

Association Between Posttraumatic Stress and Depressive Symptoms and Functional Outcomes in Adolescents Followed Up Longitudinally After Injury Hospitalization

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Objective: To assess the association between early post-traumatic stress disorder (PTSD) and depressive symptoms and functional and quality-of-life outcomes among injured youth.

Design: Prospective cohort study.

Setting: Combined pediatric-adult level I trauma center.

Participants: Randomly sampled adolescent injury survivors aged 12 to 18 years (N = 108) were recruited from surgical inpatient units.

Main Exposures: Posttraumatic stress disorder and depressive symptom levels in the days and weeks immediately following injury. We also collected relevant adolescent demographic, injury, and clinical characteristics.

Main Outcome Measure: Multiple domains of adolescent functional impairment were assessed with the 87-item Child Health Questionnaire (CHQ-87) at 2, 5, and 12 months after injury.

Results: The investigation attained greater than 80% adolescent follow-up at each assessment after injury. Mixed-model regression was used to assess the association between baseline levels of PTSD and depressive symptoms and subsequent functional outcomes longitudinally. High baseline PTSD symptom levels were associated with significant impairments in CHQ-87 Role/Social Behavioral, Role/Social Physical, Bodily Pain, General Behavior, Mental Health, and General Health Perceptions subscales. High baseline depressive symptoms were associated with significant impairments in CHQ-87 Physical Function, Role/Social Emotional, Bodily Pain, Mental Health, Self-esteem, and Family Cohesion subscales.

Conclusions: Early PTSD and depressive symptoms are associated with a broad spectrum of adolescent functional impairment during the year after physical injury. Coordinated investigative and policy efforts that refine mental health screening and intervention procedures have the potential to improve the functioning and well-being of injured youth treated in the acute care medical setting.

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EACH YEAR, APPROXIMATELY 400 000 to 600 000 adolescents presenting to US emergency departments after physical trauma are so severely injured that they require inpatient hospital admission.^{1,2} Injured trauma survivors who require inpatient hospital admission may be among those with the highest risk for the development of post-traumatic stress disorder (PTSD) and related comorbid conditions.³ High levels of PTSD symptoms have been documented in 19% to 42% of injured adolescents in the days, weeks, and months following acute care hospitalization.^{4,5}

Fewer than 10% of trauma centers in the United States are designated pediatric-only trauma centers.⁶ Preliminary study suggests that, at nonpediatric acute care centers, injured teens older than 14 years may be triaged by strict age criteria that

reflect an emphasis on body weight and organ system maturation; thus, injured adolescents are routinely hospitalized on adult trauma surgical services after an acute injury.^{6,7} The relevance of adolescent psychological development to recovery from traumatic injury currently may be underappreciated in trauma care systems and could contribute to observed deficits in the quality of mental health service delivery for injured teens.⁸

Acute care inpatient settings hold unique promise for the dissemination of evidence-based mental health screening and intervention procedures.⁹ Trauma surgery policy makers have demonstrated their willingness to act on clinical trial evidence substantiating the effectiveness of alcohol screening and brief intervention procedures through the implementation of policy mandates for these services.⁷ Investigations that elucidate prospective as-

sociations between mental health symptoms and functional impairments may hold similar promise for influencing trauma center quality-improvement mandates, particularly if followed by intervention trials that demonstrate significant symptom reductions in concert with functional improvements.

Literature review produced few investigations examining the association between high levels of PTSD and depressive symptoms and functional limitations in injured adolescents after traumatic physical injury. Holbrook et al⁵ reported a significant prospective association between elevations in acute stress disorder symptoms and diminished quality of life as assessed with the Quality of Well-being Scale at individual time points after injury. This seminal study did not assess a broad spectrum of functional outcomes, including specific outcome domains of key relevance to surgical policy makers, such as physical functioning. Also, the investigation did not consider the impact of comorbid depressive symptoms on functional outcomes. Perhaps most important, no previous injury investigations, to our knowledge, have prospectively examined the associations between adolescent symptomatic distress and functional outcomes using contemporary methods for the analyses of longitudinal data.¹⁰⁻¹²

The present investigation assessed the association between early PTSD and depressive symptoms in injured adolescents and the development of functional impairment longitudinally over the course of the year after injury. The investigation sought to determine whether high levels of PTSD and depressive symptoms were prospectively associated with functional impairment and diminished quality of life during the year after injury. The hypothesis was that high levels of adolescent PTSD and depressive symptoms would be associated with a broad spectrum of functional impairments and diminished well-being even after adjustments for relevant demographic and clinical characteristics. The investigation also sought to understand the extent to which high levels of PTSD and depressive symptoms were independently or jointly associated with specific domains of impairment.

METHODS

SETTING AND SUBJECTS

Patients included in the study were adolescent survivors of intentional (eg, injuries associated with human malice, such as physical assaults) and unintentional (eg, motor vehicle crash and work-related accident) injuries, aged 12 to 18 years, who were admitted to the University of Washington's Harborview Medical Center, a level I trauma center. All informed consent procedures were approved by the University of Washington's institutional review board, and full informed consent was obtained before data collection. For patients younger than 18 years, adolescent assent and parental consent were obtained.

Between July 2002 and August 2003, a research associate downloaded daily a list of all newly admitted injury survivors 12 to 18 years of age from the Harborview Medical Center's automated medical record. Random number assignments for each adolescent inpatient were generated, and each youth/parent dyad was approached in the order dictated by the random number assignments.

On approach, inpatients with severe injuries that prevented participation (eg, head or spinal cord injuries that severely limited verbal interchanges) were excluded from the study. Patients who were determined to have self-inflicted injuries were also excluded from the study. In addition, any patient who was non-English speaking or for whom both parents were non-English speaking was excluded. With regard to cognitive status, patients approached in the ward were evaluated with the Glasgow Coma Scale score and were required to have a score of 15 or higher, indicating a clear sensorium.¹³ Adolescent patients were also required to score at least 7 of 10 points on the 2 Mini-Mental State Examination items that assess orientation to location and date.¹⁴

Of 365 adolescent inpatients assigned random numbers for approach, 16 were ineligible because of severe injuries that prevented study participation and 2 were deceased. An additional 159 were discharged before being approached by research assistants. Of the 188 patients approached as inpatients, 34 were ineligible (ie, 15 were non-English speaking, 18 had no parent, and 1 had a self-inflicted injury), leaving 154 available for approach for consent. Forty potential participants refused study participation. Of the 114 adolescent inpatients who consented, 5 were discharged before completion of the surgical ward interview and 1 withdrew from the study, leaving 108 adolescents in the investigation.

INTERVIEWS AND MEASURES

The investigation was part of a larger prospective study that aimed to characterize adolescent posttraumatic symptomatic distress, functional outcomes, and health service utilization during the year after injury.^{4,8} Interviews contained measures that assessed adolescent posttraumatic stress, depressive symptoms, and functional and quality-of-life outcomes. Adolescent self-report was used to assess all adolescent symptoms.

The baseline interview occurred in the days and weeks immediately following the acute injury (mean [SD], 11.7 [12.1] days after injury). Follow-up interviews occurred by telephone approximately 2 months (mean [SD], 51.0 [17.8] days), 5 months (mean [SD], 154.7 [23.2] days), and 12 months (mean [SD], 367.3 [34.0] days) after the injury.

PTSD SYMPTOMS

Adolescent PTSD symptoms were assessed with the adolescent version of the University of California, Los Angeles PTSD Reaction Index (PTSD-RI) for the *Diagnostic and Statistical Manual of Mental Disorders* (Fourth Edition) (*DSM-IV*).¹⁵ The PTSD-RI includes 20 items that assess the *DSM-IV* B (intrusion), C (avoidance), and D (arousal) PTSD symptom clusters.¹⁶ To assess the development of symptoms since the injury, the stem of measure was modified. For example, the PTSD-RI item assessing nightmares read as follows: "How much of the time since your injury did you have dreams about the event in which you were injured or other bad dreams?" These items are rated on a 5-point Likert scale ranging from 0 (none of the time) to 4 (most of the time).

We decided to dichotomize PTSD (and depressive) symptom levels because surgical health services researchers and policy makers have demonstrated receptivity to dichotomized measures (eg, operative mortality [yes/no] and recurrent injury admission [yes/no]).^{7,17,18} A PTSD-RI cutoff score of 38 or higher has a sensitivity of 0.93 and a specificity of 0.87 when compared with the Child and Adolescent Version of the Clinician-Administered PTSD Scale.¹⁵ This cutoff was used to demarcate patients with high PTSD (ie, scores ≥ 38) or low PTSD (ie, scores < 38) symptom levels.

DEPRESSIVE SYMPTOMS

The Center for Epidemiological Studies–Depression Scale (CES-D),¹⁹ a 20-item self-report Likert response instrument, was used to assess adolescent and parent depressive symptoms (scale, 0-3 [0 indicates rarely or none of the time over the past week; 3, most or all of the time over the past week]). The scale has been used extensively to assess depressive symptoms in adolescents²⁰ and has excellent internal consistency and convergent validity.¹⁹ Previous investigation has suggested a CES-D cutoff score of 27 or higher as a conservative cutoff for high depressive symptom levels.²¹ This cutoff has been previously applied to both adult and adolescent acute care inpatients.^{4,22}

FUNCTIONING AND QUALITY-OF-LIFE OUTCOMES

The 87-item Child Health Questionnaire (CHQ-87) was used to assess adolescent functioning and quality-of-life outcomes.²³ The CHQ-87 has demonstrated excellent test-retest reliability and convergent and discriminant validity.^{23,24} Ten CHQ-87 subscales were included in each interview: Physical Function, Role/Social Emotional, Role/Social Behavioral, Role/Social Physical, Bodily Pain, General Behavior, Mental Health, Self-esteem, General Health Perceptions, and Family Cohesion. The CHQ-87 has been used extensively with injured youth.^{25,26} In the current investigation, pre-injury function was assessed by modifying the stem of each item to read, “During the past 4 weeks before the event in which you were injured. . . .” All 2-, 5-, and 12-month follow-up interviews used the standard CHQ-87 stem to assess function during the preceding 4 weeks.

ADOLESCENT PREINJURY ALCOHOL USE

Adolescent alcohol consumption in the year before the index injury was assessed with the Alcohol Use Disorders Identification Test (AUDIT), a 10-item self-report screening measure used for early identification of problem drinking.²⁷ The measure has established reliability, validity, and responsiveness to change and has been used extensively in acute care medical settings.⁴

INJURY SEVERITY AND TYPE

Injury severity was abstracted from surgical records using a conversion software program²⁸ that transforms recognized *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)* codes into Injury Severity Scores.

OTHER ADOLESCENT CHARACTERISTICS

Trauma registry data were also used to obtain data on adolescent age, sex, injury type (ie, intentional vs unintentional), and admission insurance status. Traumatic life events that predated the adolescent's index injury admission were assessed using a modified version of the PTSD-RI trauma history screen.¹⁵ We also used self-report to ascertain injury type and admission insurance status. Based on self-reports, we created a variable documenting any history of psychiatric diagnosis, psychotropic medication use, or mental health visits in the year before the injury. Educational attainment was also assessed through self-report.

STATISTICAL ANALYSES

To assess the representativeness of the sample, we compared the demographic and clinical characteristics of adolescent patients included in the investigation with the characteristics of

all eligible adolescent patients admitted to Harborview Medical Center's trauma surgery services during the period of the study. Next, we examined the frequency of patients with PTSD-RI scores of 38 or higher and CES-D scores of 27 or higher. We assessed the associations among dichotomized PTSD-RI and CES-D scores, baseline CHQ-87 subscale scores, and demographic and clinical characteristics using χ^2 statistics and analysis of variance. Descriptive statistics for CHQ-87 subscale scores were computed, and the longitudinal course of the CHQ-87 subscale scores was examined. We then compared adolescent baseline and 12-month CHQ-87 subscale scores to previously published population norms using unpaired, 2-tailed *t* tests.^{23,24}

Mixed-model regression analyses were used to examine the longitudinal association between dichotomized PTSD-RI and CES-D scores and each of the 10 CHQ-87 subscales. We aimed to develop the most conservative models that tested for a significant association between baseline symptoms and functional impairments while adjusting for relevant baseline demographic, injury, and clinical characteristics. We were also interested in identifying any main effect of time and any symptom group \times time interaction effects. Repeated measurements of adolescent functional outcomes (2-, 5-, and 12-month CHQ-87 subscale scores) were the dependent variables. Longitudinal data collected prospectively from hospitalized trauma survivors are characterized by correlated intraindividual observations, missing data, and dropout; mixed-model regression was selected because of its superior ability to model longitudinal data with these characteristics.¹² Therefore, our initial models included: (1) baseline PTSD-RI scores (dichotomized as ≥ 38 or < 38), (2) baseline CES-D scores (dichotomized as ≥ 27 or < 27), and (3) 2 time \times symptom group (PTSD-RI and CES-D) interaction terms. Because none of these initial models contained a significant group \times time interaction, we next developed models that included baseline CHQ-87 subscale scores, time, dichotomized baseline PTSD-RI and CES-D scores, and any baseline clinical or demographic covariates that differed significantly ($P < .05$) across dichotomized PTSD-RI and CES-D patient groups. All variables were entered simultaneously into each of the 10 models, and the coefficients, standard errors, and significance levels of PTSD-RI and CES-D scores are reported.

RESULTS

Adolescent patients included in the study ($N=108$) did not differ significantly from all adolescent patients admitted to Harborview Medical Center's surgical services ($N=544$) with regard to sex, age, injury type, injury severity, alcohol toxicology status, and insurance status. Patients included in the investigation had a significantly increased mean (SD) length of inpatient hospital stay (5.3 [6.2] days) compared with all other adolescent admissions (5.1 [7.4] days; logarithm-transformed $t_{649}=2.07$, $P=.04$).

The investigation attained 87% ($n=94$) 2-month, 83% ($n=90$) 5-month, and 82% ($n=89$) 12-month follow-up. At baseline, 45 of the adolescents (42%) had PTSD-RI scores of 38 or higher and 20 (19%) had CES-D scores of 27 or higher (**Table 1**). Posttraumatic stress and depressive symptoms were highly comorbid, with 18 patients (17%) reporting high levels of both ($\chi^2=21.2$, $P<.001$).

Comparison of adolescents with PTSD-RI scores of 38 or higher vs those with scores lower than 38 and comparison of adolescents with CES-D scores of 27 or higher vs those with scores lower than 27 showed different longitudinal patterns for different CHQ-87 subscales. For

Table 1. Baseline Demographic, Injury, and Clinical Characteristics in 108 Adolescents

Characteristic	Pooled (N = 108)	Baseline PTSD-RI Score			Baseline CES-D Score		
		≥ 38 (n = 45)	< 38 (n = 63)	χ^2 or $F_{1,106}$	≥ 27 (n = 20)	< 27 (n = 88)	χ^2 or $F_{1,106}$
Female, No. (%)	36 (33)	25 (56)	11 (17)	$\chi^2 = 17.14^a$	11 (55)	25 (28)	$\chi^2 = 5.19^b$
White, No. (%)	79 (73)	26 (58)	53 (84)	$\chi^2 = 9.28^c$	15 (75)	64 (73)	$\chi^2 = 0.04$
Private insurance, No. (%)	19 (18)	8 (18)	11 (17)	$\chi^2 = 0.00$	4 (20)	15 (17)	$\chi^2 = 0.10$
Preinjury psychiatric history or medications, No. (%)	14 (13)	7 (16)	7 (11)	$\chi^2 = 0.46$	4 (20)	10 (11)	$\chi^2 = 1.08$
≥ 4 Preinjury traumas, No. (%)	31 (29)	18 (40)	13 (21)	$\chi^2 = 5.17^b$	8 (40)	23 (26)	$\chi^2 = 1.45$
Age, mean (SD), y	15.9 (1.9)	15.7 (1.8)	16.0 (2.0)	$F_{1,106} = 0.68$	16.5 (1.4)	15.8 (2.0)	$F_{1,106} = 2.60$
Injury severity score, mean (SD)	9.7 (6.6)	8.8 (5.8)	10.4 (7.0)	$F_{1,106} = 1.50$	8.4 (5.6)	10.0 (6.8)	$F_{1,106} = 0.98$
Education, mean (SD), y	9.6 (1.9)	9.4 (1.9)	9.7 (2.0)	$F_{1,106} = 0.57$	10.0 (1.5)	9.5 (2.0)	$F_{1,106} = 0.75$
AUDIT score at baseline preinjury, mean (SD)	2.2 (4.4)	3.1 (5.3)	1.7 (3.7)	$F_{1,106} = 2.36$	4.9 (6.9)	1.7 (3.6)	$F_{1,106} = 7.35^c$
Baseline preinjury CHQ-87 subscale score, mean (SD)							
Physical Function	98.1 (8.4)	98.8 (3.2)	97.6 (10.6)	$F_{1,106} = 0.47$	98.9 (2.1)	97.9 (9.2)	$F_{1,106} = 0.21$
Role/Social Emotional	95.5 (16.5)	89.1 (24.3)	100.0 (0.0)	$F_{1,106} = 12.61^c$	87.8 (29.0)	97.2 (11.6)	$F_{1,106} = 5.56^b$
Role/Social Behavioral	95.3 (16.2)	91.9 (21.2)	97.7 (10.8)	$F_{1,106} = 3.53$	83.9 (29.4)	97.9 (9.8)	$F_{1,106} = 13.60^a$
Role/Social Physical	98.8 (7.8)	99.3 (5.0)	98.4 (9.3)	$F_{1,106} = 0.31$	100.0 (0.0)	98.5 (8.6)	$F_{1,106} = 0.61$
Bodily Pain	89.7 (15.9)	90.0 (15.2)	89.5 (16.5)	$F_{1,106} = 0.02$	84.5 (17.0)	90.9 (15.5)	$F_{1,106} = 2.69$
General Behavior	81.1 (12.0)	75.2 (13.4)	85.3 (8.9)	$F_{1,106} = 22.12^a$	69.0 (14.8)	83.9 (9.3)	$F_{1,106} = 32.76^a$
Mental Health	80.2 (13.1)	73.3 (13.8)	85.1 (10.0)	$F_{1,106} = 26.50^a$	67.9 (15.0)	83.0 (10.9)	$F_{1,106} = 27.16^a$
Self-esteem	82.4 (14.0)	79.1 (14.4)	84.8 (13.4)	$F_{1,106} = 4.48^b$	73.3 (15.7)	84.5 (12.8)	$F_{1,106} = 11.46^a$
General Health Perceptions	83.4 (15.6)	78.2 (18.8)	87.2 (11.6)	$F_{1,106} = 8.95^c$	72.8 (22.8)	85.9 (12.2)	$F_{1,106} = 12.71^c$
Family Cohesion	72.0 (24.7)	66.1 (24.8)	76.0 (24.1)	$F_{1,106} = 4.28^b$	68.3 (27.7)	72.8 (24.1)	$F_{1,106} = 0.55$

Abbreviations: AUDIT, Alcohol Use Disorders Identification Test²⁷; CES-D, Center for Epidemiologic Studies–Depression Scale¹⁹; CHQ-87, 87-item Child Health Questionnaire²³; PTSD-RI, University of California, Los Angeles Posttraumatic Stress Disorders Reaction Index.¹⁵

^a $P < .001$.

^b $P < .05$.

^c $P < .01$.

the CHQ-87 Role/Social Emotional, General Behavior, Mental Health, Self-esteem, and General Health Perceptions subscales, patients with PTSD-RI scores of 38 or higher and CES-D scores of 27 or higher demonstrated significantly lower baseline CHQ-87 scores when compared with patients with PTSD-RI scores lower than 38 and CES-D scores lower than 27 (Table 1). This pattern persisted during the year after injury (see **Figure 1** for an example). For the CHQ-87 Physical Function, Role/Social Physical, and Bodily Pain subscales, no significant baseline differences were observed (Table 1), and divergence between groups manifested during the year (see **Figure 2** for an example).

At baseline, before their injury, adolescents enrolled in the investigation demonstrated significantly higher scores on the CHQ-87 General Health Perceptions, Bodily Pain, Self-esteem, and Role/Social Physical subscales when compared with population norms (**Figure 3**). We found no significant differences between baseline scores and population norms on the Role/Social Emotional, Mental Health, and Family Cohesion subscales. Adolescents enrolled in the study demonstrated significantly lower scores on the General Behavior subscale.

Twelve months after the injury, study adolescents had significantly lower scores on the Physical Function, Role/Social Physical, Bodily Pain, General Health Perceptions, and Family Cohesion subscales. Only scores on the Self-esteem subscale were significantly higher in study patients when compared with population norms.

In regression analyses that modeled the scores for each subject longitudinally and adjusted for baseline CHQ-87 subscale scores, sex, race/ethnicity, preinjury trauma, and preinjury AUDIT scores, baseline PTSD-RI scores of 38 or higher were associated with significantly lower CHQ-87 Role/Social Behavioral, Role/Social Physical, General Behavior, and General Health Perceptions subscale scores longitudinally (**Table 2**). Scores of 27 or higher on the CES-D were associated with significantly lower CHQ-87 Physical Function, Role/Social Emotional, Self-esteem, and Family Cohesion subscale scores longitudinally. Both PTSD-RI scores of 38 or higher and CES-D scores of 27 or higher were associated with a significantly lower CHQ-87 Bodily Pain and Mental Health subscale scores. Of note, in these adjusted models the significance levels for PTSD-RI scores of 38 or higher and CES-D scores of 27 or higher did not differ substantially for most of the CHQ-87 subscales when compared with the unadjusted models without covariates. Only the Role/Social Emotional (for which a PTSD-RI score of ≥ 38 was significant in the unadjusted model), Self-esteem (for which a PTSD-RI score of ≥ 38 was significant in the unadjusted model), Role/Social Physical (for which a CES-D score of ≥ 27 was significant in the unadjusted model), and General Health Perceptions (for which a CES-D score of ≥ 27 was significant in the unadjusted model) CHQ-87 subscales demonstrated differences in statistical significance between adjusted and unadjusted models.

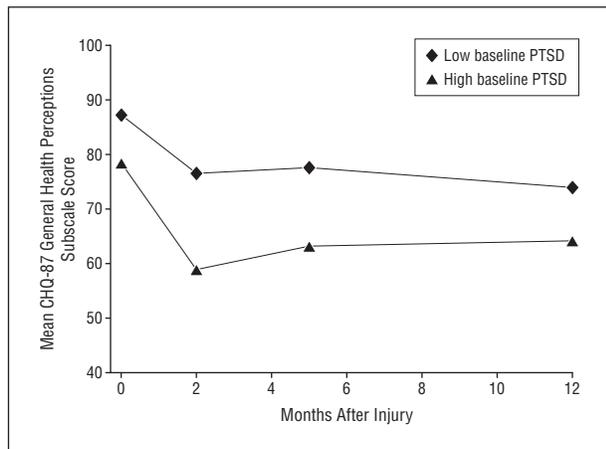


Figure 1. High vs low baseline University of California, Los Angeles Posttraumatic Stress Disorders Reaction Index¹⁵ (PTSD-RI) scores as a predictor of 87-item Child Health Questionnaire²² (CHQ-87) General Health Perceptions subscale scores in injured adolescents over time. Time 0 indicates the preinjury CHQ-87 subscale score; baseline, the initial assessment of PTSD symptoms in the days and weeks immediately following the injury. Low baseline PTSD indicates PTSD-RI scores lower than 38; high baseline PTSD, PTSD-RI scores of 38 or higher. Scores for 108 patients were included at baseline, for 94 at the 2-month follow-up, for 90 at the 5-month follow-up, and for 89 at the 12-month follow-up.

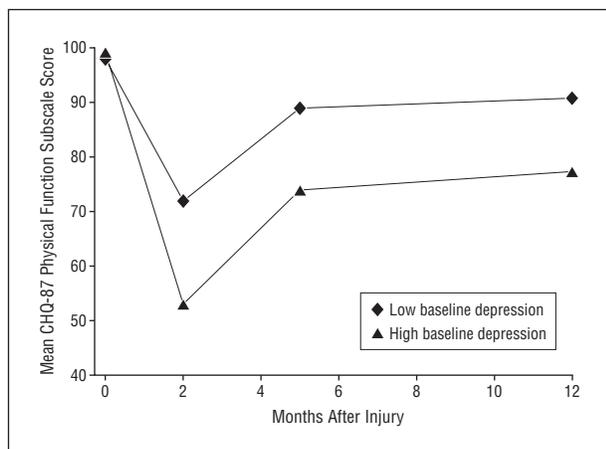


Figure 2. High vs low baseline preinjury Center for Epidemiologic–Depression Scale (CES-D)¹⁹ scores and 87-item Child Health Questionnaire (CHQ-87)²² Physical Function subscale scores in injured adolescents over time. Time 0 indicates the preinjury CHQ-87 subscale score; baseline, the initial assessment of depressive symptoms in the days and weeks immediately following the injury. Low baseline depression indicates CES-D scores lower than 27; high baseline depression, CES-D scores of 27 or higher. Scores for 108 patients were included at baseline, for 94 at the 2-month follow-up, for 90 at the 5-month follow-up, and for 89 at the 12-month follow-up.

COMMENT

The investigation documents for the first time, to our knowledge, that high levels of PTSD and depressive symptoms in randomly sampled adolescent injury survivors are prospectively associated with a broad profile of functional impairment during the year after hospitalization. Comparisons of prehospitalization and posthospitalization functional outcomes of the injured adolescent cohort with population norms demonstrated that the traumatic injury demarcated the onset

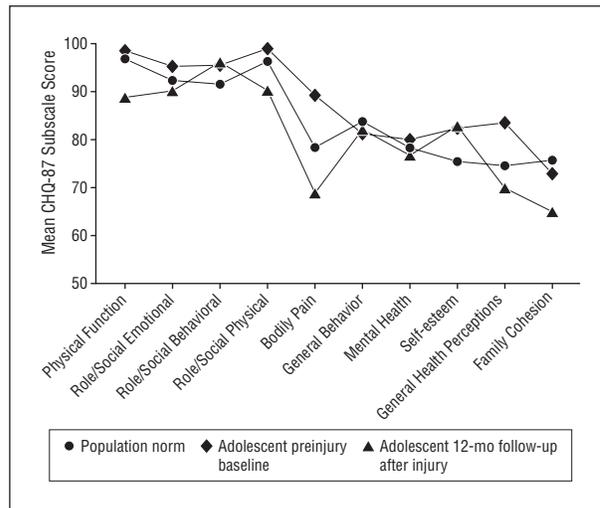


Figure 3. Adolescent 87-item Child Health Questionnaire (CHQ-87) population norms (N=444)²² and adolescent CHQ-87 subscale scores (preinjury [N=108] and 12 months after injury [n=89]).

of impairments for most of the CHQ-87 functional outcome domains.

The investigation contributes to a growing body of literature documenting the association between anxiety and depressive spectrum disorders and diminishments in function and well-being among youth and adult patients treated in general medical settings.^{29,31} In the present investigation, early PTSD and depressive symptoms after injury were associated with impairments across all 10 functional outcome domains assessed. Posttraumatic stress and depressive symptoms were associated with different profiles of impairment. High levels of early PTSD symptoms were associated with impairments in 6 of 10 CHQ-87 domains (eg, General Health Perceptions, Bodily Pain, and Role/Social Physical), whereas high levels of early depressive symptoms were associated with impairments in 6 of 10 domains (eg, Physical Function, Bodily Pain, and Role/Social Emotional). In adults, a growing body of literature suggests that both anxiety and depressive symptoms negatively affect functioning.^{29,32} The results of this investigation substantiate previous recommendations that both anxiety and depressive symptoms should be examined in studies of functional impairment for youth and adult patients presenting to general medical settings.²⁹

This investigation in injured adolescents corroborates and extends previous research^{30,33-40} on the association between PTSD, functional impairment, and diminished quality of life across trauma-exposed populations. To our knowledge, this is the first injury investigation to use a repeated-measures longitudinal design to establish a consistent association between early distress and later functional limitation during the year after trauma exposure. Previous investigation has established that acute stress symptoms are prospectively associated with quality-of-life deficits in injured adolescents.³³ Previous studies of adult injury survivors have documented prospective associations between high levels of PTSD symptoms and global functional outcome impairments at individual time points after injury.^{30,34,35} Other investigations of adult and adolescent injury survivors have demonstrated cross-sec-

Table 2. Longitudinal Associations Between PTSD-RI, CES-D, and CHQ-87 Subscale Scores^a

CHQ-87 Subscale	PTSD-RI Score \geq 38			CES-D Score \geq 27		
	Estimate	SE	t Value	Estimate	SE	t Value
Physical Function	-1.40	3.50	-0.40	-12.98	4.34	-2.99 ^b
Role/Social Emotional	-3.80	3.37	-1.13	-17.37	4.20	-4.14 ^c
Role/Social Behavioral	-6.45	2.06	-3.13 ^b	1.11	2.71	0.41
Role/Social Physical	-8.92	3.69	-2.42 ^d	-7.13	4.58	-1.56
Bodily Pain	-9.83	4.05	-2.43 ^d	-11.73	5.10	-2.30 ^d
General Behavior	-5.32	1.50	-3.56 ^b	-0.07	1.98	-0.03
Mental Health	-4.22	1.91	-2.21 ^d	-8.25	2.43	-3.40 ^c
Self-esteem	-3.40	2.02	-1.68	-6.47	2.60	-2.49 ^d
General Health Perceptions	-10.42	2.34	-4.45 ^c	-3.00	2.94	-1.02
Family Cohesion	-5.25	3.81	-1.38	-15.33	4.62	-3.32 ^b

Abbreviations: See Table 1.

^aRegression models are adjusted for sex, race/ethnicity, preinjury trauma, preinjury AUDIT score, and baseline preinjury CHQ-87 subscale score.

^b $P < .01$.

^c $P < .001$.

^d $P < .05$.

tional associations between PTSD symptoms and functional and quality-of-life impairments.^{36,37} The results of the investigation add to increasing documentation that PTSD is associated with a broad profile of functional impairment across trauma-exposed civilian and veteran populations.³⁸⁻⁴⁰

This investigation had some limitations. One concern is that, because of overlap between PTSD and depressive symptom reports, the associations that emerged between PTSD and depressive symptoms and specific functional outcome domains may not be reproducible; therefore, the present findings require replication in subsequent investigations. The investigation was conducted at a single US combined adult-pediatric trauma center. The results may not be generalizable to designated pediatric trauma centers, where the quality of mental health care delivery may be improved relative to combined centers. Also, the investigation used a random sampling procedure in an attempt to attain a representative sample of injured adolescents. The clinical and demographic characteristics of patients included in the investigation did not differ significantly from the characteristics of the population of injured adolescents admitted to the trauma center during the period of the investigation, with the exception of inpatient length of stay. In a previous investigation, patients with diagnoses of alcohol abuse or dependence demonstrated a 10% reduction in inpatient length of stay.⁴¹ Thus, adolescent patients with recognized alcohol abuse or dependence may be underrepresented in the present sample. Finally, sample size considerations did not permit the assessment of the influence of preinjury functional impairment on PTSD and depressive symptoms over time. Previous investigations in larger samples have identified a prospective association between mental health symptoms and functional impairment, as well as a longitudinal association between functional impairment and worsening symptoms.⁴²

Beyond these considerations, the present investigation established a prospective association between high levels of PTSD and depressive symptoms and a broad spectrum of functional impairment longitudinally in

conservative models that adjusted for relevant demographic and clinical characteristics. Posttraumatic stress and depressive symptoms are highly prevalent among injured adolescents, and other acute care investigation reports that 7.5% of adolescents presenting to US emergency departments had a mental health diagnosis, were prescribed a psychotropic medication, or had etiologic mental health symptoms.⁴³ Recent commentary has encouraged the extension of collaborative care approaches to pediatric care settings,⁴⁴ and initial investigation in primary care medical settings has demonstrated the effectiveness of collaborative care models for depressed adolescents.⁴⁵ Other randomized effectiveness trials in adults suggest that collaborative care interventions delivered soon after injury may help to diminish posttraumatic stress symptoms.⁴⁶

Ultimately, future research efforts could be more closely linked to changes in acute care policy surrounding the delivery of high-quality mental health care for injured youth. The American College of Surgeons has mandated that level I trauma centers must have on-site alcohol screening and brief intervention services as a requisite for trauma center accreditation.^{7,18} This policy mandate derives from a series of acute care randomized trials documenting improved outcomes for patients receiving clinical interventions targeting alcohol consumption. Investigations that refine early screening and intervention procedures for adolescent PTSD and depressive symptoms have similar potential to improve the quality of mental health care for injured youth because they may inform future American College of Surgeons mandates for sustainable clinical services in acute care settings.

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REFERENCES

- McCaig LF, Nawar EW. National Hospital Ambulatory Medical Care Survey: 2004 emergency department summary. *Adv Data*. 2006;(372):1-29.
- Centers for Disease Control and Prevention. *Injury and Mortality: National Summary of Injury Mortality Data 1984-1990*. Atlanta, GA: Centers for Disease Control and Prevention; 1993.
- Abenhaim L, Dab W, Salmi LR. Study of civilian victims of terrorist attacks (France 1982-1987). *J Clin Epidemiol*. 1992;45(2):103-109.
- Zatzick D, Russo J, Grossman DC, et al. Posttraumatic stress and depressive symptoms, alcohol use, and recurrent traumatic life events in a representative sample of hospitalized injured adolescents and their parents. *J Pediatr Psychol*. 2006;31(4):377-378.
- Holbrook TL, Hoyt DB, Coimbra R, Potenza B, Sise M, Anderson JP. Long-term post-traumatic stress disorder persists after major trauma in adolescents: new data on risk factors and functional outcome. *J Trauma*. 2005;58(4):764-769, 769-771.
- Segui-Gomez M, Chang DC, Paidas CN, Jurkovich GJ, Mackenzie EJ, Rivara FP. Pediatric trauma care: an overview of pediatric trauma systems and their practices in 18 US states. *J Pediatr Surg*. 2003;38(8):1162-1169.
- American College of Surgeons Committee on Trauma. *Resources for the Optimal Care of the Injured Patient: 2006*. Chicago, IL: American College of Surgeons Committee on Trauma; 2006.
- Sabin JA, Zatzick D, Jurkovich G, Rivara FP. Primary care utilization and detection of emotional distress after adolescent traumatic injury: identifying an unmet need. *Pediatrics*. 2006;117(1):130-138.
- Katon WJ, Zatzick D, Bond G, Williams J Jr. Dissemination of evidence-based mental health interventions: importance to the trauma field. *J Trauma Stress*. 2006;19(5):611-623.
- Wu AW, Gray SM, Brookmeyer R. Application of random effects models and other methods to the analysis of multidimensional quality of life data in an AIDS clinical trial. *Med Care*. 1999;37(3):249-258.
- Crystal S, Sambamoorthi U. Functional impairment trajectories among persons with HIV disease: a hierarchical linear models approach. *Health Serv Res*. 1996;31(4):469-488.
- Gibbons RD, Hedeker D, Elkin I, et al. Some conceptual and statistical issues in analysis of longitudinal psychiatric data: application to the NIMH treatment of Depression Collaborative Research Program dataset. *Arch Gen Psychiatry*. 1993;50(9):739-750.
- Teasdale G, Jennet B. Assessment of coma and impaired consciousness: a practical scale. *Lancet*. 1974;2(7872):81-84.
- Folstein MF, Folstein SE, McHugh PR. "Mini-mental state": a practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res*. 1975;12(3):189-198.
- Steinberg AM, Brymer MJ, Decker KB, Pynoos RS. The University of California at Los Angeles post-traumatic stress disorder reaction index. *Curr Psychiatry Rep*. 2004;6(2):96-100.
- American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed. Washington, DC: American Psychiatric Association; 1994.
- Birkmeyer JD, Stukel TA, Siewers AE, Goodney PP, Wennberg DE, Lucas FL. Surgeon volume and operative mortality in the United States. *N Engl J Med*. 2003;349(22):2117-2127.
- Gentilello LM, Rivara FP, Donovan DM, et al. Alcohol interventions in a trauma center as a means of reducing the risk of injury recurrence. *Ann Surg*. 1999;230(4):473-480.
- Radloff LS. The CES-D Scale: a self-report depression scale for research in the general population. *Appl Psychol Meas*. 1977;1:385-401.
- Wight RG, Sepulveda JE, Aneshensel CS. Depressive symptoms: how do adolescents compare with adults? *J Adolesc Health*. 2004;34(4):314-323.
- McDowell I, Newell C. The Center for Epidemiologic Studies Depression Scale (CES-D). In: McDowell I, Newell C, eds. *Measuring Health: A Guide to Rating Scales and Questionnaires*. 2nd ed. New York, NY: Oxford University Press; 1996:254-258.
- Zatzick D, Jurkovich G, Russo J, et al. Posttraumatic distress, alcohol disorders, and recurrent trauma across level 1 trauma centers. *J Trauma*. 2004;57(2):360-366.
- Landgraf JM, Abetz L, Ware JE. *The CHQ User's Manual*. Boston, MA: Health Institute, New England Medical Center; 1996.
- Raat H, Landgraf JM, Bonseel GJ, Gemke RJ, Essink-Bot ML. Reliability and validity of the Child Health Questionnaire-Child Form (CHQ-CF87) in a Dutch adolescent population. *Qual Life Res*. 2002;11(6):575-581.
- Aitken ME, Tilford JM, Barrett KW, et al. Health status of children after admission for injury. *Pediatrics*. 2002;110(2, pt 1):337-342.
- Davey TM, Aitken LM, Kassulke D, et al. Long-term outcomes of seriously injured children: a study using the Child Health Questionnaire. *J Paediatr Child Health*. 2005;41(5-6):278-283.
- Babor TF, Grant M. From clinical research to secondary prevention: international collaboration in the development of the Alcohol Use Disorders Identification Test. *Alcohol Health Res World*. 1989;13:371-374.
- Johns Hopkins Health Services Research and Development Center. *Determining Injury Severity From Hospital Discharges: A Program to Map ICD-9CM Diagnoses into AIS and ISS Severity Scores*. Baltimore, MD: Johns Hopkins University Press; 1989.
- Stein MB, Roy-Byrne PP, Craske MG, et al. Functional impact and health utility of anxiety disorders in primary care outpatients. *Med Care*. 2005;43(12):1164-1170.
- Holbrook TL, Anderson JP, Sieber WJ, Browner D, Hoyt DB. Outcome after major trauma: 12-month and 18-month follow-up results from the Trauma Recovery Project. *J Trauma*. 1999;46(5):765-773.
- Asarnow JR, Jaycox LH, Duan N, et al. Depression and role impairment among adolescents in primary care clinics. *J Adolesc Health*. 2005;37(6):477-483.
- Sherbourne CD, Wells KB, Meredith LS, Jackson CA, Camp P. Comorbid anxiety disorder and the functioning and well-being of chronically ill patients of general medical providers. *Arch Gen Psychiatry*. 1996;53(10):889-895.
- Holbrook TL, Hoyt DB, Coimbra R, et al. Trauma in adolescents causes long-term marked deficits in quality of life: adolescent children do not recover preinjury quality of life or function up to two years postinjury compared to national norms. *J Trauma*. 2007;62(3):577-583.
- Richmond TS, Kauder D, Hinkle J, Shults J. Early predictors of long-term disability after injury. *Am J Crit Care*. 2003;12(3):197-205.
- O'Donnell ML, Creamer M, Elliott P, Atkin C, Kossmann T. Determinants of quality of life and role-related disability after injury: impact of acute psychological responses. *J Trauma*. 2005;59(6):1328-1334, 1334-1335.
- Zatzick DF, Jurkovich GJ, Gentilello LM, Wisner DH, Rivara FP. Posttraumatic stress, problem drinking, and functional outcomes after injury. *Arch Surg*. 2002;137(2):200-205.
- Holbrook TL, Hoyt DB, Coimbra R, Potenza B, Sise M, Anderson JP. High rates of acute stress disorder impact quality-of-life outcomes in injured adolescents: mechanism and gender predict acute stress disorder risk. *J Trauma*. 2005;59(5):1126-1130.
- Zatzick DF, Marmar CR, Weiss DS, et al. Posttraumatic stress disorder, and functioning and quality of life outcomes in a nationally representative sample of male Vietnam veterans. *Am J Psychiatry*. 1997;154(12):1690-1695.
- Mendlowicz MV, Stein MB. Quality of life in individuals with anxiety disorders. *Am J Psychiatry*. 2000;157(5):669-682.
- Schnurr PP, Hayes AF, Lunney CA, McFall M, Uddo M. Longitudinal analysis of the relationship between symptoms and quality of life in veterans treated for post-traumatic stress disorder. *J Consult Clin Psychol*. 2006;74(4):707-713.
- Zatzick DF, Kang SM, Kim SY, et al. Patients with recognized psychiatric disorders in trauma surgery: incidence, inpatient length of stay, and cost. *J Trauma*. 2000;49(3):487-495.
- Orlando M, Tucker JS, Sherbourne CD, Burnam MA. A cross-lagged model of psychiatric problems and health-related quality of life among a national sample of HIV-positive adults. *Med Care*. 2005;43(1):21-27.
- Grupp-Phelan J, Harman JS, Kelleher KJ. Trends in mental health and chronic condition visits by children presenting for care at U.S. emergency departments. *Public Health Rep*. 2007;122(1):55-61.
- Kelleher KJ, Horwitz SM. Quality of mental health care for children: a familiar storyline. *Med Care*. 2006;44(12):1061-1063.
- Asarnow JR, Jaycox LH, Duan N, et al. Effectiveness of a quality improvement intervention for adolescent depression in primary care clinics: a randomized controlled trial. *JAMA*. 2005;293(3):311-319.
- Zatzick D, Roy-Byrne P, Russo J, et al. A randomized effectiveness trial of stepped collaborative care for acutely injured trauma survivors. *Arch Gen Psychiatry*. 2004;61(5):498-506.

- (HCUP). <http://hcupnet.ahrq.gov/HCUPnet.jsp?Id=93133CE5C8E0F34D&Form=DispTab&GoTo=MAINSEL&JS=Y>. Accessed September 25, 2008.
21. Crocker D, Kinyota S, Dumitru G, et al; Task Force on Community Preventive Services. Home based environmental interventions to reduce asthma morbidity. In: Proceedings of the Task Force on Community Preventive Services Meeting; June 25-26, 2008; Atlanta, GA.
 22. Office of Healthy Homes and Lead Hazard Control, US Department of Housing and Urban Development. Office of Healthy Homes and Lead Hazard Control Web site. <http://www.hud.gov/offices/lead/index.cfm>. Accessed May 9, 2006.
 23. US Environmental Protection Agency. Indoor air quality. <http://www.epa.gov/iaq/index.html>. Accessed May 9, 2006.
 24. Krieger J; CDC/NCHH Healthy Homes Expert Panel. Report out of findings, panel 1: biologic agents. Paper presented at: 2008 National Healthy Homes Conference; September 16, 2008; Baltimore, MD.
 25. Seattle-King County Healthy Homes. Public health: Seattle and King County. <http://www.metrokc.gov/health/asthma/healthyhomes/>. Accessed September 22, 2007.
 26. US Environmental Protection Agency. Implementing an asthma home visit program: 10 steps to help health plans get started. http://www.epa.gov/asthma/pdfs/implementing_an_asthma_home_visit_program.pdf. Accessed September 25, 2008.
 27. Hoppin P, Jacobs M, Ribble M. Enhancing asthma management using in-home environmental interventions: a review of public health department programs. http://www.asthmaregionalcouncil.org/documents/EnhancingAsthmaManagement-UsingIn-HomeEnvironmentalInterventionsHoppin_000.doc. Accessed September 25, 2008.
 28. Friedman AR, Butterfoss FD, Krieger JW, et al. Allies community health workers: bridging the gap. *Health Promot Pract*. 2006;7(2)(suppl):96S-107S.
 29. Drugstore.com Web site. <http://www.drugstore.com>. Accessed September 25, 2008.
 30. Stankaitis JA, Brill H, Towner K, Brill E. *Monroe Plan and ViaHealth Partnership: 2001-2004: Improving Asthma Care for Children*. Hamilton, NJ: Center for Health Care Strategies; 2006.
 31. Swider SM. Outcome effectiveness of community health workers: an integrative literature review. *Public Health Nurs*. 2002;19(1):11-20.
 32. Love MB, Gardner K, Legion V. Community health workers: who they are and what they do. *Health Educ Behav*. 1997;24(4):510-522.

Correction

Errors in Text, Tables, and Figure Legend. In the Article titled "Association Between Posttraumatic Stress and Depressive Symptoms and Functional Outcomes in Adolescents Followed Up Longitudinally After Injury Hospitalization" by Zatzick et al, published in the July issue of the *Archives* (2008;162[7]:642-648), the University of California, Los Angeles posttraumatic stress disorder (PTSD) Reaction Index (PTSD-RI) scale scores reported as 38 or higher were actually 21 or higher. The error in the original manuscript was due to an inadvertent problem in coding. A PTSD-RI score of 21 or higher is consistent with moderate elevations in PTSD symptom levels that approximate a diagnosis of PTSD during the course of the year after the injury. On page 643 of this article, in the "Methods" section, "PTSD Symptoms" subsection, the second and third sentences of the second paragraph should be replaced with the following: "A PTSD-RI cutoff score of 21 or higher has a sensitivity of 1.0 and a specificity of 0.66 to 0.86 for symptoms consistent with a diagnosis of PTSD, when using the recommended PTSD-RI algorithm criterion of a score of 3 or greater.¹⁵ For the algorithm, symptoms consistent with a *DSM-IV* diagnosis of PTSD are considered present when a score of 3 or greater is reported for at least 1 PTSD intrusive symptom, 3 PTSD avoidant symptoms, and 2 PTSD arousal symptoms." In addition, throughout the remaining text, in the table headings, and in the legend to Figure 1, any references to a PTSD-RI cutoff of 38 should be replaced with 21.