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Children of Terrorism Survivors: Physiological Reactions Seven Years Following a Terrorist Incident

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Keywords

Children; disasters; physiological reactivity; posttraumatic stress disorder; secondary trauma; trauma; terrorism

1. Introduction

The 1995 bombing of the Federal Building in Oklahoma City was, at the time, the deadliest act of terrorism in U.S. history, killing 168 individuals and injuring more than 800 others. North and colleagues [1] found high rates of psychiatric disorders in a representative sample of directly-exposed survivors six months after the attack: 34% of the survivors met criteria for bombing-related posttraumatic stress disorder (PTSD), 23% met criteria for major depression, and 45% met criteria for a post-disaster psychiatric disorder. At seven-year follow up, 26% of the sample met criteria for current PTSD and 10% met criteria for current major depression [2]. Tucker and colleagues [3] demonstrated physiological reactivity with increases in heart rate and blood pressure in response to a bombing reminder interview in a subgroup of the seven-year follow-up sample (which excluded survivors with unstable medical illnesses and those taking medications that might affect physiological assessment). Although posttraumatic stress symptoms were below levels considered clinically relevant, these survivors had significantly greater autonomic reactivity than unexposed age- and gender-matched community comparison participants [3].

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Little is known about the psychological or physiological effects of terrorist events on the children of survivors. In a prior study of the children of bombing survivors examined seven years after the incident, we found physiological reactivity relative to an unexposed community comparison sample despite generally low levels of posttraumatic stress and depressive symptoms [4]. For this report, we examined survivors and their children comparing psychiatric diagnoses and physiological reactivity in the two groups.

2. Methods

The University of Oklahoma Health Sciences Center, Washington University School of Medicine, and University of Texas Southwestern Medical Center Institutional Review Boards approved the study. Adult participants provided informed consent. Participants under 18 years of age provided assent and their parents provided consent. Participants were paid \$125 for their time and effort.

2.1 Sample

Survivors in the Oklahoma City bombing study conducted six months after the event [1] were recruited by letter and/or telephone for the seven-year follow-up study [2]. Of 182 survivors who participated in the index study [1], 113 were seen in the follow-up study conducted between November 2001 and October 2002 [2]. The survivors' children were recruited through their bombing-survivor parent. None of the children were directly exposed to the bomb blast. The 113 participants in the seven-year follow-up study included 36 survivors who together had a total of 59 children less than 18 years of age at the time of the bombing. We excluded participants with unstable medical illnesses and those who were taking psychotropic or cardiovascular medications that might affect physiological assessment. From this group, we recruited 18 survivor families with 22 children for the current study. One family was excluded due to incomplete physiological data on the survivor's child, yielding 17 families with complete diagnostic and physiological data for 17 bombing survivors and 21 children. Children included four sibling pairs (2 children per family representing 8 of the 21 children in the sample) and 13 children from 13 other different families.

2.2 Procedures

Approximately seven years after the bombing (mean 82.6 months after the bombing ranging from 79 to 88 months), participants completed a physiological assessment and a diagnostic interview as described in prior publications [3,4].

2.3 Variables

Demographic variables were gender, age, and race/ethnicity.

Bombing-related PTSD was defined as meeting *DSM-IV-TR* [5] criteria A through F for PTSD related to the incident at any time since the bombing. Similarly, *DSM-IV-TR* [5] criteria were used to identify major depressive disorder, generalized anxiety disorder, panic disorder, alcohol abuse/dependence, and drug abuse/dependence in all participants and oppositional defiant disorder and conduct disorder in the children. Any post-bombing

disorder was defined as meeting criteria for any of the disorders at any time since the bombing.

Physiological measures included heart rate (bpm) and systolic and diastolic blood pressure in the pre-test, test, and post-test time periods.

2.4 Statistical Analysis

We used nonparametric Cochran-Mantel-Haenszel (CMH) statistics based on ranks to determine whether parental post-disaster psychiatric disorders were associated with mental disorders in their children. Two sample t approximation Wilcoxon rank sum was used to determine if children's physiological responses and reactivity to the bombing reminder interview differed by their seven-year post-disaster psychiatric diagnosis (with and without a psychiatric disorder) and their parent's current and post-disaster psychiatric diagnoses.

We did not test children's physiological responses and reactivity to the bombing reminder interview in relation to their current psychiatric diagnosis because only one child was diagnosed with a current psychiatric disorder at the time of assessment. Means and standard deviations for each physiological variable—heart rate, systolic blood pressure, and diastolic blood pressure— were calculated for each group during the pre-test, test, and post-test phases. Measures of physiological reactivity were calculated by subtracting pre-test from test scores for heart rate, systolic blood pressure, and diastolic blood pressure.

Multivariable linear models were fitted to assess the relationship between children's physiological reactivity and parental bombing-related mental disorder. All models were adjusted for children's age and sex. The ordinary least squares method was used to estimate the effects of the covariates. The model assumptions of linearity, homoscedasticity, and normality were checked with the studentized residuals. Despite the relatively small sample size ($n=21$), these assumptions did not appear to be violated. Type I error probability was set at 0.10. SAS version 9.3 (SAS Institute, Cary, NC) was used for data analysis.

3. Results

3.1 Demographics

Of 17 survivors, 9 (53%) were male and 8 (47%) were female. Their mean age at the time of the assessment was 47.9 years (standard deviation of 5.7 years) with a range between 38 and 57 years. Fifteen (88%) of the survivors were White, 1 (6%) was African American, and 1 (6%) was Asian American.

Of 21 children of survivors, 10 (48%) were adolescents under age 18 years of age (between 13 and 17 years) and 11 (52%) were young adults (between 18 and 25 years) at the time of assessment. Eleven (52%) were male and 10 (48%) were female; 20 (95%) reported themselves to be White and 1 (5%) was African American.

3.2 Survivors' Exposure

Of 17 survivors, 13 (76%) were injured in the event and 1 (6%) had been hospitalized for bombing-related injury (a three-day hospital stay). Ten (59%) survivors knew someone

killed in the blast and 15 (88%) survivors knew someone injured in the blast. No survivors reported a family member killed or injured.

3.3 Post-Bombing Psychiatric Disorders

Eight (47%) of the 17 survivors included in this study met criteria for any post-disaster psychiatric disorder. Of these eight survivors, five (63%) qualified for a post-disaster diagnosis of bombing-related PTSD, two (25%) for current bombing-related PTSD, seven (88%) for post-disaster major depression, and four (50%) for current major depression. Six (29%) of the survivors' 21 children met criteria for any post-disaster psychiatric disorder. Of these six survivors' children, one (17%) met criteria for bombing-related PTSD since the disaster and currently, two (33%) met criteria for post-disaster major depression, and four (67%) met criteria for a post-disaster behavior disorder (either oppositional defiant disorder or conduct disorder).

There was a statistically-significant positive association between survivors and their children with respect to both post-disaster and current PTSD. Having a parent with post-disaster bombing-related PTSD increased the child's likelihood of having post-disaster (CMH=3.20, $df=1$, $p=0.0736$) or current (CMH=3.20, $df=1$, $p=0.0736$) bombing-related PTSD, compared to children of survivors with no post-disaster bombing-related PTSD. Similarly, current bombing-related PTSD in the survivor parent increased their children's likelihood of being diagnosed with post-disaster bombing-related PTSD (CMH=9.50, $df=1$, $p=0.0021$) or current bombing-related PTSD (CMH=9.50, $df=1$, $p=0.0021$). Parental post-disaster and current major depression were positively associated with post-disaster behavior disorder (CMH=2.72, $df=1$, $p=0.0992$ for parental post-disaster major depression; CMH = 6.80, $df=1$, $p=0.0091$ for parental current major depression) and with any post-disaster psychiatric disorder (CMH=2.77, $df=1$, $p=0.0961$ for parental post-disaster major depression; CMH=3.03, $df=1$, $p=0.0820$ for parental current major depression) in their children.

3.4 Children's Physiological Measurements

Systolic blood pressure in male children of survivors was significantly higher in both pre-test (Wilcoxon $p = 0.0998$) and post-test (Wilcoxon $p = 0.0438$) periods than systolic blood pressure in female children. There were no significant gender differences in systolic blood pressure in the test period, in children's heart rate or diastolic blood pressure in any periods, or in heart rate or blood pressure reactivity (test minus pre-test values) to the bombing reminder interview.

There were no significant differences in any of the physiological measures between children whose parents knew someone killed and/or injured in the bombing and children whose parents did not report these experiences.

3.5 Children's Physiological Measurements in Relation to Children's and Survivors' Diagnoses

Children who met criteria for any post-disaster psychiatric diagnosis had higher heart rates at baseline (Wilcoxon $p = 0.0413$) and during the test (Wilcoxon $p = 0.057$) and post-test (Wilcoxon $p = 0.0605$) periods than children who did not meet criteria for any disorder.

Children whose bombing-survivor parent met criteria for bombing-related PTSD had greater heart rate reactivity to the bombing reminder interview than those whose parents did not (Wilcoxon $p = 0.0430$). Diastolic blood pressure during the test (Wilcoxon $p = 0.0558$) and post-test (Wilcoxon $p = 0.0267$) periods was significantly higher in children whose bombing-survivor parent met criteria for post-disaster major depression than for children whose parent did not. Children of bombing survivors who met criteria for any post-disaster psychiatric disorder showed higher heart rate reactivity to the bombing reminder interview than children whose parent did not (Wilcoxon $p = 0.0512$). See Table 1.

Among the linear models fitting children's physiological responses on parental psychiatric diagnosis, only one model was found significant and is presented in this report (child's heart reactivity on parental post-bombing PTSD, adjusted for child's sex and age). The difference in heart reactivity between children of survivors with any post-disaster psychiatric disorder and children of survivors without a post-disaster psychiatric disorder remained significant after controlling for children's age and sex (coefficient estimate $p = 0.0234$). Furthermore, heart reactivity significantly increased with age ($p = 0.0329$) and was higher in males compared to females ($p = 0.0867$). See Table 2.

4. Discussion

The children of the bombing survivors we studied were exposed to the disaster through their parents' experiences, reactions, and recovery and potentially through changes in the parent-child or family dynamics, diminished parental support at home, identification with a parent figure who is seen as either vulnerable or resilient, and/or alterations in the shared environment of the home life. Survivors' psychiatric conditions and physiological reactivity may have influenced their availability or affected their parenting. Dekel and Goldblatt [6] noted that changes in the parenting role, parenting, or family life may affect the intergenerational transmission of trauma effects in the children of combat veterans. Ideally, caregivers provide support and protection to their children but parents may be hampered post disaster by their own reactions or by the need to address other pressing concerns, potentially decreasing their physical and emotional availability to their children. In addition to role modeling emotions, parents may provide models for affect dysregulation, portraying expectations of surprise and alarm. Little is known about mitigating factors that might influence effects on children of traumatized adults [6]. In addition, physiologic arousal and reactivity in close family members may have a basis in heredity and similar biology that may underlie emotional states or disorders.

4.1 Diagnostic Findings

The experiences of an immediate family member qualify an individual as a "close associate" for exposure in the diagnostic criteria for PTSD [5]. Nonetheless, only one child met criteria for bombing-related PTSD. This adult child and her bombing-survivor parent both had current bombing-related PTSD and the parent met criteria for other pre- and post-disaster disorders. While this child was close enough to the bomb site to have felt the blast and to have seen smoke after the attack, she was not in immediate danger. Her PTSD by definition therefore reflects her indirect exposure associated with learning about the bombing and the

involvement of her parent. The failure to find other cases of PTSD in the children of survivors is not surprising given (1) that none of the children were directly exposed to the incident, (2) the potential for selection bias created by limiting participation to survivors and children who were free of medical conditions and were not using medications that might affect physiological functioning, and/or (3) the possibility that those with PTSD may have declined to participate in the study.

Three of the children of survivors had pre-disaster disorders; two of these children were from the same family in which the survivor parent had pre-bombing, post-bombing, and current major depression. The third child met criteria for pre-disaster oppositional defiant disorder but did not meet criteria for any post-disaster disorder; his bombing-survivor parent was free of disorders. These findings serve as a reminder that disasters do not occur in a vacuum. Their victims come with a range pre-existing problems including psychiatric disorders in some. As marker events, families may attribute an array of problems occurring in the post-disaster period to the disaster making a careful history essential in work with survivors and their families. This is exemplified by one family in which the two children gave discrepant reports with one child attributing a host of family problems to the bombing while the second child did not.

The survivor parent of the one child in our sample with bombing-related PTSD also had PTSD, and major depression in parents was associated with behavior disorder and any psychiatric diagnosis in children. September 11 studies of preschool children residing or attending school in the vicinity of the World Trade Center revealed a relationship between maternal psychopathology (PTSD and depression) and clinically significant behavior problems in their children three years later [7]. Of particular interest was the relationship of maternal psychopathology with emotional reactivity and aggressive behavior in the children [8]. Using a general-population rather than a traumatized sample, Kim-Cohen and colleagues [9] found evidence of both genetic and environmental processes in the association between antisocial behavior in children and depression in their mothers. Thus, the potential role of parental depression in creating risk for behavior problems, or other psychiatric disorders, in the children we studied was likely independent of the parents' trauma experiences.

4.2 Physiological Findings

In a prior publication describing physiological reactivity in a sample comprised of many of the child participants in the current study, Pfefferbaum and colleagues [4] found that despite generally low levels of posttraumatic stress and depressive symptoms seven years after the bombing, the children of survivors showed physiological reactivity to disaster reminders in heart rate and systolic and diastolic blood pressure relative to a community comparison group. They also reported a positive correlation between heart rate reactivity and posttraumatic stress reactions in the survivors' children.

The findings of this study suggest that children's sensitivity to their parents' psychiatric conditions may have lasting physiological manifestations. Those whose parents had any post-disaster psychiatric disorder were more reactive in heart rate to the bombing reminder interview than children whose parents did not have psychiatric disorders. A meta analysis of

studies of children of combat veterans [6] suggests the importance of the intergenerational transmission of the emotional residues of trauma. The processing and outcomes of these experiences are likely to be influenced by the child's own trauma history and background.

4.3 Limitations

This pilot study examined a small non-representative sample of children of Oklahoma City bombing survivors. Potential participants were excluded if they suffered a medical illness or if they were taking medications that might affect physiological and psychiatric functioning possibly eliminating more symptomatic individuals. A larger sample without these restrictions may have resulted in finding greater similarity between survivors and their children. The unconventional p -value of greater than 0.05 but less than 0.10 in a small pilot sample like ours also indicates that further study with larger samples is needed to confirm the findings. Another limitation in the study was the uneven composition of the families we studied. It is unclear what effect accrued from the inclusion of siblings in four of the families as physiological variables may be correlated within a family, leading to the underestimation of p values when testing for between-subject effects. A larger number of families with two or more children would have allowed us to estimate the correlation of physiological variables among children of the same family.

We do not minimize the potential role of the changed family environment in influencing the results of this study. Unfortunately, we did not examine a number of possible individual, family, and social variables such as coping, subsequent stressors (e.g., disability status, job loss, continuing or new health problems in parents), interpersonal relationships and family dynamics, or social support.

This investigation was scheduled for implementation in early September 2001. Because of the September 11 attacks, we delayed data collection until November 2001, but it is possible that the temporal proximity to the September 11 attacks influenced the reactions of participants. Furthermore, studying the children of survivors earlier in the post-disaster course would likely have provided important information about their experiences and diagnoses that we failed to detect at seven years. While our strong finding related to heart rate is remarkable, we might have demonstrated blood pressure effects if studied earlier in the post-disaster course. Following the children longitudinally beginning soon after the event would have provided opportunities to examine the course of recovery. Moreover, earlier assessment of physiological results also would have enhanced our study, perhaps demonstrating a trajectory of response. Future studies are needed to examine these issues.

5. Conclusions

We conducted this pilot study to explore the potential for long-term emotional, behavioral, and physiological effects of a major terrorist incident in the children of directly-exposed survivors and to investigate relationships between the children and their parents. Although our pilot study is far from definitive, our findings are provocative in suggesting parallel reactions between children and their bombing-survivor parents and in revealing children's physiological reactions in relation to their own psychiatric illnesses and the psychiatric illnesses of their survivor parents. These findings warrant further exploration in studies

using larger representative samples assessed early and over time with objective and rigorous subjective assessments.

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References

1. North CS, Nixon SJ, Shariat S, Mallonee S, McMillen JC, Spitznagel EL, Smith EM. Psychiatric disorders among survivors of the Oklahoma City bombing. *JAMA*. 1999; 282:755–762. [PubMed: 10463711]
2. North CS, Pfefferbaum B, Kawasaki A, Lee S, Spitznagel EL. Psychosocial adjustment of directly exposed survivors 7 years after the Oklahoma City bombing. *Comp Psychiatry*. 2011; 52:1–8.
3. Tucker PM, Pfefferbaum B, North CS, Kent A, Burgin CE, Parker DE, Hossain A, Jeon-Slaughter H, Trautman RP. Physiologic reactivity despite emotional resilience several years after direct exposure to terrorism. *Am J Psychiatry*. 2007; 164:230–235. [PubMed: 17267785]
4. Pfefferbaum B, Tucker P, North CS, Jeon-Slaughter H. Physiological reactivity in children of Oklahoma City bombing survivors 7 years postdisaster: A pilot study. *Ann Clin Psychiatry*. 2011; 23(3):202–207. [PubMed: 21808752]
5. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed.. The American Psychiatric Association; Washington, DC: 2000. text rev
6. Dekel R, Goldblatt H. Is there generational transmission of trauma? The care of combat veterans' children. *Am J Orthopsychiatry*. 2008; 78(3):281–289. [PubMed: 19123747]
7. Nomura Y, Chemtob CM. Effect of maternal psychopathology on behavioral problems in preschool children exposed to terrorism: Use of generalized estimating equations to integrate multiple informant reports. *Arch Pediatr Adolesc Med*. 2009; 163(6):531–539. [PubMed: 19487609]
8. Chemtob CM, Nomura Y, Rajendran K, Schwartz D, Yehuda R, Abramovitz R. Impact of maternal posttraumatic stress disorder and depression following exposure to the September 11 attacks on preschool children's behavior. *Child Dev*. 2010; 81(4):1129–1141. [PubMed: 20636686]
9. Kim-Cohen J, Moffitt TE, Taylor A, Pawlby SJ, Caspi A. Maternal depression and children's antisocial behavior: Nature and nurture effects. *Arch Gen Psychiatry*. 2005; 62:173–181. [PubMed: 15699294]

Table 1

Children's physiological status and reactivity in association with psychiatric disorders

Children's Physiological Status and Reactivity	Child Any Post-disaster Psychiatric Disorder		Survivor Post-disaster Bombing-related PTSD		Survivor Post-disaster Major Depression		Survivor Any Post-disaster Psychiatric Disorder	
	Yes (n=6)	No (n=15)	Yes (n=5)	No (n=16)	Yes (n=8)	No (n=13)	Yes (n=9)	No (n=12)
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Heart rate (bpm)								
Pre test	77.0 (7.6) *	67.2 (9.2)	68.8 (8.5)	70.3 (10.3)	71.3 (8.3)	69.2 (10.7)	70.1 (8.5)	69.9 (10.9)
Test	80.7 (7.4) *	73.4 (9.8)	78.1 (11.8)	74.7 (9.1)	78.7 (10.3)	73.5 (9.0)	77.7 (10.0)	73.8 (9.4)
Post test	78.9 (8.6) *	69.2 (9.9)	72.6 (9.3)	71.8 (10.9)	73.3 (8.9)	71.2 (11.4)	72.3 (8.7)	71.7 (11.8)
Test – Pretest	3.7 (2.8)	6.2 (4.2)	9.3 (4.5) *	4.31 (3.1)	7.4 (4.5)	4.3 (3.3)	7.6 (4.2) *	3.9 (3.1)
Systolic Blood Pressure (mmhg)								
Pre test	111.6 (13.4)	111.6 (10.9)	113.8 (16.5)	110.9 (9.8)	113.6 (15.2)	110.4 (8.6)	111.8 (15.1)	111.4 (8.1)
Test	121.5 (20.2)	118.4 (17.2)	118.9 (30.8)	119.4 (12.8)	121.6 (27.1)	117.8 (9.3)	119.9 (25.9)	118.8 (8.9)
Post test	109.7 (11.4)	112.0 (11.6)	113.8 (16.8)	110.6 (9.6)	114.7 (15.3)	109.3 (8.1)	112.7 (15.4)	110.3 (7.5)
Test – Pretest	9.9 (8.6)	6.8 (11.3)	5.1 (20.3)	8.5 (5.9)	8.1 (16.8)	7.5 (4.4)	8.1 (15.7)	7.4 (4.6)
Diastolic Blood Pressure (mmhg)								
Pre test	66.3 (5.6)	64.3 (6.9)	66.2 (9.9)	64.5 (5.4)	67.8 (6.7)	63.1 (5.9)	66.0 (8.1)	64.0 (5.1)
Test	72.5 (8.1)	72.0 (8.4)	74.5 (13.0)	71.4 (6.4)	76.1 (9.1) *	69.7 (6.7)	73.9 (10.9)	70.8 (5.5)
Post test	67.3 (5.1)	63.8 (8.1)	68.1 (13.4)	63.7 (4.6)	69.6 (7.7) *	61.8 (5.7)	67.3 (10.0)	62.8 (4.4)
Test – Pretest	6.3 (4.0)	7.6 (3.8)	8.3 (5.0)	6.9 (3.5)	8.4 (3.9)	6.6 (3.7)	7.9 (3.9)	6.8 (3.8)

* Statistically significant difference from children/young adults who did not have the specified diagnosis, with two-sided p value for Wilcoxon rank sum test < 0.10.

Table 2

Linear regression of children's heart reactivity on age, sex, and parental post-bombing PTSD

Parameter	Estimate	t Value	Pr > t	90% CI	
Intercept	−4.6	−1.29	0.2152	−10.9	1.6
Age (years)	0.4	2.32	0.0329	0.1	0.7
Sex					
Male	2.5	1.82	0.0867	0.1	4.8
Female (reference)	-	-	-	-	-
Parent Post-Bombing PTSD					
Yes	4.0	2.49	0.0234	1.2	6.7
No (reference)	-	-	-	-	-
Model significance and coefficient of determination	F (3, 17) = 5.90; p= 0.0060; R-squared = 0.51				