

RESEARCH ARTICLE

Probable posttraumatic stress disorder related to the September 11, 2001, terrorist attacks and self-inflicted injury-related hospitalizations and emergency department visits

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Abstract

Self-inflicted injury is a known risk factor for suicide. Previous studies have reported associations between posttraumatic stress disorder (PTSD) and self-inflicted injury; however, this association has not been widely studied among disaster-exposed populations. Among 50,386 enrollees in the World Trade Center Health Registry, a cohort of individuals exposed to the September 11, 2001, attacks in New York City (9/11), we examined longitudinal associations between probable 9/11-related PTSD and hospitalizations and emergency department (ED) visits for self-inflicted injuries that occurred between study enrollment (2003–2004) and 2015. Time-dependent Cox proportional hazard models were used to estimate hazard ratios and 95% confidence intervals (CIs) for associations of time-varying probable 9/11-related PTSD and self-inflicted injury, adjusting for sociodemographic and pre-9/11 mental health symptoms. At study enrollment, 11.0% of enrollees had probable PTSD. Over a median follow-up period of 11.2 years, a total of 171 hospitalizations/ED visits for self-inflicted injury occurred among 146 enrollees. When comparing individuals with probable PTSD to those without probable PTSD, the multivariable-adjusted hazard ratio for self-inflicted injury was 2.45, 95% CI [1.63, 3.66]. Evidence of effect modification by age group was not observed. Our findings suggest that surveillance for PTSD among disaster-exposed populations may help identify individuals at high risk of self-inflicted injury who could benefit from targeted interventions.

Self-inflicted injuries, including suicide attempts and nonsuicidal self-injuries, represent a significant public health concern. Self-inflicted injury is a strong risk factor for suicide (Geulayov et al., 2019) and may itself result in serious bodily harm. The prevalence of self-inflicted

injury is highest in adolescence, with decreases generally observed as individuals enter young adulthood (Moran et al., 2012; Plener et al., 2015). However, the 12-month prevalence of nonsuicidal self-injury among adults is approximately 1% (Klonsky, 2011), and among patients

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who present to hospitals with self-inflicted injury, morbidity and mortality are disproportionately high among older compared to younger patients (Schaffer et al., 2022). Additionally, although increases in emergency department visits for self-inflicted injury in the United States increased among all age groups between 2011 and 2020, the largest proportional increase (30%) was observed among adults aged 65 years and older (Bommersbach et al., 2024). Therefore, there is a need for a thorough understanding of upstream risk factors to mitigate the risks associated with self-inflicted injury over the life course.

Previous research has found that trauma-exposed individuals have a higher risk of self-inflicted injury compared to those who have not experienced trauma exposure; these associations appear to be at least partially mediated through symptoms of posttraumatic stress disorder (PTSD), either alone or via symptoms of comorbid PTSD and depression (Ford & Gomez, 2015; Livingston et al., 2020; Shenk et al., 2010; Smith et al., 2014; Weierich & Nock, 2008). Emotional dysregulation is common among individuals with PTSD (Tull et al., 2007) and is a risk factor for self-inflicted injury (Wolff et al., 2019), suggesting that these behaviors may be a maladaptive coping strategy used to regulate or avoid distressing emotions. Associations between PTSD and self-inflicted injury have been noted in prior literature (Dixon-Gordon et al., 2014; Gradus et al., 2014; Smith et al., 2014), with a meta-analysis showing that individuals with PTSD were approximately twice as likely as those without PTSD to engage in self-inflicted injury (Bentley et al., 2015). Associations between PTSD and suicide attempts have also been consistently observed both in the general population (Kessler et al., 1999; Pietrzak et al., 2012) and among populations with a high prevalence of trauma exposure (Akbar et al., 2023).

The September 11, 2001, terrorist attacks (9/11) on the World Trade Center (WTC) and their aftermath directly exposed hundreds of thousands of community members and rescue and recovery workers (RRWs) to severe psychological trauma (Murphy et al., 2007). Among exposed individuals, increases in PTSD symptoms were noted in the period immediately following the attacks (Galea et al., 2002), and a persistently high prevalence of PTSD symptoms in this population has been noted up to 20 years after the disaster (Bromet et al., 2016; Sisti et al., 2025). Associations between PTSD and self-inflicted injury have not previously been examined among individuals exposed to the WTC attacks; however, previous evidence shows that among exposed individuals, those with PTSD are more likely to report prescription opioid misuse and self-medication with alcohol (Garrey et al., 2020; Takemoto et al., 2021), possibly as coping mechanisms for symptom-related emotional distress (Luciano et al., 2022). Understanding the associations between PTSD

and self-inflicted injury among individuals exposed to the WTC disaster may inform postdisaster surveillance and the prioritization of intervention efforts to mitigate ongoing physical and mental health consequences of the WTC attacks and other mass casualty events.

In the present study, we assessed the associations between 9/11-related PTSD symptoms and hospitalizations and emergency department visits for self-inflicted injuries among the WTC-exposed population, hypothesizing that individuals with probable PTSD would have a higher likelihood of self-inflicted injury. Because of differences in the prevalence of self-inflicted injury throughout the life course, we also assessed whether associations differed by age group.

METHOD

Participants and procedure

The WTC Health Registry, hereafter referred to as the Registry, is a closed, longitudinal cohort established in 2002 to track the long-term physical and mental health effects of exposure to the WTC disaster among RRWs and community members. Eligible RRWs included workers and volunteers involved in rescue, recovery, cleanup, or other disaster-related activities at the WTC site and/or at the Staten Island Fresh Kills Landfill and barges. Eligible community members were residents, workers, students, and passersby in the vicinity of the disaster on 9/11. Enrollment was completed in 2003–2004 when more than 71,000 enrollees (17% of the estimated 410,000 exposed population) responded to a Wave 1 survey querying sociodemographic characteristics, 9/11-related experiences, and health behaviors and outcomes (Murphy et al., 2007). Four additional waves of survey data collection have occurred in the Registry between 2006–2021. The present study used data from the Registry baseline survey in 2003–2004 (Wave 1) and follow-up surveys conducted in 2006–2007 (Wave 2) and 2011–2012 (Wave 3). The Registry protocol was approved by the U.S. Centers for Disease Control and Prevention (CDC) and the New York City Department of Health and Mental Hygiene institutional review boards. Informed consent was obtained verbally from enrollees at the time of enrollment.

Among 71,423 total Registry enrollees, we excluded those who did not reside in New York State (NYS) at any point between 2004 and 2015 ($n = 16,210$), as they were less likely to be hospitalized in NYS; were deceased prior to the Wave 1 survey ($n = 130$); were under 18 years old on 9/11; those with missing data on age ($n = 2,488$); had an incomplete Wave 1 PTSD assessment ($n = 2,180$); or were hospitalized for a self-inflicted injury prior to their Wave 1 survey date ($n = 29$), resulting in a final analytic sample of 50,386 enrollees.

Measures

Self-inflicted injury

We used data from the New York Statewide Planning and Research Cooperation System (SPARCS), an administrative database that includes 95% of statewide hospitalizations and emergency department (ED) visits (NYS Department of Health, n.d.), to identify visits related to self-inflicted injury. To identify Registry enrollees in SPARCS data, a linkage to hospital discharge data between September 2001 and September 2015 was performed based on a matching algorithm that used enrollee name, Social Security number, date of birth, sex, and zip code in hierarchical rounds. Hospitalizations and ED visits for self-inflicted injury were identified using *International Classification of Diseases* (9th rev., clinical modification; ICD-9-CM; CDC, 2011) external cause of injury codes (E-codes; Centers for Medicare and Medicaid Services & National Center for Health Statistics, 2011). The E-codes provide supplemental information about the mechanism and intent of an injury, including those that are self-inflicted. We defined self-inflicted injury as a hospitalization or ED visit where the diagnosis included codes E950–E959, which indicate that the intent of an injury was suicide or intentional self-harm (CDC, 1997).

Probable 9/11-related PTSD

Probable 9/11-related PTSD (hereafter, *probable PTSD*) was assessed at Waves 1, 2, and 3 using the 17-item PTSD Checklist–Specific (Weathers et al., 1993), which was tailored to reflect symptoms associated with the 9/11 WTC disaster. Items on this version were specific to 9/11-related experiences (e.g., “In the past 4 weeks, how much have you been bothered by repeated, disturbing dreams of the events of 9/11?”) and reflected the three PTSD symptom clusters (reexperiencing, avoidance, and hyperarousal) outlined in the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; DSM-IV; American Psychiatric Association, 1994). Respondents rated each item on a 5-level Likert scale ranging from 1 (*not at all*) to 5 (*extremely*), with scores summed (possible range: 17–85) and higher scores reflecting higher symptom levels. Probable PTSD was defined as a score of 50 or higher to reduce the potential for false positives (Blanchard et al., 1996; Terhakopian et al., 2008) and rating at least one reexperiencing symptom, three avoidance symptoms, and two hyperarousal symptoms with a score of 3 (*moderately*) or higher. The 17-item PCL has demonstrated excellent reliability (greater than .90; Weathers et al., 1993). In the primary analysis, we carried forward the last known PCL-S score for enrollees if they were missing

PCL-S scores after the Wave 1 survey (Wang et al., 2009). In this sample, Cronbach’s alpha was .94 at Wave 1.

Covariates

Covariates were selected a priori based upon evidence from the literature and prior subject matter knowledge (Boscarino, 2006; Kimbrel et al., 2014) regarding their potential as confounders of the association between PTSD and self-inflicted injury. Covariates assessed at Wave 1 included age; sex (male, female); race/ethnicity (non-Hispanic White, any other race/ethnicity); educational attainment (high school or less, some college, college graduate and above); marital status (married or live with partner, never married, divorced, widowed); daily smoking status (yes, no); self-reported pre-9/11 depression, anxiety, or other emotional problem (yes, no); and enrollee type (RRW, community member).

Although depressive symptoms were not captured on Registry surveys until Wave 3, we hypothesized that depression that occurred after 9/11 may represent a mediator in the pathway between PTSD and self-inflicted injury and, therefore, adjustment for post-9/11 depression would not be appropriate (Jiang et al., 2021). However, we hypothesized that self-reported mental health symptoms that occurred before 9/11 were likely to be confounders in the association between PTSD and self-inflicted injury, and we adjusted for them in the main analyses.

Data analysis

We describe Wave 1 sociodemographic characteristics of the overall sample and stratified by probable PTSD status. To assess the association between probable PTSD and self-inflicted injury, an extended Cox proportional hazard model with repeated outcomes and time-varying exposure was used to estimate hazard ratios (HRs) and 95% confidence intervals (CIs). A counting process was utilized to measure the repeated outcomes (Andersen & Gill, 1982). To account for correlations between observations within subjects, robust sandwich estimates were used to calculate standard errors (Allison, 2010). Person-time was calculated from the beginning of the follow-up period (i.e., the study enrollment date or discharge date from the previous hospitalization or ED visit for self-inflicted injury) until the earliest date of death, study withdrawal, or end of follow-up (September 30, 2015). Multivariable models adjusted for all previously listed covariates. To assess whether age moderated the association between probable PTSD and self-inflicted injury, we stratified the analysis by age group (18–30 years, 31–40 years, 41–50 years, and 51 years or

older). Tests of interaction by age group were conducted in the full model by assessing the statistical significance of a product term between age group and probable PTSD status. The proportional hazards assumption was assessed using the Schoenfeld residuals method (Schoenfeld, 1982); we did not find evidence that the assumption was violated. Multivariable-adjusted models excluded 1,195 (2.4%) of enrollees missing data on any covariate. Statistical analyses were performed using SAS (Version 9.4). In the main analyses, missing values for PCL-S scores after Wave 1 were addressed by carrying forward the last nonmissing score. As this method may bias the results (Little et al., 2012), we conducted a sensitivity analysis that excluded person-time when PCL-S scores were unknown.

RESULTS

Table 1 presents sociodemographic and other select characteristics of the analytic sample. Of the 50,386 study enrollees, 5,537 had probable PTSD at Wave 1 (11.0%). Enrollees were predominantly men (59.4%), non-Hispanic White (60.4%), and had graduated from college (48.8%). Over half of the participants were married or lived with a partner (60.5%) and were WTC RRWs (58.2%). The prevalence of probable PTSD at Wave 1 was highest in individuals aged 41–50 years (12.6%) and those older than 50 years (12.2%). The median follow-up time was 11.2 years. During the follow-up period, 171 hospitalizations and/or ED visits for self-inflicted injury occurred among 146 enrollees.

Table 2 presents the unadjusted and multivariable-adjusted hazard ratios for the association between probable PTSD and self-inflicted injury. In the unadjusted analyses, the risk of self-inflicted injury was nearly 3 times higher among enrollees with probable PTSD compared to those without probable PTSD, $HR = 2.92$, 95% CI [2.01, 4.24]. After multivariable adjustment, probable PTSD was associated with a nearly 2.5-fold increased risk of self-inflicted injury, $HR = 2.45$, 95% CI [1.63, 3.66]. When stratified by age group, associations were observed among enrollees older than 30 years of age at enrollment, 31–40 years: $HR = 2.95$, 95% CI [1.26, 6.90]; 41–50 years: $HR = 3.31$, 95% CI [1.60, 6.85]; older than 50 years: $HR = 2.62$, 95% CI [1.14, 6.02]. We did not observe associations between probable PTSD and self-inflicted injury among enrollees who were 18–30 years of age at the Wave 1 survey, $HR = 1.02$, 95% CI [0.42, 2.48], though the 95% confidence intervals for the hazard ratios in age group overlapped with those for older age groups, and the test of interaction was not significant, $p = .310$.

In the sensitivity analysis, we did not carry forward the last PCL-S observation if the subsequent PCL-S

score was missing, and we excluded enrollees who only had PCL-S scores available for the Wave 1 survey. The number of hospitalizations and ED visits related to self-inflicted injury decreased from 171 occurrences to 98. The multivariable-adjusted hazard ratio between probable PTSD and self-inflicted injury in the sensitivity analyses was similar to the hazard ratio in the main analysis, $HR = 2.65$, 95% CI [1.62, 4.33].

DISCUSSION

Terrorist attacks are violent, unpredictable events that are perpetrated with the intent to intimidate civilian populations and can result in trauma exposure for civilians and first responders. Mental health consequences of terrorist attacks on exposed individuals include high rates of depression and PTSD (North et al., 2011; Paz Garcia-Vera et al., 2016), and some evidence suggests that mass acts of violence are more strongly linked to poor mental health outcomes than other types of disasters (Norris et al., 2002). Associations between PTSD and suicidal ideation have been reported among civilian and responder populations following terrorist attacks (Galea et al., 2005; Nourry et al., 2023), but to our knowledge, the association between disaster-related PTSD and self-inflicted injury among individuals exposed to these events has not previously been studied. In the present study with a large cohort of adult enrollees exposed to the 9/11 WTC attacks, we found evidence of significantly higher risk (approximately 2.5-fold) for hospitalizations and ED visits for self-inflicted injury among those with 9/11-related probable PTSD. Although the associations between PTSD and self-harm have been observed in other populations, to our knowledge, our study is the first to examine this association among disaster-exposed individuals, offering insight into a previously underrepresented area of the literature.

Our findings are consistent with previous literature reporting associations between PTSD and self-inflicted injury in other populations (Bentley et al., 2015). The mechanism of the association between PTSD and self-inflicted injury is not fully understood, though hypotheses have been proposed. A review paper by Klonsky (2007) summarized that deliberate self-injury may serve multiple functions that are not mutually exclusive, including as a means to alleviate negative affect. Individuals with PTSD often struggle with emotional dysregulation (Ehring & Quack, 2010), the inability to manage emotional states or responses in a way that interferes with goal-directed activity (Thompson, 1994). Intense and fluctuating emotions related to PTSD may be overwhelming; self-harm may be used as a maladaptive coping mechanism to manage these emotions (Brereton & McGlinchey, 2020;

TABLE 1 Characteristics of study sample, by probable September 11, 2001, terrorist attacks (9/11)–related posttraumatic stress disorder (PTSD) status, assessed at Wave 1

Characteristic	Overall		Probable 9/11-related PTSD at Wave 1			
			Yes		No	
	<i>N</i> ^a	%	<i>n</i>	%	<i>n</i>	%
Total	50,386	100.0	5,537	11.0	44,849	89.0
Age (years)						
18–30	6,858	13.6	553	8.1	6,305	91.9
31–40	14,180	28.1	1,341	9.5	12,839	90.5
41–50	15,470	30.7	1,943	12.6	13,527	87.4
> 50	13,878	27.5	1,700	12.2	12,178	87.8
Sex						
Male	29,914	59.4	2,744	9.2	27,170	90.8
Female	20,472	40.6	2,793	13.6	17,679	86.4
Race/ethnicity						
Non-Hispanic White	30,433	60.4	2,264	7.4	28,169	92.6
Other race/ethnicity ^b	19,953	39.6	3,273	16.4	16,680	83.6
Educational attainment						
High school or less	12,971	25.9	2,158	16.6	10,813	83.4
Some college	12,679	25.3	1,496	11.8	11,183	88.2
College graduate and above	24,430	48.8	1,839	7.5	22,591	92.5
Marital status						
Married or live with partner	30,266	60.5	2,825	9.3	27,441	90.7
Never married/divorced/widowed	19,722	39.5	2,658	13.5	17,064	86.5
WTC rescue/recovery worker status						
Rescue/recovery worker	21,058	58.2	2,189	10.4	18,869	89.6
Community member	29,328	41.8	3,348	11.4	25,980	86.5
Pre-9/11 mental health symptoms						
Yes	4,273	8.6	777	18.2	3,496	81.8
No	45,603	91.4	4,716	10.3	40,886	89.7
Daily cigarette smoking						
Yes	5,019	10.0	855	17.0	4,164	83.0
No	45,185	90.0	4,644	10.3	40,541	89.7

Note: WTC = World Trade Center. Two-sided *p* values from chi-squared tests comparing characteristics among participants with and without probable PTSD were all < .001.

^aCategory totals may not equal 50,386 due to missing data on some covariates.

^bIncludes non-Hispanic Black, Hispanic, non-Hispanic Asian, non-Hispanic other, non-Hispanic multiracial.

Klonsky, 2007). Therefore, PTSD may increase vulnerability to self-inflicted injury, as individuals experiencing PTSD symptoms may use self-harm to attempt to manage intense emotional distress.

Consistent with previous research showing a higher prevalence of self-harm among younger age groups (Moran et al., 2012; Plener et al., 2015), the rates of self-inflicted injury in our study were highest among individuals who were 18–30 years of age at the time of cohort enrollment. However, we did not find evidence that associations between PTSD and self-inflicted injury were modified by age group, suggesting that the

higher likelihood of self-inflicted injury among younger adults is not attributable to stronger associations with PTSD among these individuals relative to those in older age groups. To reduce morbidity related to self-inflicted injury among younger individuals, postdisaster monitoring and intervention efforts should also give consideration to other established risk factors for self-harm among adolescents and young adults, including adverse childhood experiences and peer conflict (McEvoy et al., 2023).

Although the association between PTSD and self-inflicted injury has not previously been examined among the WTC disaster-exposed population, Giesinger et al.

TABLE 2 Hazard ratios (HR) and 95% confidence intervals (CIs) for associations between probable posttraumatic stress disorder related to the September 11, 2001, terrorist attacks and self-inflicted injury–related hospitalization and emergency department (ED) visits, overall and stratified by age category

Age at Wave 1 (years)	Enrollees (N)	Events (n) ^a	Person-years (n)	Unadjusted HR	95% CI	Adjusted HR ^b	95% CI
All	50,386	171 ^c	565,340	2.92	[2.01, 4.24]	2.45	[1.63, 3.66]
18–30	6,858	46	78,245	1.46	[0.61, 3.49]	1.02	[0.42, 2.48]
31–40	14,180	49	161,211	3.70	[1.79, 7.63]	2.95	[1.26, 6.90]
41–50	15,470	47	174,975	4.24	[2.16, 8.31]	3.31	[1.60, 6.85]
> 50	13,878	29	150,909	2.91	[1.28, 6.62]	2.62	[1.14, 6.02]

^aNumber of hospitalizations/ED visits related to self-inflicted injury. Enrollees may have experienced more than one event.

^bAdjusted for age, sex, race/ethnicity, educational attainment, marital status, daily smoking status, rescue/recovery worker status, pre–September 11, 2001, terrorist attack (9/11) mental health symptoms.

^cThe total number of events in multivariable analysis was 169 due to missing data on covariates.

(2020) reported that time-varying PTSD was associated with a risk of suicide deaths among WTC responders. A smaller, cross-sectional study also noted an association between post-9/11 PTSD and suicidal thoughts and behaviors 3 years after the disaster, though these analyses were not adjusted for potential confounders (Xue et al., 2022). Other studies among individuals exposed to the WTC disaster have demonstrated an increased risk of depression (Adams et al., 2019), substance misuse (Garrey et al., 2020; Takemoto et al., 2021), and lower levels of social support (Liu et al., 2022) among individuals with 9/11-related PTSD; these factors may partially mediate the associations between PTSD and self-inflicted injury. Understanding these interconnected risk factors is crucial for developing targeted interventions to reduce self-inflicted injury in this population and warrants further study.

Our study benefits from several strengths. The outcome of interest was defined using administrative hospital data, minimizing bias due to self-report. We also benefited from a long follow-up period and a relatively large sample size. In contrast to cross-sectional analyses in many studies of PTSD and self-harm, we collected data on longitudinal, repeated measurements of PTSD symptoms, which enabled us to assess the association between time-varying probable PTSD and self-inflicted injury over a period of up to 12 years. Although many previous studies of PTSD and self-harm have been conducted among veterans and treatment-seeking individuals (Bentley et al., 2015; Gradus et al., 2014), our study suggests that findings of a positive association are generalizable to other populations, including disaster-exposed civilians and responders.

This study has several limitations that must be acknowledged. First, SPARCS does not include data on hospitalizations or ED visits outside of NYS or those at federal or psychiatric hospitals; therefore, the generalizability of our study is limited. We also lacked data on some potential confounders in the association between PTSD and self-inflicted injury, including pre-9/11 substance use and prior

self-harm behaviors, and we had limited data on pre-9/11 mental health symptoms. Additionally, the administrative data used in this study lacked information on the motivation and circumstances for self-inflicted harm behaviors leading to hospitalization or ED visits, so we cannot separately assess suicide attempts and nonsuicidal self-inflicted injuries, which represent distinct phenomena (Nock, 2010) and may differ in terms of their associations with PTSD. Though our use of self-reported PTSD symptoms may reduce misclassification due to differential mental health care access among enrollees, a diagnostic interview is the gold standard to identify individuals with PTSD. As our identification relied on clinical codes to identify hospital visits for self-inflicted injury, misclassification of our outcome may have occurred if E-codes were missing or did not accurately reflect the cause of injury. For example, some self-inflicted injuries may have been classified as accidental injuries and vice versa.

Our findings have implications for efforts to reduce self-harm among WTC-exposed populations. Monitoring and treatment for a range of WTC-related conditions, including PTSD, are provided at no out-of-pocket cost to affected community members and RRWs through the federally funded World Trade Center Health Program (WTCHP). Among WTCHP enrollees, screening for PTSD symptoms, as well as for self-injurious thoughts and behaviors in those with PTSD, may enable timely intervention for vulnerable individuals. Examples of potential interventions may include preventive efforts by the treatment of PTSD symptoms or by promoting healthy coping strategies among individuals with PTSD (Heffer & Willoughby, 2017) through cognitive behavioral therapies (Witt et al., 2021). Although barriers to mental health care have previously been reported among individuals enrolled in the WTCHP (DePierro et al., 2021), our results underscore the importance of increasing access to treatments for WTC-related mental health sequelae. The findings from our analysis are also relevant to disaster-exposed populations that may

also have a high prevalence of PTSD and may benefit from efforts to prevent self-harm.

AUTHOR NOTE

Sean Locke and Julia Sisti contributed equally to this work.

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OPEN PRACTICES STATEMENT

The study reported in this article was not formally pre-registered. World Trade Center Health Registry Data may be made available following review of applications to the Registry from external researchers. New York Statewide Planning and Research Cooperation System (SPARCS) data may be requested from the New York State Department of Health. The data are not publicly available due to privacy or ethical restrictions.

AUTHOR CONTRIBUTIONS

Sean Locke: Conceptualization, Methodology, Data curation, Writing - original draft, Writing - review & editing, Formal analysis; **Julia Sisti:** Conceptualization, Methodology, Formal analysis, Validation, Writing - original draft, Writing - review & editing; **Erin Takemoto:** Conceptualization, Methodology, Supervision, Writing - original draft, Writing - review & editing; **Kacie Seil:** Conceptualization,

Data curation, Writing - review & editing; **Cristina Pollari:** Writing - review & editing; **James E. Cone:** Writing - review & editing; Jiehui Li: Writing - review & editing, Supervision.

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