

# Posttraumatic Stress Disorder and Physical Comorbidity Among Female Children and Adolescents: Results From Service-Use Data

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**ABSTRACT.** *Objective.* In adults, posttraumatic stress disorder (PTSD) is associated with adverse health outcomes and high medical utilization and cost. PTSD is twice as common in women and is associated with increased risk for a range of diseases, chronic conditions, and reproductive-health problems. Little is known about the health effects of PTSD in children. The purpose of this study was to explore patterns of physical comorbidity in female children and adolescents with PTSD by using population data.

*Methods.* This study was a cross-sectional, descriptive epidemiologic case-control analysis of a Midwestern state's Medicaid eligibility and paid-claims data for girls (0–8 years old) and teens (9–17 years old). Data were from 1994–1997. All those with the PTSD diagnostic code were compared with randomly selected controls in relation to 3 sets of outcomes: (1) *International Classification of Diseases, Ninth Revision* (ICD-9) categories of disease; (2) chronic conditions previously associated with sexual trauma and PTSD in women; and (3) reproductive-health problems. Analyses included bivariate odds ratios (OR) and logistic-regression models that control for the extent of insurance coverage and the independent associations of victimization and psychiatric comorbidity with the 3 sets of outcomes. The mental health covariate was categorical to allow consideration of a range of severity. There were 4 categories for the young girls: neither PTSD nor depression, PTSD without depression, depression without PTSD, and PTSD + depression. For the adolescent analysis, a fifth category reflecting a “complex PTSD” was added, defined as having PTSD complicated by a dissociative disorder or borderline personality disorder diagnosis.

*Results.* There were 647 girls and 1025 adolescents with the PTSD diagnosis. Overall, PTSD was associated with adverse health outcomes in both age strata. Victimization was sometimes independently associated with adverse health outcomes, but PTSD often was a mediator, especially in the adolescent age stratum. The importance of PTSD diagnosis as a predictor of the ICD-9 categories of disease or chronic conditions seemed to increase with age.

In the younger age stratum, the increased bivariate ORs of significant associations with PTSD ranged from 1.4 for digestive disorders to 3.4 for circulatory disorders. Among younger girls, PTSD diagnosis was associated with significantly greater bivariate odds for 9 of the 12 ICD-9 categories of disease but not for neoplasms, blood disorders, or respiratory disorders and with threefold increased odds for chronic fatigue. They also had 1.8 times greater odds for sexually transmitted infections, some of which could be from congenital transmission in this age group, which includes infants. In the multivariate models for the young girls, the mental health variable seemed to mediate the relationship between victimization and increased odds of infectious and parasitic diseases, endocrine/metabolic/immune disorders, circulatory diseases, skin and cutaneous tissue disorders, and having any 1 of the 5 chronic conditions. The mental health categories that were significantly associated with health outcomes varied across the conditions. There were no health outcomes in which the depression-without-PTSD category was the only one significantly associated with the outcome condition. Circulatory and musculoskeletal disorders were significantly associated with all 3 of the mental health categories. Having any 1 of the 5 chronic conditions was significantly associated only with simple PTSD (PTSD without depression). Genitourinary disorders and signs/symptoms/ill-defined conditions were significantly associated with both simple and comorbid PTSD. PTSD with comorbid depression, the most severe of the mental health categories in this younger age group, was the only category associated with the endocrine/metabolic/immune disorders and skin disorders outcomes.

In the adolescent age stratum, the bivariate ORs significantly associated with PTSD ranged from 2.1 for blood disorders to 5.2 for irritable bowel syndrome. Adolescents with PTSD were nearly twice as likely to have a sexually transmitted infection and 60% more likely to have cervical dysplasia. However, their rate of pregnancy was lower (23% vs 31%), a one-fourth decreased odds. In the adolescent group, only 4 outcomes (nervous system/sense organ, digestive, and genitourinary disorders and signs/symptoms/ill-defined conditions) remained statistically significantly associated with victimization after the mental health variable was added, suggesting an additive model of risk for these outcomes but a mediating role for PTSD in relation to the majority of the health outcomes. Among the adolescent girls, the range of ORs for the ICD-9 and chronic-condition diagnoses generally increased across the categories of the mental health variable in a dose-response pattern. Compared with adolescents with neither PTSD nor depression, those with PTSD without depression had statistically significant ORs from 1.5 to 3.6. Those with depression without PTSD had statistically significant ORs from 1.9 to 4.4.

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The significant ORs for those with PTSD comorbid with depression were from 2.3 to 6.6, and those in the complex-PTSD category had significant ORs of between 2.5 and 14.9. Only blood disorders seemed to be more strongly associated with depression alone than with the comorbid and complex forms of PTSD. The simple-PTSD category was not significantly associated with blood disorders, chronic pelvic pain, fibromyalgia, or dysmenorrhea. Depression without PTSD was not significantly associated with chronic pelvic pain or fibromyalgia. Fibromyalgia was only significantly associated with complex PTSD.

**Conclusions.** In young girls who receive Medicaid benefits, PTSD was associated with increased odds of a range of adverse health conditions. The pattern and odds of physical comorbidity among adolescent recipients with PTSD was nearly as extensive as that seen in adult women. Overall, the pattern observed suggests that objective disease states (eg, circulatory problems, infections) may be associated with PTSD to an extent nearly as great as that of PTSD with more subjective somatic experience of loss of wellness. Using the concepts of allostatic load and allostatic support, professionals who work with children and adolescents may be able to decrease the toll that traumatic stress takes on health even if available interventions can only be thought of as supportive and fall short of completely preventing trauma exposure or completely healing posttraumatic stress. Clinical research to extend these exploratory findings is warranted. *Pediatrics* 2005;116:e767–e776. URL: [www.pediatrics.org/cgi/doi/10.1542/peds.2005-0608](http://www.pediatrics.org/cgi/doi/10.1542/peds.2005-0608); *stress disorder, posttraumatic, epidemiology, comorbidity, pediatrics, adolescents, women's health*.

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ABBREVIATIONS. PTSD, posttraumatic stress disorder; ICD, *International Classification of Diseases, Ninth Revision*; OR, odds ratio; SSRI, selective serotonin-reuptake inhibitor; STI, sexually transmitted infection.

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**E**merging information about the health consequences of violence and posttraumatic stress disorder (PTSD) for women indicates that PTSD is associated with increased risk for a range of diseases and chronic conditions, including multiple idiopathic physical symptoms, as well as reproductive-health problems.<sup>1–5</sup> Furthermore, comorbidity with depression and a dissociative or borderline personality disorder increases the risk of physical comorbidity with PTSD in a dose-response pattern.<sup>6</sup> PTSD is the anxiety disorder associated with the most days of lost work<sup>7</sup> and the highest medical utilization and cost,<sup>8</sup> and it accounts for 7% of the daily-activity loss-years related to mental health.<sup>9</sup> Some proportion of this physical comorbidity and medical utilization may be directly related to the trauma that was the antecedent to PTSD (eg, injury from motor vehicle accident or pelvic pain after infection transmitted during a rape). Theoretical perspectives, however, suggest that there are psychological, biological, behavioral, and attentional factors associated with PTSD that contribute to both care-seeking and adverse health outcomes in adults.<sup>10–13</sup> Risk for trauma exposure peaks among females in adolescence, in the 16- to 20-year age range,<sup>14</sup> and many women with the chronic, severe forms of PTSD most strongly associated with physical comorbidity were exposed to maltreatment in early childhood.<sup>15</sup>

Health risk behaviors associated with PTSD in women with a history of intrafamilial and sexual trauma are found already during adolescence,<sup>16,17</sup> but little is known about the physical health of trauma-exposed girls or girls who have PTSD.

There have been a few studies that considered somatic effects of trauma or PTSD in children. Two studies with cohorts in which all or most of the members (Cambodian refugee adolescents and adopted Romanian orphans) had suffered trauma did not find different levels of health symptoms or health-perception reports by PTSD status.<sup>18,19</sup> Another study compared older adolescents with and without PTSD in a community sample and found that those with PTSD were more likely to rate their health as fair or poor and to have had >3 sick days per month over the past year.<sup>20</sup> Studies of PTSD related to life-threatening illness among children and adolescents were reviewed recently by Stuber et al,<sup>21</sup> with newer studies showing that greater morbidity, nonadherence to treatment regimens, and potentially greater mortality are associated with PTSD in these medical patients (eg, see refs 22 and 23). Our recent study that compared poor preschool children with posttraumatic stress symptoms to trauma-exposed and nonexposed peers found a higher prevalence of specific health conditions in the posttraumatic stress-affected group.<sup>24</sup> Rates of 3 focal health problems (asthma, allergies, and attention-deficit/hyperactivity disorder) in this sample were compared with rates for young children living in poverty in the National Health Interview Survey 2002.<sup>25</sup> Those who had  $\geq 1$  of these National Health Interview Survey-studied conditions were more likely to be exposed to family violence and to have traumatic stress reactions reaching diagnostic levels.<sup>26</sup> The rates of headache, cold and flu, and gastrointestinal problems were also higher among those characterized as meeting PTSD diagnostic criteria. Those with asthma and gastrointestinal problems were  $\sim 4$  times more likely to have a PTSD diagnosis than children without these health problems. In a multivariate model, being abused and exposed to family violence remained independently and significantly associated with having health problems. The strongest predictors of poor child health, however, were the mother's own poor physical health and the child's level of traumatic stress symptoms.

Trauma and PTSD are not restricted to special populations of children but, rather, are significant and salient features in the lives of many children, with 25% of children and adolescents reported to be traumatized by  $\geq 1$  events each year, including witnessing or experiencing community and intrafamilial violence and abuse.<sup>27</sup> Lifetime rates of trauma exposure approached 50% in a community sample by late adolescence.<sup>20</sup> Rates of PTSD range from 14.5% to 27% of trauma-exposed teens to 39% of trauma-exposed preschoolers (K.E. Fletcher, PhD, University of Massachusetts Medical Center at Worcester, *What We Know About Children's Post-traumatic Stress Responses: A Meta-analysis of the Empirical Literature*, unpublished manuscript, 1994).<sup>20,28</sup> In a nationally representative sample of 12- to 17-year-olds, overall

6-month prevalence of PTSD was 3.7% among boys and 6.3% among girls.<sup>29</sup> In the National Comorbidity Survey in which 15- to 24-year-olds were oversampled, the 12-month prevalence was 5.0% for men and 10.4% for women.<sup>30</sup>

In the adult literature cited above, PTSD increased risk for poor health above and beyond the risk associated with the trauma itself. More severe PTSD, which is complicated with depression comorbidity and the associated features of dissociation and borderline personality disorder, has been associated with greater health risk in adult women.<sup>6</sup> Depression occurs in the aftermath of PTSD in 25% to 70.6% of children and adolescents,<sup>28,29</sup> and dissociative and borderline personality diagnoses occur disproportionately among young women.<sup>31</sup> These comorbid conditions are associated with somatization, and depression has been associated with poor health. Preliminary research with large samples is needed to elucidate patterns of physical comorbidity with PTSD, taking both victimization and psychiatric comorbidity into account to estimate the extent of the risk of adverse health outcomes for girls with PTSD during childhood and adolescence.

The present study is a descriptive epidemiologic case-control analysis of Michigan Medicaid fee-for-service claims data from 1994 to 1997 for female children from birth to 17 years of age. This data set offers the opportunity to study an entire population: all cases of female child Medicaid recipients who received a PTSD diagnosis in Michigan over a 4-year period and randomly selected controls. The purpose of this descriptive epidemiologic analysis was to determine, in a systematic exploration of systems data, the extent to which PTSD diagnosis is associated with adverse health outcomes among girls. The adverse health outcomes to be examined are (1) the *International Classification of Diseases, Ninth Revision* (ICD-9) taxonomy's categories of diseases, (2) having 1 of the chronic conditions previously associated with sexual trauma and PTSD, and (3) among adolescents, reproductive-health problems. We compare the PTSD cases and controls on demographics, prevalence rates, and odds ratios (ORs) related to the 3 sets of outcomes, and we then consider the relative effects of victimization and psychiatric comorbidity with PTSD in a hierarchically structured set of logistic regressions.

## METHODS

This is a cross-sectional, case-comparison analysis of existing service-use data. Data are from Michigan's Medicaid eligibility and paid-claims data for females in fee-for-service programs from 1994 through 1997. This relational data set includes tables with eligibility information and inpatient, practitioner, and pharmacy claims. Using queries in a relational database-management program, we extracted relevant codes, reduced them primarily to dichotomous variables, and transferred them for analysis to the statistical software program. Demographic variables available included age, ethnicity, and coverage information from the eligibility table. Most other variables were created out of inpatient and practitioner claims tables from individual codes (eg, PTSD, which is code 309.81) or ranges of codes (eg, infectious disease codes 001-139) in the ICD-9 taxonomy.<sup>32</sup> Some visit codes (eg, for counseling with a victim of abuse or emergency department observation after sexual assault), explanation codes (eg, explaining the means of an injury to be battering), procedure codes (eg, psycho-

therapy), and pharmacy codes (eg, selective serotonin-reuptake inhibitor [SSRI] drug class) were used also. Cases were defined as those having the PTSD code. Comparison records were drawn at random and thus may have had no mental health diagnosis or any mental health diagnosis except PTSD.

The University of Michigan institutional review board gave approval for this analysis. Health Management Associates, Inc, of Lansing, Michigan, provided the delimited data set with encrypted recipient identification numbers per a data-use agreement in accordance with the Health Insurance Portability and Accountability Act.

This article reports results for the child and adolescent age strata from a 2-part analysis of PTSD and physical comorbidity among females across the life span.<sup>6</sup>

## Sample and Power Analysis

Claims records for every female (age range: 0-94 years) with the ICD-9 diagnostic code for PTSD were extracted as cases ( $n = 4894$  within the 4 years) to determine the annual prevalence of the PTSD diagnosis in this population regardless of age. Thereafter, analysis was limited to those who had exclusively fee-for-service coverage during the 4-year period, because capitated Michigan Medicaid records do not contain detailed coding. Healthy people were more likely to move to capitated programs (Dennis Roberts, PhD, verbal communication, September 2001); therefore, we expected to lose more comparison records. Also, we expected a peak in PTSD prevalence among adolescents and young adults,<sup>14</sup> and we wanted a minimum 3:1 ratio to assure adequate power for low-prevalence health conditions.<sup>33</sup> Therefore, comparison records were extracted by using a random-number-assignment process from all remaining females in a 10:1 ratio ( $n = 48\ 940$ ). After excluding records with any months in capitated programs, 3816 PTSD case records and 27\ 366 comparison records remained, and the desired 3:1 ratio in the adolescent age range was achieved. The records then were stratified by age. Effects of PTSD on health may differ by premenarchal and postmenarchal status. The decision to separate children and adolescents at the age of 9 was made so that most postmenarchal girls would be in the adolescent group and be included in the reproductive-health analyses. The extraction process resulted in 9088 records in the child group, but this included female infants born as late as the last day of the 4-year window, who thus could not contribute PTSD-related data. Therefore, child recipients were included only if they were born on or before January 1, 1994, resulting in loss of 11 PTSD cases from among the very young children and 2940 comparison records, leaving 647 child PTSD cases and 5490 comparison children and 1025 PTSD case and 3988 comparison adolescents in the analysis.

Power analysis was done with the PASS 2000 software program.<sup>34,35</sup> To have a 2-tailed  $\alpha$  value of .05 and power of 80% for a low-prevalence disorder (2%), using a conservative OR (2.4), with 25% of the variance explained by other predictors, and a 10% proportion of PTSD cases in the less-sensitive child analysis, a sample size of 4500 would be required to prevent type II error. The sample sizes for the analyses of children ( $n = 6137$ ) and adolescents ( $n = 5013$ ) exceed this size.

## Data Analysis and Model Specification

Bivariate analysis was conducted by using the  $t$  or  $\chi^2$  test to compare PTSD cases with all others in terms of demographic and insurance characteristics and rates of victimization and to describe the PTSD profile. Bivariate ORs then were obtained for both the child and adolescent age groups in relation to 2 sets of outcome variables. The first set of outcomes were ICD-9 categories of diseases (eg, infectious and parasitic diseases, neoplasms, etc). The second set of outcomes were the 5 chronic conditions previously associated with a history of sexual trauma or with PTSD: chronic fatigue, chronic pelvic pain, fibromyalgia, irritable bowel syndrome, and dysmenorrhea. The adolescents were also compared in relation to the third set of outcome variables: reproductive-health conditions including pregnancy, sexually transmitted infections (STIs), and cervical dysplasia. The only reproductive-health outcome that occurred at sufficient rates to consider statistically among the younger girls was STI.

Multivariate analysis was conducted by using a series of parsimonious hierarchical logistic-regression models to assess the risk of these adverse health outcomes.<sup>36</sup> Because of the low prevalence rates of the individual 5 chronic conditions among the girls aged

0 to 8, only 1 logistic-regression model was created for that stratum, estimating the odds of having any 1 of the 5 conditions. Limited demographic covariates are available to use as predictors in the Medicaid database. The effect of age is addressed by using a stratified analysis. Two other covariates, race and exposure to insurance, were included (exposure to insurance) or excluded (race/ethnicity) based on the Mantel-Haenszel test of conditional independence and Breslow-Day test of homogeneity of the ORs to assess confounding and effect modification, respectively.<sup>37,38</sup> Exposure to insurance is a confounder controlled for in all models, contrasting those with continuous coverage with all others. Victimization could be taken into account with a variable that included all episodes of emergency department services related to rape or inflicted injury and visit codes for counseling of a victim of abuse. Depression was almost entirely collinear with PTSD, so simply entering depression as a covariate would have violated the assumption of independence.<sup>39</sup> Therefore, we created a categorical mental health variable. For the 0- to 8-year-old girls there were 4 categories: neither PTSD nor depression (the reference category), PTSD with no depression, depression with no PTSD, and both PTSD and depression. For the adolescents, a fifth category could be added because the prevalence rates of dissociative and borderline personality disorder diagnoses were sufficient ( $n = 71$ ) to include cases with either or both of these associated features as a "complex-PTSD" category.<sup>15</sup> The insurance coverage and victimization variables were entered first to determine the association of this known trauma exposure with the health outcomes, controlling for coverage. The 4- or 5-category mental health variable was then added to the models within each age stratum to determine the change in the association of victimization with the health outcomes once psychiatric conditions were taken into account.

## RESULTS

Demographic, eligibility, and potential trauma-exposure variables are summarized in Table 1. The mean age for younger girls with a PTSD diagnosis is older by 1 year, and the mean age for teens with PTSD diagnosis is younger by 1 year. In both age strata, girls with PTSD were more likely to be white, to have more months of Medicaid coverage, and to be eligible for Medicaid because of disability. In the PTSD-diagnosed groups, 14% of the young girls and 13% of the teens were seen in the emergency department for rape or inflicted injury, 2 types of encounters that could be antecedent trauma exposures. In a posthoc, manual check of chronology, 23% of the adolescents and 13% of the younger girls had the

emergency code related to sexual assault occurring after the first date on which the PTSD code appears, reflecting a potential revictimization. The rate of having a cancer diagnosis code, another established antecedent trauma exposure, was approximately twice as high for PTSD-diagnosed girls in both age strata.

Psychiatric characteristics and treatment information are presented in Table 2. PTSD-diagnosed girls in both age groups had similar duration of coding for PTSD, which likely reflects the duration of treatment focused on PTSD, which could be affected by successful conclusion, dropout, change of focus away from PTSD, or loss of coverage. More than twice as many adolescents had the PTSD code appear in the context of an inpatient claim (18% vs 8% in the younger group). Young girls with PTSD had psychotherapy procedure codes (29%) and SSRI pharmacy codes (20%) less frequently than the teenage girls (38% and 48%, respectively). The control-group girls (12%) and control-group teens (19%) also had psychiatric diagnostic codes, exclusive of PTSD, which can include any disorder in the ICD-9 coding range 290 to 319, including mental retardation. Among the younger girls, nearly all depression, anxiety, substance use, and eating disorders occurred in the PTSD case group (ORs: 14–30). All dissociative disorder ( $n = 2$ ) and borderline personality disorder ( $n = 2$ ) diagnoses occurred in the PTSD group. In the adolescent age stratum, 4% of the control teens were in therapy, and 8% were using SSRIs. Odds of depression and anxiety diagnoses were 11 to 17 times higher in the adolescent PTSD case group, which also had 7 times the odds of a substance-use diagnosis and eightfold increased odds of an eating disorder. In the adolescent age stratum, the number of dissociative disorder diagnoses increased to 33 (OR: 40.1), and the number of borderline personality disorder diagnoses increased to 51 (OR: 38.3).

The importance of PTSD diagnosis as a predictor of the ICD-9 categories of disease or chronic conditions seemed to increase with age (Table 3). In the

**TABLE 1.** Demographic Characteristics of the PTSD and Comparison Groups

	Children ( $n = 6137$ )		Adolescents ( $n = 5013$ )	
	Comparison ( $n = 5490$ )	PTSD Cases ( $n = 647$ )	Comparison ( $n = 3988$ )	PTSD Cases ( $n = 1025$ )
Age, y, mean (SD)	3.38 (2.5)	4.83 (2.3)	13.4 (2.7)	12.8 (2.5)
Ethnicity				
White, %	60.2	70.2	60.7	76.1
Black, %	31.1	25.5	31.2	18.7
Asian, %	1.3	0.2	1.4	0.5
Hispanic, %	5.2	2.0	5.5	2.8
Native American, %	0.7	1.1	0.5	1.1
Unknown, %	1.4	1.1	0.8	0.8
Medicaid fee-for-service coverage				
Months, mean (SD)	25.0 (15.1)	34.5 (13.2)	21.7 (14.9)	33.0 (13.6)
Continuous, %	10.4	24.0	7.7	20.2
Reason eligible				
Poverty, %	67.8	67.6	59.1	53.9
Uninsured, %	25.2	24.1	29.5	28.2
Disabled, %	3.4	7.5	5.6	16.1
Caretaker situation, %	3.6	0.8	5.8	1.8
Victim of violence (per emergency department code), %	1.4	13.9	1.9	13.0
Diagnostic code for neoplasm, %	2.3	4.2	6.0	12.5

Significance of all  $t$ -test and  $\chi^2$  comparisons:  $P < .001$ .

**TABLE 2.** Profile of Girls With a PTSD Diagnosis Compared With Comparison Girls, Including Risk for Comorbid Psychiatric Disorder Diagnoses

	Children ( <i>n</i> = 6137)				Adolescents ( <i>n</i> = 5013)			
	Comparison ( <i>n</i> = 5490)		PTSD Cases ( <i>n</i> = 647)		Comparison ( <i>n</i> = 3988)		PTSD Cases ( <i>n</i> = 1025)	
Proportion with ICD-9 psychiatric code, %	11.7		100 (by definition)		18.9		100 (by definition)	
Mean duration (SD) of days of PTSD coding	—		153 (217)		—		143 (225)	
PTSD code found in inpatient claim, %	—		7.9		—		18.2	
	%	%	OR*	95% CI	%	%	OR	95% CI
Treatment								
Psychotherapy	1.5	29.4	28.1	21.3–37.1	3.7	38.0	16.0	13.0–19.7
SSRI use	1.3	19.9	19.0	14.0–25.7	7.6	48.3	11.4	9.6–13.5
Diagnosis								
Depression	0.7	16.4	26.0	18.0–37.7	5.6	49.5	16.5	13.8–19.8
Anxiety	0.2	3.2	15.3	7.5–31.3	1.0	10.0	11.0	7.6–16.0
Substance abuse	0.1	0.8	14.3	3.4–59.7	2.3	13.3	6.6	5.0–8.6
Eating disorder	0.0	1.1	30.0	6.2–144.8	0.2	1.2	7.9	2.9–21.0
Dissociative disorder	0.0	0.3	—	—	0.1	2.9	40.1	12.2–131.5
Borderline personality	0.0	0.3	—	—	0.1	4.6	38.3	15.2–97.0

Significance of all *t*-test and  $\chi^2$  comparisons: *P* < .001; SD indicates standard deviation.

\* ORs are risk estimates by Mantel-Haenszel common ORs.

**TABLE 3.** Prevalence and Bivariate ORs for 3 Sets of Health Outcomes: ICD-9 Categories of Disease, Chronic Conditions, and Reproductive-Health Conditions for Children and Adolescents.

	Children ( <i>n</i> = 6137)					Adolescents ( <i>n</i> = 5013)				
	<i>n</i> *	Comparison, % ( <i>n</i> = 5940)	PTSD, % ( <i>n</i> = 647)	OR†	95% CI	<i>n</i> *	Comparison, % ( <i>n</i> = 3988)	PTSD, % ( <i>n</i> = 1025)	OR	95% CI
Disease category‡										
Infectious/parasitic	2441	38.4	51.6	1.7	1.5–2.0	1819	31.9	53.5	2.5	2.1–2.8
Neoplasms	154	2.3	4.2	1.8	1.2–2.8	369	6.0	12.5	2.2	1.8–2.8
Endocrine/metabolic/immune	482	7.2	13.4	2.0	1.6–2.6	810	13.3	27.1	2.4	2.1–2.9
Blood	819	13.1	15.8	1.3	0.99–1.6	797	13.5	25.1	2.1	1.8–2.5
Nervous system/sense organs	3164	50.4	61.1	1.5	1.3–1.8	1622	27.8	50.0	2.6	2.3–3.0
Circulatory system	226	3.0	9.6	3.4	2.5–4.7	461	6.4	20.0	3.7	3.0–4.5
Respiratory system	4116	66.5	72.0	1.3	1.1–1.6	2766	49.7	76.6	3.3	2.8–3.9
Digestive system	1366	21.6	28.0	1.4	1.2–1.7	1095	17.6	38.2	2.9	2.5–3.4
Genitourinary system	1299	19.0	39.6	2.8	2.4–3.3	2392	42.4	68.4	2.9	2.5–3.4
Skin/cutaneous tissue	1545	24.2	33.7	1.6	1.3–1.9	1206	20.4	38.4	2.4	2.1–2.8
Musculoskeletal/connective	707	10.6	19.2	2.0	1.6–2.5	1354	22.2	45.9	3.0	2.6–3.4
Signs/symptoms/ill-defined conditions	2697	42.1	59.2	2.0	1.7–2.4	2530	43.7	76.7	4.2	3.6–5.0
Chronic conditions (separately)										
Chronic fatigue	74	1.0	2.9	3.0	1.8–5.1	327	4.4	14.7	3.7	3.0–4.7
Chronic pelvic pain	21	0.3	0.8	2.7	0.97–7.3	309	4.8	11.6	2.6	2.1–3.3
Fibromyalgia	22	0.3	0.9	3.2	1.3–8.2	112	1.8	3.9	2.2	1.5–3.3
Irritable bowel syndrome	12	0.2	0.3	1.7	0.37–7.8	62	0.7	3.4	5.2	3.1–8.6
Dysmenorrhea	0	—§	—	—	—	166	2.3	7.2	3.3	2.4–4.5
Any 1 of these 5	129	1.8	4.9	2.9	1.9–4.4	809	12.3	31.2	3.3	2.8–3.8
Reproductive health										
Pregnancy	5¶	0.0	0.5	12.8	2.1–76.6	1460	30.7	22.9	0.67	0.6–0.8
STI	234	3.5	6.2	1.8	1.3–2.6	681	11.5	21.7	2.1	1.8–2.5
Cervical dysplasia	1	0.0	0.0	0.9	0.89–0.90	204	3.6	5.8	1.6	1.2–2.2

\* Columns show the number of cases of the health condition of interest within the age stratum.

† ORs are risk estimates by Mantel-Haenszel common ORs.

‡  $\chi^2$ ; Bonferroni correction for multiple tests requires *P* < .002 (*P* = .05/21 tests). All differences are significant for adolescents. Among the girls aged 0 to 8, neoplasms (*P* = .004), blood disorders (*P* = .056), and respiratory disorders (*P* = .005) do not reach statistical significance after Bonferroni correction, nor do any of the reproductive conditions except STIs, and nor do any individual chronic conditions except chronic fatigue.

§ No cases occurred when column contains —.

|| A small number of cases occurred, but they were <0.1% of the group.

¶ Of the 5 pregnancies recorded in the younger age stratum, 1 was coded for a girl whose maximum age was 8, 1 for a girl whose maximum age was 10, and 3 for girls whose maximum age by the end of the database time frame was 12.

younger age stratum, the increased bivariate ORs of significant associations with PTSD ranged from 1.4 (digestive system) to 3.4 (circulatory). In the adolescent age stratum, the ORs significantly associated with PTSD ranged from 2.1 (blood disorder) to 5.2

(irritable bowel syndrome). The adolescents with PTSD were nearly twice as likely to have an STI and 60% more likely to have cervical dysplasia. However, their rate of pregnancy was lower (23% vs 31%), a one-fourth decreased odds. All of these differences in

risk were significant after Bonferroni correction for multiple comparisons set the level of significance at  $P = .0024$  ( $\alpha = .05$  divided by 21 total tests). Among the younger girls, a PTSD diagnosis was associated with significantly greater bivariate odds for 9 of the 12 ICD-9 categories of disease but not for neoplasms, blood disorders, or respiratory disorders. For these younger PTSD case girls, the prevalence of chronic pelvic pain, fibromyalgia, and irritable bowel syndrome was greater, but the overall prevalence rate was too low for adequate power and did not attain statistical significance after Bonferroni correction. Their threefold increased odds for chronic fatigue was statistically significant. They also had 1.8 times greater odds for STIs, some of which could be from congenital transmission in this age group, which includes infants. Five pregnancies were noted, one of which (occurring in a girl who could not have been more than 8 years old in the last year of the data) may reflect a coding error.

The series of models presented in Tables 4 and 5 shows that, within the younger age stratum, the mental health variable seemed to mediate the relationship between victimization and increased odds of infectious and parasitic diseases, endocrine/metabolic/immune disorders, circulatory diseases, skin and cutaneous tissue disorders, and having any 1 of the 5 chronic conditions. In the adolescent group, only 4 outcomes (nervous system/sense organ, digestive, and genitourinary disorders and signs/

symptoms/ill-defined conditions) remained statistically significantly associated with victimization after the mental health variable was added, suggesting an additive model of risk for these outcomes.

Among the younger girls, the mental health categories that were significantly associated with health outcomes varied across the conditions. There were no health outcomes in which the depression-without-PTSD category was the only one that was significantly associated with the outcome condition. Having any 1 of the 5 chronic conditions was significantly associated only with simple PTSD (PTSD with no depression). Comorbid PTSD and depression, the most severe of the mental health categories in this younger age group, was the only category associated with the endocrine/metabolic/immune disorders and skin disorders outcomes. Genitourinary disorders and signs/symptoms/ill-defined conditions were significantly associated with both simple and comorbid PTSD but not with depression without PTSD. Circulatory and musculoskeletal disorders were significantly associated with all 3 of the mental health categories.

Among the adolescent girls, the range of ORs for the ICD-9 and chronic-condition diagnoses generally increased across the categories of the mental health variable. Compared with adolescents with neither PTSD nor depression, those with PTSD but not depression had statistically significant ORs from 1.5 to 3.6; those with depression but not PTSD had statis-

**TABLE 4.** Hierarchical Logistic-Regression Model ORs for Health Outcomes Associated First With Coverage and Victimization, Then Also With the 4 Mental Health Diagnostic Categories Among Girls Aged 0 to 8 Years

Health Outcome*	Predictor†				
	Coverage	Victimization	PTSD, No Depression	Depression, No PTSD	PTSD Plus Depression
Infectious/parasitic <i>n</i> = 2441	3.1 2.9	1.8 1.5 (NS)	1.4	2.5 (NS)	1.9
Neoplasms <i>n</i> = 154	3.3 3.1	1.2 (NS) 1.0 (NS)	1.5 (NS)	2.1 (NS)	1.7 (NS)
Endocrine/metabolic/immune <i>n</i> = 482	2.3 2.2	2.3 1.9 (NS)	1.5 (NS)	2.6 (NS)	2.3
Blood <i>n</i> = 819	1.3 (NS) 1.3 (NS)	2.4 2.3	0.9 (NS)	2.1 (NS)	1.8 (NS)
Nervous system/sense organs <i>n</i> = 3164	2.8 2.8	2.1 1.9	1.2 (NS)	1.1 (NS)	1.6 (NS)
Circulatory system <i>n</i> = 226	2.4 2.1	2.7 1.6 (NS)	2.4	5.6	6.3
Respiratory system <i>n</i> = 4116	2.8 2.8	2.4 2.3	1.0 (NS)	1.3 (NS)	1.2 (NS)
Digestive system <i>n</i> = 1366	2.2 2.2	1.5 (NS) 1.4 (NS)	1.2 (NS)	1.6 (NS)	1.2 (NS)
Genitourinary system <i>n</i> = 1299	2.8 2.6	3.2 2.3	2.1	1.7 (NS)	3.0
Skin/cutaneous tissue <i>n</i> = 1545	2.5 2.4	1.7 1.4 (NS)	1.3 (NS)	1.6 (NS)	1.9
Musculoskeletal/connective <i>n</i> = 707	2.8 2.6	2.2 1.8	1.5	4.4	2.2
Signs/symptoms/ill-defined conditions <i>n</i> = 2697	2.8 2.6	2.8 2.3	1.5	1.5 (NS)	2.5
Any 1 of these 5 <i>n</i> = 129	2.7 2.4	3.0 2.0 (NS)	2.2	1.3 (NS)	2.4 (NS)
STIs <i>n</i> = 234	2.4 2.8 2.3	2.4	1.1 (NS)	4.6	2.8

NS indicates not significant.

\* Adjusted ORs achieve significance at  $P < .004$ , after Bonferroni correction for multiple comparisons ( $.05/14 = .0036$ ).

† The reference group consists of those with neither PTSD nor depression.

**TABLE 5.** Hierarchical Logistic-Regression Model ORs for Health Outcomes Associated First With Coverage and Victimization, Then Also With the 4 Mental Health Diagnostic Categories Among Adolescents Aged 9 to 17 Years

Health Outcome*	Predictor†					
	Coverage	Victimization	PTSD, No Depression	Depression, No PTSD‡	PTSD Plus Depression	Complex PTSD
Infectious/parasitic <i>n</i> = 1819	2.8	2.0				
	2.4	1.4 (NS)	1.9	2.0	2.7	2.8
Neoplasms <i>n</i> = 369	1.3 (NS)	2.4				
	1.1 (NS)	1.6 (NS)	2.0	2.3	2.3	2.9
Endocrine/metabolic/immune <i>n</i> = 810	2.2	2.2				
	1.8	1.4 (NS)	1.5	2.1	2.9	5.3
Blood <i>n</i> = 797	1.8	1.8				
	1.5	1.2 (NS)	1.4 (NS)	2.3	3.0	2.2 (NS)
Nervous system/sense organs <i>n</i> = 1622	3.0	2.5				
	2.6	1.6	1.9	2.0	2.7	4.3
Circulatory system <i>n</i> = 461	1.7	3.2				
	1.3 (NS)	1.6 (NS)	2.4	4.0	4.7	11.8
Respiratory system <i>n</i> = 2766	3.7	1.9				
	3.1	1.1 (NS)	2.7	2.5	3.7	4.5
Digestive system <i>n</i> = 1,095	1.9	2.8				
	1.5	1.6	2.0	2.2	3.4	7.2
Genitourinary system <i>n</i> = 2392	1.6	3.2				
	1.3 (NS)	1.9	1.9	2.2	4.4	5.3
Skin/cutaneous tissue <i>n</i> = 1206	2.3	1.7				
	1.9	1.1 (NS)	1.9	2.1	2.9	2.5
Musculoskeletal/connective <i>n</i> = 1354	2.7	2.4				
	2.3	1.5 (NS)	2.3	1.9	2.9	5.6
Signs/symptoms/ill-defined conditions <i>n</i> = 2530	3.1	5.2				
	2.5	2.8	2.5	3.1	6.6	11.3
Chronic fatigue <i>n</i> = 327	2.5	2.1				
	1.9	1.1 (NS)	2.5	2.7	5.0	4.2
Chronic pelvic pain <i>n</i> = 309	1.4 (NS)	2.4				
	1.1 (NS)	1.5 (NS)	1.6 (NS)	1.6 (NS)	3.3	5.8
Fibromyalgia <i>n</i> = 112	1.6 (NS)	1.6 (NS)				
	1.3 (NS)	1.0 (NS)	1.7 (NS)	2.1 (NS)	2.0 (NS)	8.0
Irritable bowel syndrome <i>n</i> = 62	1.9 (NS)	4.5				
	1.3 (NS)	2.0 (NS)	3.6	4.4	5.9	14.9
Dysmenorrhea <i>n</i> = 166	2.7	2.5				
	2.1	1.3 (NS)	1.7 (NS)	3.1	4.0	8.6
Any 1 of these 5 <i>n</i> = 809	2.3	2.8				
	1.8	1.6 (NS)	2.0	2.4	4.2	6.5
Pregnancy <i>n</i> = 1460	0.4	1.2 (NS)				
	0.5	1.3 (NS)	0.7	0.9 (NS)	0.6	1.2 (NS)
STI <i>n</i> = 681	2.1	2.0				
	1.8	1.4 (NS)	1.5	2.1	2.5	2.8
Cervical dysplasia <i>n</i> = 204	1.3 (NS)	0.8 (NS)				
	1.1 (NS)	0.6 (NS)	1.6 (NS)	2.8	2.2	1.4 (NS)

\* Adjusted ORs achieve significance at  $P < .002$ , after Bonferroni correction for multiple comparisons ( $.05/21 = .0024$ ).

† The reference group is those with neither PTSD nor depression.

‡ Complex PTSD is the PTSD diagnosis plus either a dissociative or borderline personality diagnosis.

tically significant ORs from 1.9 to 4.4; the significant ORs for those with both PTSD and depression were from 2.3 to 6.6; and those in the complex-PTSD category had significant ORs of between 2.5 and 14.9. Only blood disorders seemed to be more strongly associated with depression alone than with the comorbid and complex forms of PTSD. The simple-PTSD category was not significantly associated with blood disorders, chronic pelvic pain, fibromyalgia, or dysmenorrhea. Depression without PTSD was not significantly associated with chronic pelvic pain or fibromyalgia. Fibromyalgia was only significantly associated with complex PTSD.

## DISCUSSION

The hypothesis that PTSD would be associated with adverse health outcomes was confirmed in both age groups, with the pattern and ORs for adolescents

resembling those of adult women,<sup>6</sup> including a pattern of increasing odds for physical comorbidity when PTSD was complicated by depression and by the associated features of dissociation and borderline personality disorder, 2 psychiatric conditions that are related to early and repeated interpersonal trauma. This pattern resembles a dose-response relationship, varying with severity of the mental health sequelae of trauma exposure. This finding also suggests that clinical research that looks at PTSD as a potential factor in child and adolescent, as well as adult, health is warranted. Studies that consider all the factors in current theoretical models (eg, psychological, biological, behavioral, and attentional)<sup>10</sup> are likely to be most fruitful. Because of the additional predictive role of psychiatric comorbidity in the models in this analysis, clinical studies of trauma, posttraumatic stress, and health outcomes should

measure these other disorders and include biological measures, such as cortisol levels, that may help to distinguish the potential behavioral and biological contributions of each.

Overall, the pattern observed here suggests that objective disease states (eg, circulatory problems, infections) may be associated with PTSD to an extent nearly as great as that of PTSD with more subjective somatic experience of loss of wellness. Health risk behaviors (eg, substance use and unprotected sex) may be associated to an even greater extent, although teens who had the PTSD diagnostic code had lower odds of pregnancy. Decreased odds of adolescent pregnancy in this PTSD group could be occurring because of altered fertility (a potential adverse health effect) or an intervening effect of PTSD treatment. Using the concepts of allostatic load and allostatic support,<sup>40</sup> professionals who work with children and adolescents may be able to decrease the toll that traumatic stress takes on health even if available interventions can only be thought of as supportive and fall short of completely preventing trauma or completely healing posttraumatic stress.

In both age groups, the 5 chronic conditions and ICD-9 coding for signs/symptoms/ill-defined conditions were strongly associated with PTSD. A total of 938 had diagnostic codes for chronic fatigue, fibromyalgia, irritable bowel syndrome, chronic pelvic pain, or dysmenorrhea, and 144 had  $\geq 2$  of these diagnoses. In these data, 5227 girls had diagnoses within the ICD-9 category of signs/symptoms/ill-defined conditions, which is consistent with the high levels of somatization and medical care seeking that are found among adults. Health care providers contending with care seeking for multiple idiopathic physical symptoms among pediatric and adolescent patients should consider the potential for traumatic stress-related underpinnings to these bodily concerns. The large proportion who had a chronic condition or sought care for idiopathic symptoms (one tenth and one half, respectively, in these data) suggests that this is an area in which interdisciplinary collaboration or integrated primary mental health care<sup>41</sup> may improve well-being in the short term and potentially across the life span.

In the adult literature on health care utilization and health status of women with histories of intrafamilial abuse and sexual trauma, victimization has been associated with conditions that could be directly related to the trauma (eg, STI after rape) and conditions that do not seem associated by a direct injury mechanism (eg, chronic fatigue). In a few studies, PTSD and trauma have both been considered, and PTSD was a stronger predictor (eg, in relation to irritable bowel syndrome)<sup>4</sup> and was associated with physiologic differences in potential mechanisms (eg, immune cell count differences and faster progression of HIV to AIDS).<sup>42</sup> The extent to which victimization itself was a sole or additional predictor in this study varied by age group. In the child age group, victimization and PTSD were predictive of adverse health outcomes in relation to an approximately equal number of conditions. Among the adolescents, PTSD was more frequently a signifi-

cant predictor. Among the adolescents, the risk of STI was mediated by PTSD, which may reflect a pattern of sexual revictimization or more high-risk sexual behaviors, both of which have been noted in the literature.<sup>43-45</sup> Although it goes beyond the information that these data can provide, it is possible that this general pattern reflects children still being exposed to intrafamilial traumatic events, including maltreatment that results in injury and hospital encounters. By the end of the adolescent period covered in these data, girls may be experiencing less intrafamilial abuse, such that PTSD is the more prominent factor. Alternatively, interactions between the physiology of PTSD and the postmenarchal hormonal context may distinguish the pattern of comorbidity in the 2 age groups. Studies that include male and female children and take both physical and psychological developmental milestones into account are needed.

Because of the cross-sectional nature of these data, it is not possible to know the extent to which certain physical health diagnoses are risk factors for PTSD rather than adverse outcomes of traumatic stress. For example, cancer and/or cancer treatment is an example of an antecedent of PTSD among children and adolescent survivors. However, if, as seems to be the case from this analysis, PTSD is associated with worse health generally, then there is a strong impetus for additional research on the extent and mechanisms of effect of PTSD on medical course and survival among children with life-threatening illness or injury.

Limitations of this study are those inherent in the use of existing data for cross-sectional analysis. PTSD may not be reliably diagnosed in these data. Standards for diagnosis of PTSD among young children are still evolving. However, the 6.3% 6-month prevalence rate in the National Survey of Adolescents suggests that the 0.4% prevalence of the PTSD diagnosis in this data set represents underdiagnosis.<sup>29</sup> Thus, cases in this analysis, diagnosed by clinicians in practice, potentially represent only a minority of the actual cases of PTSD. This is especially likely to be the case because studies such as the Detroit Area Study,<sup>46</sup> which have taken poverty and urban neighborhood into account, have found higher rates of PTSD, and these are factors that likely affect these Medicaid recipients. Underdiagnosis of PTSD could result in type I error and has implications for generalizability if only the most severe cases are diagnosed. Conversely, if the majority of PTSD-affected girls are undiagnosed and thus are classified in the comparison group (or as having depression only when it is really a comorbidity of PTSD), this analysis could underestimate the association between PTSD and adverse health outcomes. Furthermore, because the PTSD coding occurred in relation to treatment in a large proportion of cases, effective mental health treatment could be decreasing the impact of PTSD on health. Thus, the results of this analysis could be an underestimate of the toll that PTSD takes on the majority of PTSD-affected girls whose PTSD goes undiagnosed and untreated. Coding of victimization as the reason for a hospital epi-

sode is also unreliable and likely represents an underestimate of actual exposures to violence. Future studies that achieve more reliable measurement of violence trauma may find different patterns in terms of the strength of associations of victimization and PTSD with health outcomes.

Few data sets collected for research purposes and available for secondary analysis contain data on mental and physical health and victimization. The Michigan Medicaid claims data are in the public domain and present an opportunity to study the service use of a large population of people living in relative poverty. It is reasonable to generalize from the Michigan Medicaid population to the US population of Medicaid recipients, because the eligibility and enrollment profiles are very similar.<sup>47-49</sup> Twenty-six percent of Michigan's children aged 5 to 15 years and 27% in that age group nationally are covered by Medicaid programs.<sup>50</sup> Rates of disability in these data also are similar to rates in US data,<sup>51</sup> in which 3.1% of girls aged 5 to 15 years have a mental health disability compared with 3.4% in our younger control group and 5.6% among our control-group adolescents, a rate that may be higher, and closer to an adult rate, because the oldest girls are 21 years old by the end of the 4 years. The higher rates of disability among the PTSD case younger girls (7.5%) and teens (16.1%) may be caused by either PTSD or the antecedent trauma. The sociodemographic profile of Michigan in general resembles that of the United States as a whole.<sup>52</sup> Although replication with more affluent, privately insured children is needed, it is especially important to study poor children, because they already are at increased risk for poor health. By focusing exclusively on children who are Medicaid recipients, this study indicates that PTSD conveys a risk for health problems above and beyond the risk associated with poverty. Administrative data sets do not distinguish between tentative and confirmed diagnoses, so more in-depth analyses that consider repeated occurrence of individual diagnoses over time or clinical research with laboratory and physical examination data are required to verify that disease states, and not merely care seeking, are occurring at greater rates. Inclusion within a single ICD-9 category of common conditions (eg, colds) with more severe conditions (eg, asthma) obscures estimation of morbidity and mortality for the subset of children with severe diseases but provides an estimation of overall greater morbidity for 2 young age groups that are generally considered to enjoy good health. Categories with prevalence rates that are high because of common, nonserious conditions also may have ORs that overestimate relative risk.<sup>53</sup> Studies with medical clinical samples will provide more precise estimates of the strength of association of trauma and PTSD with a variety of conditions.

There also are strengths to descriptive epidemiology as a preliminary phase of research that are present in this study. Inference is strengthened by having the entire population of cases in the Medicaid sector of the state's populace included rather than a sampling. Although coding errors do occur (eg, as may be the case for the 8-year-old with a pregnancy

code), these likely occur randomly. The pattern of coding reflects actual clinical practice without any of the distortions that can affect practice or documentation in the context of a research study, and the sample size is large enough to provide stringent thresholds for concluding that associations are not likely to be occurring by chance. Based on this analysis, clinical research on the health of children and adolescents that considers the impact of trauma and posttraumatic stress is urgently needed.

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**Posttraumatic Stress Disorder and Physical Comorbidity Among Female Children and Adolescents: Results From Service-Use Data**  
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