be impacted, reporting lower life satisfaction and more functional impairment.

Keywords World Trade Center · Injury · Qualitative · Life satisfaction · Quality of life

Introduction

Exposure to disasters is associated with long-term sequelae including psychological, occupational, functional, and quality of life (QoL) impairments [1–3]. QoL refers to general well-being and satisfaction with various aspects of life, including physical health, family, education, employment, and finances [4]. QoL among survivors of the terrorist attacks on the World Trade Center (WTC) on September 11, 2001 (9/11) is poorly understood, despite evidence that both physical [5–7] and mental health conditions [5, 8, 9] associated with the disaster can persist for years.

Despite using different definitions of QoL, 9/11-related chronic physical [5, 10, 11] and mental health conditions [5, 8, 12] consistently are associated with a diminished QoL. For example, one year after 9/11, QoL (measured with the Quality of Life Enjoyment and Satisfaction Questionnaire-short form) was inversely related to mental health symptoms among 9/11-exposed adults [12]. A study of New York City (NYC) firefighters found that, as the number of aerodigestive conditions increased, both physical and mental component summary scores from the SF-12 decreased, indicating a lower health-related QoL [10]. Finally, 10–11 years after

✉ Lisa M. Gargano
lgargano1@health.nyc.gov

[1] Division of Epidemiology, NYC Department of Health and Mental Hygiene, World Trade Center Health Registry, 125 Worth Street, 10th Floor, New York, NY 10013, USA

[2] Department of Psychology, University of Minnesota, Minneapolis, MN 55455, USA

9/11, exposed persons with persistent lower respiratory symptoms reported significantly lower life satisfaction and more poor physical and mental health days [11].

Outside of the disaster literature, traumatic injury, in particular, is associated with long-term negative outcomes, including poorer mental health and self-rated health, more functional limitations, and lower QoL [13–15]. Studies of disaster-related injuries have also found more adverse mental and physical health outcomes in those who were injured. For instance, injured survivors of the Oklahoma City bombing had higher rates of PTSD than those who were not injured [16]. Among survivors of the 1998 US embassy bombings in East Africa, injury was the only factor significantly associated with posttraumatic stress reactions [17]. Finally, studies of those injured on 9/11 have found an increased risk of PTSD and chronic physical health conditions up to 11 years after 9/11 [18, 19].

There is a paucity of literature on the long-term impact of injury on 9/11 on QoL (e.g., life satisfaction) as opposed to physical and mental health outcomes. A previous exploratory qualitative study of persons injured on 9/11 identified themes regarding long-term recovery and QoL issues, including poor ongoing health status, functional limitations and disabilities, lifestyle/economic impact, and lack of social support [20]. This exploratory qualitative study served as the basis for the development of the current quantitative survey.

The purpose of this study was to build upon these previous findings of decreased QoL in persons injured on 9/11 by exploring differences among 9/11 survivors with and without physical injuries using (1) quantitative analysis of self-reported life satisfaction and number of limited activity days and (2) qualitative analysis of free-response text. Because previous research has shown that persons injured on 9/11 have chronic mental and physical health problems [18, 19] and that these health conditions are associated with poorer QoL assessed using several different measures [5, 8, 10–12], we hypothesized that injured survivors would report lower life satisfaction and more days of limited activity compared to survivors without injuries. Similarly, we hypothesized that qualitative analysis of the free-response data would underscore the long-term effects of the 9/11 disaster for injured survivors compared to those without injuries.

Methods

Study design and sample

"The Health and Quality of Life 15 Years after 9/11 study" (HQoL study) sampled from the World Trade Center Health Registry (WTCHR), a cohort study of over 70,000 individuals exposed to the events of 9/11 in NYC [21]. The WTCHR has disseminated four extensive survey waves that included questions on enrollees' physical and mental health status: Wave 1 (W1; 2003–2004), Wave 2 (W2; 2006–2007), Wave 3 (W3; 2011–2012), and Wave 4 (W4; 2015–2016). The HQoL study population was restricted to enrollees who completed all prior WTCHR surveys. All enrollees who, on the W1 survey, reported being south of Chambers Street on the morning of 9/11 and an injury on 9/11 (at least one of the following: cut, abrasion, or puncture wound; sprain or strain; burn; broken bone, fracture, or dislocation; concussion, head injury, or knocked out by being hit on the head; or any other type of injury) were included ($n=2701$) along with a simple random sample of those who were eligible but not injured ($n=2598$). Data collection was from March to July 2017 by web or paper survey, with 4033 completed surveys (76.1% response rate), including 2038 injured (50.5%) and 1995 non-injured (49.5%) respondents. To be included in analyses regarding medical intervention sought after injury on 9/11, respondents needed to say "yes" to being injured on the HQoL survey. In addition, to reduce recall bias, those with inconsistent reporting of injury from the W1 and HQoL surveys ($n=1212$) were excluded. The final sample size was 2821: 1003 (35.6%) were injured and 1818 (64.4%) were non-injured. The study protocol was approved by the NYC Department of Health and Mental Hygiene's Institutional Review Board.

Quantitative analysis

Outcome measures

There were two QoL outcomes of interest. The first was life satisfaction which was assessed using the question: "In general, how satisfied are you with your life: very satisfied, satisfied, dissatisfied, or very dissatisfied?" Response categories were dichotomized into very satisfied/satisfied vs. dissatisfied/very dissatisfied, consistent with previous research [11, 22–24], because the distribution of responses, particularly at the extremes which had smaller numbers, was inadequate to detect associations. The second was the number of limited activity days: "For about how many days did poor physical or mental health keep you from doing your usual activities during the last 30 days?" [25] Responses were dichotomized into <14 days versus ≥ 14 days, consistent with previous studies [25]. Scores on both of these measures have good validity and reliability [22, 25].

Injury measures

HQoL survey participants were asked if they were injured on 9/11 (Y/N). Among those who reported "yes," we examined injury severity using responses from the HQoL survey. Injury severity was defined by the degree of medical intervention sought after the injury and was defined as a

three-level measure: severe (using a wheelchair in the week following the injury or having sought treatment at a hospital, emergency room, or doctor's office, and/or having surgeries due to their injury on 9/11), moderate (using a cane or crutch in the week following the injury, needing bed rest for at least 1 day, and/or needing physical therapy due to their injury on 9/11), and low (those who did not report any intervention or care) [26, 27]. We also examined whether the injury affected their ability to work. Work was defined as full or part-time employment including self-employment, housework, and/or being a college or university student. Participants were asked whether at any time since 9/11 their injury (1) completely prevented them from working (Y/N) or (2) partially restricted their ability to work (Y/N). If participants said yes to the first question, they were categorized as "injury completely prevented work," if they said no to question 1 but yes to question 2 they were categorized as "injury partially restricted work," and if they said no to both questions they were categorized as "injury did not prevent or restrict work."

Covariates

Sociodemographic variables included age at HQoL survey, gender, and race/ethnicity from W1, and income, employment status, and marital status at W4. Other WTC exposures collected at W1 included witnessing traumatic events (i.e., seeing planes hit the buildings, buildings collapsing, people falling or jumping from buildings, people injured, or people running), being caught in the dust cloud, and being a rescue/recovery worker (RRW). Probable 9/11-related PTSD was assessed at each survey Wave using a 9/11-specific PTSD Checklist-Civilian Version (PCL-17). The PCL-17 is a self-reported, 17-item scale corresponding to PTSD criteria in the DSM-IV. It is commonly used in epidemiological research and has good psychometric properties, with sensitivity ranging from 0.94 to 0.97, specificity from 0.86 to 0.99, and diagnostic efficiency from 0.83 to 0.96 [28, 29]. Cronbach's alpha in this sample was 0.95. Enrollees with a PCL score of ≥ 44 at any Wave were considered to have ever had probable PTSD [19]. Chronic health conditions were defined based on self-report at W4 of having ever received a physician diagnosis for angina, heart attack, asthma, diabetes, or non-neoplastic lung disease (chronic bronchitis, emphysema or COPD, reactive airway dysfunctions syndrome, sarcoidosis).

Analysis

Quantitative analysis Chi square tests were used to test for significant associations between outcome measures and selected sociodemographic characteristics, WTC exposures, 9/11-related PTSD, and 9/11-related injury. Cramer's V and phi coefficients were used to estimate effect sizes. Adjusted odds ratios (AOR) were calculated using logistic regression to estimate the association between injury and life dissatisfaction or ≥ 14 limited activity days, adjusting for covariates found to be significant in the bivariate analysis. A separate analysis was conducted among the injured to estimate the associations between outcomes and injury severity and functional impairment. For the regressions, we used case-wise deletion. There was approximately 8% missing in each of the models, which still provided adequate statistical power to detect the effects of interest; therefore, we do not believe this had any practical effect on the outcome [30–32]. All data analyses were conducted using SAS version 9.4 (Cary, NC).

Qualitative analysis At the end of the HQoL survey, participants were given a free-response area, which followed the question: "Do you have any additional comments about your 9/11 experiences and health?" Content analysis, a systematic classification process of coding and identifying themes or patterns [33], was used to analyze these data using Microsoft Excel. Two team members (LMG and HKM) independently iteratively reviewed the data for themes and subthemes until meaningful patterns emerged. Recurrent themes were identified, and common themes were grouped together into categories. Discrepancies in coding were discussed and resolved by the two coders. A high level of interrater reliability was achieved after several rounds of discussion (kappa > 0.90; $p < 0.01$). Quotes were used to illustrate final themes. Coders were blinded to participant injury status until all thematic coding was completed. Themes were then compared between participants with and without injuries.

Results

Quantitative results

Study population characteristics

Of the 2821 enrollees in this study, the largest proportions were male (56.3%), aged 45–64 years at the time of HQoL study (59.6%), non-Hispanic white (74.5%), had household incomes between $75,000 to ≥ $150,000 (34.8%), employed (63.3%), and married or living with a partner (68.3%) at W4 (Table 1). Just over one-third had ever had 9/11-related PTSD and 40.5% reported at least one chronic health condition. For the WTC exposures, over half witnessed three or more traumatic events, 44.8% were caught in the dust cloud, and 23.5% were RRW. Those who were male, 45–64 years of age, Hispanic, had an income of less than $25,000, unemployed due to health, or divorced/separated were more likely to have been injured as were those who ever had 9/11-related PTSD, had at least one chronic health condition, witnessed 0–2 horrific events, were exposed to the dust cloud, or were RRW.

Table 1 Sociodemographic characteristics, mental and physical health, and World Trade Center (WTC) exposures by injury status among participants in the Health and Quality of Life 15 years after 9/11 study

	Total *N* (%)*	Injured *N* (%)	Non-injured *N* (%)	*p* value
Total	2821 (100)	1003 (35.6)	1818 (64.4)	
Gender				**0.0001**
Male	1589 (56.3)	614 (38.6)	975 (61.4)	
Female	1232 (43.7)	389 (31.6)	843 (68.4)	
Age (at HQoL survey)				**< 0.0001**
65 +	822 (29.1)	265 (32.2)	557 (67.8)	
45–64	1682 (59.6)	670 (39.8)	1012 (60.2)	
30–44	317 (11.2)	68 (21.5)	249 (78.6)	
Race/ethnicity				**0.0011**
White Non-Hispanic	2101 (74.5)	715 (34.0)	1386 (66.0)	
Black Non-Hispanic	267 (9.5)	112 (42.0)	155 (58.1)	
Hispanic	267 (9.5)	117 (43.8)	150 (56.2)	
Asian/other	186 (6.6)	59 (31.7)	127 (68.3)	
Income (W4)				**< 0.0001**
> 150K	883 (33.1)	236 (26.7)	647 (73.3)	
75K– < 150K	929 (34.8)	319 (34.3)	610 (65.7)	
50K- < 75K	366 (13.7)	134 (36.6)	232 (63.4)	
25K- < 50K	291 (10.9)	138 (47.4)	153 (52.6)	
< 25K	198 (7.4)	112 (56.6)	86 (43.4)	
Employment status				**< 0.0001**
Employed	1764 (63.0)	520 (29.5)	1244 (70.5)	
Unemployed—health	212 (7.6)	162 (76.4)	50 (23.6)	
Unemployed—others	826 (29.5)	310 (37.5)	516 (62.5)	
Marital status (W4)				**< 0.0001**
Married or living with partner	1909 (68.3)	624 (32.7)	1285 (67.3)	
Divorced or separated	360 (12.9)	182 (50.6)	178 (49.4)	
Widowed	106 (3.8)	50 (47.2)	56 (52.8)	
Never married	419 (15)	128 (30.6)	291 (69.5)	
9/11-related PTSD				**< 0.0001**
Ever	1008 (36.1)	650 (64.5)	358 (35.5)	
Never	1785 (63.9)	345 (19.3)	1440 (80.7)	
Chronic health conditions				**< 0.0001**
0	1679 (59.5)	434 (25.9)	1245 (74.2)	
1 +	1142 (40.5)	569 (49.8)	573 (50.2)	
WTC exposure				
Witness traumatic events				**< 0.0001**
0–2	1380 (48.9)	761 (55.1)	619 (44.9)	
3–5	1441 (51.1)	242 (16.8)	1199 (83.2)	
Dust				**< 0.0001**
No	1556 (55.2)	232 (14.9)	1324 (85.1)	
Yes	1265 (44.8)	771 (61)	494 (39.1)	
RRW				**< 0.0001**
No	2157 (76.5)	580 (26.9)	1577 (73.1)	
Yes	664 (23.5)	423 (63.7)	241 (36.3)	

*Missing data: Income $n = 154$; Employment status $n = 19$; Marital status $n = 27$; 9/11-related PTSD $n = 28$

Quality of life

Overall, 16.1% of respondents reported being dissatisfied/very dissatisfied with life and 16.8% reported having ≥ 14 limited activities days. Enrollees who were 45–64 years of age, Hispanic, had a household income of < $25,000, unemployed due to health, divorced or separated, ever had 9/11-related PTSD, had a least one chronic health

condition, witnessed ≥ three traumatic events on 9/11, were caught in the dust cloud on 9/11, or were injured on 9/11 had a higher prevalence of reporting being dissatisfied/very dissatisfied with life and having ≥ 14 limited activities days (Table 2). In addition, having been a RRW was associated with greater limited activity days but not life satisfaction. The magnitude of the effect sizes for most of these associations was small to medium (Table 2).

In the logistic regression analyses, after adjusting for covariates—women (vs. men), 45–64 years of age (vs. 65 years or older), divorced or separated (vs. married or living with a partner), and unemployed due to health (vs. employed)—were more likely to report being dissatisfied/very dissatisfied with life (Table 3). There was a dose–response relationship between household income and life satisfaction—the lower the income the more likely enrollees were to report being dissatisfied/very dissatisfied with life (trend test $p < 0.01$). Those who were injured on 9/11 were 50% more likely to report being dissatisfied/very dissatisfied with life compared with those who were not injured (AOR: 1.5, 95% CI 1.1–2.0). Compared with those who never had 9/11-related PTSD, those who had ever had 9/11-related PTSD were 4.1 times more likely to report being dissatisfied/very dissatisfied (AOR: 4.1, 95% CI 3.1–5.4). RRWs were less likely to report being dissatisfied/very dissatisfied with life (AOR: 0.7, 95% CI 0.5–0.9). Similar patterns of associations with ≥ 14 limited activity days were observed, including a dose–response relationship between income and reporting ≥ 14 limited activity days. Those who were injured on 9/11 were 40% more likely to report ≥ 14 limited activity days compared with those who were not injured (AOR: 1.4, 95% CI 1.0–1.9).

Among those who were injured, 45.0% reported that their injury completely prevented them from working at some point after 9/11, and 13.7% reported that their injury partially restricted their ability to work at some point after 9/11 (Table 4). Almost two-thirds were categorized as severely injured. In adjusted analyses, those who reported that their injury completely prevented them from working were 3.3 times more likely to report being dissatisfied/very dissatisfied with life (95% CI 2.2–5.0) and 3.7 times more likely to report ≥ 14 limited activity days (95% CI 2.4–5.6) compared with those who reported no work restrictions because of their injury. Those who reported that their injury partially restricted them from working were 1.6 times more likely to report being dissatisfied/very dissatisfied with life (95% CI 0.9–2.9) and 2.0 times more likely to report ≥ 14 limited activity days (95% CI 1.1–3.5) compared with those who reported no work restrictions because of their injury. There was no significant associations between injury severity and either reporting being dissatisfied/very dissatisfied with life or ≥ 14 limited activity days.

Qualitative results

Of the 2821 enrollees who completed the study survey, 884 (31.3%) wrote responses in the free-response section. Of these, 451 (51.0%) were injured on 9/11 and 433 (49.0%) were not (Table 5). Thematic analysis yielded nine themes: (1) anger/lack of recognition or appreciation, (2) health issues/cancer/breathing issues, (3) emotional trauma/depressed/anxious, (4) financial/health care access issues, (5) gratitude to investigators, (6) worry/life disrupted, (7) substance use/abuse, (8) moved on, and (9) not impacted.

Thematic analysis

For both injured and non-injured respondents, the most common theme that emerged was emotional trauma/depressed/anxious. One enrollee wrote how after 9/11, "I find myself more emotional and nervous." Another enrollee wrote of personal and loved ones' emotional trauma, "The mental effects of 9/11 have worsened over time for me and my family." Other enrollees wrote of avoiding the subject of 9/11, "I still get emotional when I think about 9/11… It's been so many years and yet I can't always talk about it." A high number also reported health issues/cancer/breathing problems, with comments like, "[I] recently developed stomach cancer despite a healthy lifestyle. No cancer [history] in family. One of my doctors feels that it could [be]related to 9/11." Others wrote about chronic health issues since 9/11, "Within 3 months of the event, I found it difficult to walk up the 3 flights of stairs to our home and had rashes. All these years later those conditions continue." Comments around health and healthcare were also seen within the financial/healthcare access issues theme. For example, one enrollee wrote, "I was very disappointed that there was no compensation for [PTSD] which I am experiencing daily." Another enrollee wrote of financial hardship, "[I am] financially not as successful [its] more of a struggle to maintain employment and normal life."

To a lesser extent, enrollees expressed worry/life disrupted, especially a fear of the future: "Yes I am constantly concerned about getting some kind of cancer from 9/11 because I have lost about 6 fireman friends to post 9/11 cancers." Some expressed anger or a lack of appreciation. One RRW wrote, "I wish it never happened - it ruined my life…. I never got any recognition or appreciation for what I did on 9/11 and for the next 6 years at ground zero."

A smaller number wrote on the theme of substance use/abuse: "I took up daily marijuana use, a small amount, each evening. I had done this from time to time earlier in my life. After 9–11, it became daily. It works for me and doesn't impact my professional life. It has some impact on my personal life–wife disapproves of daily intake."

Table 2 Sociodemographic characteristics, mental and physical health, and World Trade Center (WTC) exposures by life satisfaction and limited activity days among participants in the Health and Quality of Life 15 years after 9/11 study

	Life satisfaction			Limited activity days		
	Very satisfied/satisfied	Very dissatisfied/dissatisfied	Effect size	< 14 days	≥ 14 days	Effect size
	N (%)	*N* (%)	*V* or ϕ	*N* (%)	*N* (%)	*V* or ϕ
Total	2352 (83.9)	450 (16.1)		2314 (83.2)	468 (16.8)	
Gender						
Male	1333 (84.4)	246 (15.6)	0.01	1315 (84.0)	251 (16.0)	0.02
Female	1019 (83.3)	204 (16.7)		999 (82.2)	217 (17.9)	
Age (at HQoL survey)						
65+	711 (87.4)	103 (12.7)	0.09	676 (83.8)	131 (16.2)	0.10
45-64	1359 (81.3)	312 (18.7)		1348 (81.1)	314 (18.9)	
30-44	282 (89.0)	35 (11.0)		290 (92.7)	23 (7.4)	
Race/ethnicity						
White Non-Hispanic	1792 (85.7)	299 (14.3)	0.08	1751 (84.2)	328 (15.8)	0.07
Black Non-Hispanic	205 (78.2)	57 (21.8)		211 (81.2)	49 (18.9)	
Hispanic	204 (77.6)	59 (22.4)		196 (75.4)	64 (24.6)	
Asian/Other	151 (81.2)	35 (18.8)		156 (85.3)	27 (14.8)	
Income (W4)						
> 150K	817 (92.8)	63 (7.2)	0.29	813 (93.3)	58 (6.7)	0.28
75K–< 150K	809 (87.6)	115 (12.5)		783 (85.2)	136 (14.8)	
50K–< 75K	287 (79.1)	76 (20.9)		284 (78.0)	80 (22.0)	
25K–< 50K	198 (68.8)	90 (31.3)		199 (69.6)	87 (30.4)	
< 25K	112 (57.4)	83 (42.6)		106 (55.8)	84 (44.2)	
Employment status						
Employed	1542 (87.9)	213 (12.1)	0.29	1565 (89.7)	179 (10.3)	0.40
Unemployed—health	96 (46.2)	112 (53.9)		66 (31.6)	143 (68.4)	
Unemployed—others	699 (85.2)	121 (14.8)		668 (82.5)	142 (17.5)	
Marital status (W4)						
Married/living with partner	1663 (87.5)	238 (12.5)	0.16	1618 (85.9)	265 (14.1)	0.13
Divorced or separated	250 (70.8)	103 (29.2)		254 (71.4)	102 (28.7)	
Widowed	87 (82.9)	18 (17.1)		83 (79.8)	21 (20.2)	
Never married	333 (79.9)	84 (20.1)		343 (83.1)	70 (16.9)	
9/11-related PTSD						
Never	1660 (93.4)	118 (6.6)	0.35	1652 (93.5)	114 (6.5)	0.37
Ever	667 (66.9)	330 (33.1)		640 (64.7)	350 (35.4)	
Chronic health conditions						
0	1478 (88.4)	194 (11.6)	0.15	1489 (90.0)	166 (10.0)	0.22
1+	874 (77.4)	256 (22.7)		825 (73.2)	302 (26.8)	
WTC exposure						
Witness traumatic events						
0-2	1269 (88.7)	162(11.3)	0.13	1255(88.2)	168 (11.8)	0.14
3-5	1083 (79.0)	288(21.0)		1059(77.9)	300 (22.1)	
Dust						
No	1370 (88.6)	176 (11.4)	0.14	1376 (89.6)	160 (10.4)	0.19
Yes	982 (78.2)	274 (21.8)		938 (75.3)	308 (24.7)	
RRW						
No	1811 (84.5)	333 (15.5)	0.03	1810 (85.1)	317 (14.9)	0.09
Yes	541 (82.2)	117 (17.8)		504 (77.0)	151 (23.1)	
Injury						

Table 2 (continued)

	Life satisfaction			Limited activity days		
	Very satisfied/satisfied	Very dissatisfied/dissatisfied	Effect size	< 14 days	≥ 14 days	Effect size
	N (%)	*N* (%)	*V* or ϕ	*N* (%)	*N* (%)	*V* or ϕ
No	1634 (90.3)	176 (9.7)	0.23	1626 (90.6)	168 (9.4)	0.27
Yes	718 (72.4)	274 (27.6)		688 (69.6)	300 (30.4)	

Shaded cells are significant p <= 0.05

The theme of having moved on also emerged: "I moved on very quickly from 9/11, probably just weeks after." Some respondents wrote about not being impacted at all: "It never really changed me…"

Theme frequencies by injury status

Five of the nine themes were endorsed by similar proportions of injured and non-injured enrollees: health issues/cancer/breathing issues, emotional trauma/depressed/anxious, financial/health care access issues, gratitude to investigators, and worry/life disrupted (Table 5). Of those who reported on the theme of anger/lack of recognition/appreciation 62.9% were injured compared to 37.1% who were not injured. Those who reported on the theme of substance use/abuse 81.8% were injured compared to 18.2% for non-injured. Conversely, for the theme of "moved on", 85.7% were not injured, while 14.3% were injured and for "not impacted", 80.0% who reported this theme were not injured compared to 20.0% who were injured.

Discussion

Our two complementary analyses represent a longer-term, in-depth description of two aspects of QoL among both injured and non-injured persons exposed to the events of 9/11 in NYC, and support and deepen previous findings [20]. Specifically, we found that more than 15 years after the WTC attacks, those who were injured on 9/11 reported significantly diminished life satisfaction and more limited activity days, even after controlling for other factors such as PTSD, chronic health conditions, and unemployment due to health reasons. In addition, those whose injuries resulted in complete or partial restriction of work reported even lower life satisfaction and more limited activity days. Furthermore, a descriptive analysis of free-text responses demonstrated the depth of the psychological and physical consequences of 9/11 among those who both were injured and not injured 15 years after the event.

The long-term relationship between injury and QoL also has been documented in other populations. Combat-related injuries have been shown to be associated with lower health-related QoL [34–37]. These studies examined specific and very severe injuries, including traumatic brain injury [34], amputation [35], and spinal cord injury [36]. However, one study of veterans with mild to severe bodily injuries found that injury was associated with lower health-related QoL up to 5 years after the injury [37]. Aside from studies of veterans, a study of Danish adults found that, compared with non-injured, injured participants had lower self-reported general health up to 10 years after the injury [14]. Further, a study of persons aged 65 years or older who were hospitalized for an injury found that, compared to age-adjusted norms, there was a significant decrement in seven of the eight SF-36 domains among those who were injured, including physical functioning, role-physical and role-emotional functioning, social functioning, mental health, vitality, and general health [38].

We did not find an association between injury *severity* and life satisfaction or limited activity days. Previous research on the relationship between injury severity and different QoL measures is mixed. Although several studies found that injury severity was unrelated to QoL [39, 40], one study of military personnel found that those with minor injuries had the highest health-related QoL, whereas those with the most severe injuries had the lowest health-related QoL [37]. One potential explanation is that each of these studies, including ours, have used different definitions of QoL. However, we did find that, among those who were injured, being partially or completely prevented from working due to the injury was associated with greater likelihood of being dissatisfied with life and ≥ 14 limited activity days compared with those whose ability to work was not affected. This is consistent with previous research showing that the ability to work is strongly associated with QoL after injury using various measures of QoL including health-related QoL and SF-36 [41–43]. These findings were supported by qualitative analysis of the free-response section with financial issues being one of the most commonly mentioned themes, especially among the injured. There was a high correlation in this study between injury severity and ability to work ($p < 0.0001$, data not shown). Despite this, only ability to work was associated with the outcomes in adjusted models.

Table 3 Adjusted odds ratios (AOR) for life dissatisfaction and ≥ 14 limited activity days

	Life dissatisfaction* ($n=2602$)	≥ 14 limited activity days** ($n=2584$)
	AOR (95% CI)	AOR (95% CI)
Gender		
Male	Ref.	Ref.
Female	1.3 (1.0, 1.8)	1.1 (0.9, 1.5)
Age (at HQoL survey)		
65 +	Ref.	Ref.
45–64	1.8 (1.3, 2.5)	1.3 (0.9, 1.7)
30–44	1.2 (0.8, 2.1)	0.7 (0.4, 1.3)
Race/ethnicity		
White Non-Hispanic	Ref.	Ref.
Black Non-Hispanic	0.9 (0.6, 1.3)	0.6 (0.4, 1.0)
Hispanic	0.9 (0.6, 1.3)	1.0 (0.7, 1.4)
Asian/other	1.2 (0.7, 1.8)	0.8 (0.5, 1.3)
Income (W4)		
> 150K	Ref.	Ref.
75K–< 150K	1.4 (1.0, 2.0)	1.6 (1.2, 2.4)
50K–< 75K	2.2 (1.5, 3.4)	2.4 (1.5, 3.6)
25K–< 50K	2.9 (1.9, 4.5)	2.3 (1.5, 3.6)
< 25K	4.1 (2.5, 6.7)	4.1 (2.5, 6.8)
Employment status		
Employed	Ref.	Ref.
Unemployed—health	3.0 (2.1, 4.4)	6.1 (4.1, 9.0)
Unemployed—others	1.0 (0.8, 1.4)	1.3 (1.0, 1.8)
Marital status (W4)		
Married or living with partner	Ref.	Ref.
Divorced or separated	1.7 (1.3, 2.4)	1.4 (1.0, 2.0)
Widowed	1.1 (0.6, 2.0)	1.0 (0.6, 1.8)
Never married	1.2 (0.9, 1.8)	0.9 (0.6, 1.3)
9/11-related PTSD		
Never	Ref.	Ref.
Ever	4.1 (3.1, 5.4)	3.6 (2.7, 4.8)
Chronic health conditions		
0	Ref.	Ref.
1 +	1.2 (0.9, 1.5)	1.8 (1.4, 2.3)
WTC exposure		
Witness traumatic events		
0–2	Ref.	Ref.
3–5	1.0 (0.7, 1.3)	1.1 (0.8, 1.5)
Dust		
No	Ref.	Ref.
Yes	1.1 (0.8, 1.4)	1.3 (1.0, 1.7)
RRW		
No	Ref.	Ref.
Yes	0.7 (0.5, 0.9)	1.0 (0.8, 1.4)
Injury		
No	Ref.	Ref.
Yes	1.5 (1.1, 2.0)	1.4 (1.0, 1.9)

*Adjusted for age at HQoL, race/ethnicity, income, employment status, marital status, 9/11-related PTSD, chronic health conditions, witnessing traumatic events, dust, and injury

**Adjusted for age at HQoL, race/ethnicity, income, employment status, marital status, 9/11-related PTSD, chronic health conditions, witnessing traumatic events, dust, RRW, and injury

Table 3 (continued)

A potential explanation is that working full- or part-time better meets a variety of needs (e.g., physiological, emotional, financial and social) [44] and provides the ability to be active in the community [43].

Table 4 Adjusted odds ratios of life dissatisfaction and ≥ 14 limited activity days among injured

	Total	Life dissatisfaction* ($n=874$)	≥ 14 limited activity days** ($n=871$)
	N (%)	AOR (95% CI)	AOR (95% CI)
Injury preventing or restricting work[a]			
Not at all	399 (41.4)	Ref.	Ref.
Partially restricted	132 (13.7)	1.6 (0.9, 2.9)	2.0 (1.1, 3.5)
Completely prevented	434 (45.0)	3.3 (2.2, 5.0)	3.7 (2.4, 5.6)
Injury severity[a]			
Low	110 (11.7)	Ref.	Ref.
Moderate	237 (25.2)	1.3 (0.7, 2.6)	1.4 (0.7, 2.8)
Severe	593 (63.1)	1.4 (0.7, 2.6)	1.4 (0.8, 2.6)

[a]Run in separate models for each of the two outcomes (four models total)

*Adjusted for age at HQoL, race/ethnicity, income, employment status, marital status, 9/11-related PTSD, chronic health conditions, witnessing traumatic events, dust, and injury

**Adjusted for age at HQoL, race/ethnicity, income, employment status, marital status, 9/11-related PTSD, chronic health conditions, witnessing traumatic events, dust, RRW, and injury

Table 5 Free-text free response themes by frequency

	Injured *N* (%)	Non-injured *N* (%)
Total	451 (51.0)	433 (49.0)
Themes		
Anger/lack of recognition/appreciation	22 (62.9)	13 (37.1)
Health issues/cancer/breathing issues	132 (53.0)	117 (47.0)
Emotional trauma/depressed/anxious	136 (50.2)	135 (49.8)
Financial/health care access issues	36 (58.1)	26 (41.9)
Gratitude to investigators	80 (47.6)	88 (52.4)
Worry/life disrupted	31 (54.4)	26 (45.6)
Substance use/abuse	9 (81.8)	2 (18.2)
Moved on	3 (14.3)	18 (85.7)
Not impacted	2 (20.0)	8 (80.0)

Row %

The descriptive analysis of the free-response section of the survey revealed a similar narrative of lower life satisfaction and more limited activity days among those who were injured on 9/11 compared with those not injured. Similar to another qualitative study conducted on persons injured on 9/11 [20], themes around poor ongoing mental and physical health, adverse economic impacts, and substance use emerged. However, regardless of injury, the survivors in our study reported that they struggled with the lasting impact of 9/11 on their physical and mental health. Similar to findings from a study comparing injured and non-injured survivors of The Station nightclub fire [45], the injury sustained on 9/11 was not the primary focus of the free text responses of those who were injured. Rather, the focus was mostly on emotional issues, health problems, and difficulties faced. These findings demonstrate the critical need for long-term follow-up of disaster survivors, regardless of injury status.

Proper treatment may be important, not only for the injury itself, but also for any long-term health effects of the injury. MacKenzie et al. compared adult patients with at least one lower-limb injury in hospitals with a level-I trauma center to those in a hospital without a trauma center and found that those in care at a trauma center had greater improvements in physical functioning and overall vitality at 1 year after the injury compared to those in care without a trauma center [46]. In addition, the known association between injury and mental health conditions [19, 35] and the current study's qualitative findings indicate that identification and treatment of mental health conditions early in the rehabilitation process may not only improve the mental health of injured individuals but also improve their QoL.

Limitations

The findings of this study are subject to several limitations. First, selection bias may be a concern because participants in the HQoL survey had to have completed all previous WTCHR survey waves. However, a previous study showed that, although those with PTSD symptoms were slightly less likely to continue to participate than those without, the degree of exposure to the WTC attacks, including sustaining an injury on 9/11, was not associated with participation over time [47]. Second, although we asked about treatment received after the injury, we lacked clinical information on treatment (e.g., type and duration of medication) that could have been included in the severity scale. Third, we did not have information on the length of time the person was out of work due to injury, which could have provided a more detailed analysis of the relationship between ability to work and the outcomes of interest. Fourth, we did not collect information on current disability status, which has been shown to be an important mediator between injury and QoL [48]. The analyses can therefore not differentiate whether observed relationships are, for example, due to the trauma/injury in 2001 or due to current physical health problems, which might have their (partial) origin in the injury sustained in 2001. Fifth, the exclusion of those with inconsistent responses to being injured, while potentially reducing recall bias, may have biased the sample toward those with more severe injuries. Those who said they were injured at W1 were more likely to report that they were not injured on 9/11 in the HQoL survey compared with those who said they were not injured on 9/11 at W1. Among those at W1 who reported they were injured on 9/11, those with more severe or several injuries were less likely to have discrepant reports compared with those with more superficial injuries or just one injury type, respectively. Finally, participants who contributed to the free-response section did not differ statistically from those who did not by injury status, the main independent variable of interest, but did by sex, age, and income ($p < 0.01$). Also, among the injured, free-text respondents differed by sex and race/ethnicity ($p < 0.05$). These differences could limit the generalizability of the findings, although this is not the purpose of qualitative findings [49].

Conclusions

The use of quantitative and qualitative analysis provided a more nuanced picture of the long-term effects of being injured on 9/11. Early treatment for disaster-related injuries, as well as identification and treatment of co-morbid mental health conditions, may improve long-term QoL-related outcomes.

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