

# Predicting Teen Dating Violence Perpetration

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abstract

**OBJECTIVES:** With our study we aimed to (1) understand what factors uniquely conferred risk for physical and sexual forms of teen dating violence (TDV) perpetration and (2) create a screening algorithm to quantify perpetration risk on the basis of these factors.

**METHODS:** A total of 1031 diverse public high school students living in Southeast Texas participated in our study (56% female; 29% African American, 28% white, and 31% Hispanic). Self-report measures concerning TDV and associated risk factors were completed annually for 6 years.

**RESULTS:** Results suggested that family violence (domestic violence exposure, maltreatment) together with deficits in conflict resolution incrementally improved our forecasts above and beyond lifetime history of physical TDV perpetration (net reclassification improvement = 0.44; 95% confidence interval [CI] = 0.30–0.59). Meanwhile, a violent dating history (TDV sexual perpetration, sexual victimization, and emotional perpetration) and acceptance of TDV incrementally improved our models for forecasting sexual forms of perpetration (net reclassification improvement = 0.41; 95% CI = 0.24–0.58). These models adequately discriminated between future perpetrators and nonoffenders (area under the curve statistic >0.70; 95% CI: 0.69–0.74). Overall, adolescents with positive test results on our algorithms were over twice as likely to perpetrate dating violence over the course of 6 years.

**CONCLUSIONS:** Our study represents one of the first applications of reclassification analyses to psychosocial research in a pediatric population. The result is a theoretically informed, empirically based algorithm that can adequately estimate the likelihood of physical and sexual TDV perpetration during vulnerable developmental periods. These findings can immediately aid emerging preventive initiatives for this increasing public health concern.



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Dr Cohen and Ms Menon conceptualized and designed the study, conducted all analyses, drafted the initial manuscript, and reviewed and revised the manuscript; Dr Shorey reviewed and revised multiple drafts of the manuscript and provided content expertise on teen dating violence; Dr Temple designed the original study that provided the data for the current study, coordinated and supervised data collection, and critically reviewed the manuscript; and all authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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**WHAT'S KNOWN ON THIS SUBJECT:** Because of the deleterious consequences of teen dating violence (TDV), identifying which adolescents are most likely to perpetrate violent behavior is an important public health priority. To date, ~50 risk factors for TDV perpetration have been identified.

**WHAT THIS STUDY ADDS:** Using a panel study design and translational analytic approach, we identified which factors conferred the greatest risk for prospective physical and sexual TDV perpetration. With our proposed algorithms, we offer the first empirically based assessment tools for TDV perpetration.

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Adolescents exposed to physical and sexual forms of teen dating violence (TDV) are at risk for a myriad of chronic health issues.<sup>1-3</sup> In the last decade, federal organizations have called for increased attention on TDV to address this increasing public health concern.<sup>4,5</sup> An important priority for researchers with this agenda is to identify individuals who are at greatest risk to perpetrate TDV. An impressive response by the research community to these initiatives has resulted in the identification of 53 correlated liabilities for prospective TDV perpetration.<sup>6</sup> This burgeoning area of research now needs to be synthesized so that prevention initiatives aimed at reducing the public health burden of TDV can capitalize on these significant research gains.

Across a number of explanatory models, there is some consensus concerning the developmental underpinnings for TDV perpetration.<sup>7-9</sup> Early childhood adversities, both with regard to family violence (ie, maltreatment, domestic violence [DV] exposure<sup>10-12</sup>) and poverty exposure,<sup>13,14</sup> represent well-documented risk factors for TDV perpetration across theoretical and empirical explanatory models. Parenting styles<sup>15,16</sup> and unstable romantic relationships<sup>17</sup> are more proximal risk factors for TDV perpetration potentially stemming from these early childhood adversities. As one ages into adolescence, friends also influence the formation of intimate adolescent relationships and behaviors and contribute toward adolescents' own TDV perpetration.<sup>18</sup> Finally, more recent theories<sup>19</sup> focus heavily on modifiable individual difference factors as explanatory causes of TDV perpetration. These theories suggest that emotional (eg, hostility<sup>20</sup>), mental health

(eg, internalizing disorders and substance use<sup>21</sup>), and cognitive factors and/or beliefs (eg, acceptability of relationship violence<sup>20</sup>) predict prospective adolescent TDV perpetration.

Although these studies reveal domains of risk associated with TDV perpetration, it is challenging to translate these findings into a preventive framework. It may be that more proximal risk factors attenuate the longitudinal effect of more distal risk factors<sup>22,23</sup> and subsequently offer the strongest signal for TDV perpetration risk. On the other hand, a diversity of risk pathways may stem from early childhood experiences (ie, equifinality<sup>24</sup>), making it difficult to know which proximal risk factors to target in screening initiatives for TDV perpetration. Therefore, early childhood adversities may represent a more homogeneous vulnerability for TDV perpetration and function as the best indicators for violent dating behaviors. Complicating the picture further is the fact that answers to these questions may vary on the basis of demographics (eg, sex, race), perpetration history, and TDV perpetration subtype (eg, physical or sexual forms of violence) because there are few longitudinal studies in which researchers have adequately tested these potential moderating variables.

Formal tests of incremental validity can help prioritize the most salient risk factors for TDV perpetration. Traditionally, receiver operating characteristic (ROC) approaches are preferred to solely using regression-based techniques to determine the appropriateness of a screening protocol.<sup>25</sup> However, area under the curve (AUC) statistics may not adequately capture the incremental impact of additional indicators. Instead, reclassification analyses may be a more sensitive approach for determining whether a novel indicator should be included within a multi-indicator screening

approach.<sup>26</sup> Despite the common use of reclassification analyses for testing screening solutions for other health conditions,<sup>27-29</sup> there are few studies in which researchers have used them with regard to psychosocial outcomes,<sup>30</sup> and there are no studies in which they have been used within the context of TDV.

With our study we aimed to create the first algorithms for physical and sexual TDV perpetration. We examined theoretically relevant, empirically validated predictors of TDV perpetration in a large sample of ethnically and racially diverse adolescents as they transitioned into emerging adulthood, a high-risk developmental transition for TDV perpetration.<sup>18,31</sup> We examined whether assessing these distinct risk factors led to better forecasts for future TDV perpetration compared with assessing TDV perpetration history alone. With our final algorithms we provide an evidence-based screening tool that can be used to operationalize the likelihood of future TDV perpetration and inform existing TDV prevention programs on the most salient risk factors to target.

## METHODS

### Sample and Study Design

The 6-year longitudinal study was approved by the institutional review board of the University of Texas Medical Branch. Data collection began in the spring of 2010. Recruitment occurred during school hours in courses with mandated attendance. Both written parental consent and adolescent assent were obtained for study participation. Participants were recontacted at the age of 18. The response rate for the overall study was 62% ( $N = 1031$ ). Freshman ( $N = 781$ ) and sophomores ( $N = 250$ ) completed self-report measures concerning TDV experiences as well

**TABLE 1** Descriptive Statistics for Risk Factors and TDV Perpetration

	Measures	Mean (SD) or %
Perpetration during study	TDV-P	35.89
	TDV-S	23.66
Parenting	TP parental relationship quality	9.87 (3.63)
	TP parental monitoring	5.21 (1.94)
Family violence	Maltreatment	39.33 (13.46)
	DV exposure	2.86 (1.31)
Poverty-exposure	Material poverty exposure	0.72 (0.83)
	Parental education	1.66 (0.78)
	TP family income	2.06 (0.56)
Friend environment	Friend TDV perpetration	5.62 (2.28)
	Friend substance use	5.23 (1.98)
Mental health	Depression	20.46 (4.57)
	GAD	8.17 (4.22)
	PTSD	6.79 (1.36)
	Substance use	7.2 (1.69)
Sociocognitive factors	Hostility	11.72 (3.77)
	Conflict resolution	23.84 (6.83)
	Attitude toward women	29.32 (3.53)
	TDV acceptance	15.43 (5.21)
Dating history	Number of partners	2.56 (1.42)
	Age started dating	13.65 (1.09)
	TDV-P lifetime	21.50
	TDV-S lifetime	12.30
	TDV-P victim	21.70
	TDV-S victim	22.40
	TDV emotional perpetration	19.60

TDV-P and TDV-S: physical and sexual TDV perpetration during the course of the study as measured by the CADRI; TP parental relationship quality: teenager-perceived relationship quality measured by the adapted Attachment to Parents Scale; TP parental monitoring: teenager-perceived parental monitoring as measured by the adapted Parental Supervision Scale; maltreatment: scores on the CTQ-SF; DV exposure: if adolescents witnessed a caregiver physically assault the opposite-sex caregiver; material poverty exposure: sum of how many cars, televisions, and computers the family had growing up; parental education: highest degree earned by a caregiver (0 = some high school; 1 = graduated high school; 2 = some college; 3 = graduated college; 4 = graduate school); TP family income: rating of adolescents' perceptions of whether parents were poor (0 = "money was always a concern"; 1 = "money was sometimes a concern"; 2 = "money was rarely a concern"); friend TDV perpetration: how many friends perpetrated TDV (1 U equals a form of perpetration or multiple friends committing a single form of TDV perpetration); friend substance use: how many friends used alcohol or drugs; depression: CESD-10; GAD: SCARED-GAD Subscale; PTSD: Primary Care PTSD; substance use: Monitoring The Future-Substance Use Subscale; hostility: Symptom Checklist-90-Revised, Hostility subscale; attitudes toward women: Attitudes Toward Women Scale; TDV acceptance: Acceptance of Couples Violence Scale; number of partners: number of lifetime dating partners; age started dating: the age one started dating at baseline; TDV-P lifetime: baseline CADRI measurement, physical perpetration lifetime; TDV-S lifetime: baseline CADRI measure, sexual perpetration lifetime; TDV-P victim: baseline CADRI measurement, physical victimization lifetime; TDV-S victim: baseline CADRI measurement, sexual victimization lifetime; TDV emotional perpetration: baseline CADRI measurement, threatening, relational aggression, and psychological aggression perpetration subscales, standardized scores.

as interpersonal, intrapersonal, and environmental risk factors for TDV perpetration annually for 6 years. While the students attended high school, assessments were completed during school hours in a private classroom. Once students were no longer attending high school, all measures were completed over the Internet. Participants were compensated with a \$10 gift certificate at waves 1, 2, and 3; \$20 at waves 4 and 5; and \$30 at wave 6. Our study was diverse with regard to sex (56% female), ethnicity and race (31%

Hispanic; 29% African American; 28% white), and socioeconomic status (eg, 48% had a caregiver who graduated college). Retention rates from wave 1 were the following: wave 2: 92.5%; wave 3: 85.8%; wave 4: 74.5%; wave 5: 67.0%; and wave 6: 72.7%.

## Measures

### TDV Perpetration

Perpetration of physical and sexual TDV was measured by using the Conflict in Adolescent Dating Relationships Inventory (CADRI).<sup>32</sup>

Adolescents responded with yes or no to questions about their own behavior in their lifetime (wave 1) and in the past year (wave 2–wave 6). Four items assessed physical forms of TDV (eg, "I kicked, hit, or punched him/her") and sexual forms of TDV (eg, "I forced him/her to have sex when he/she didn't want to"), respectively. Items for each subscale from waves 2 to 6 were dichotomized as present or not present and were summed across waves for our dependent variable. If individuals perpetrated physical teen dating violence (TDV-P) or sexual teen dating violence (TDV-S) at any wave, they were identified as perpetrators.

### Parenting

Teenager-perceived parental monitoring was assessed by asking adolescents how important it was for their caregivers to know the following: (1) who their friends are, (2) where they are, and (3) whom they are dating. These 3 questions were adapted from the Parental Supervision Scale.<sup>33</sup> The internal consistency of this scale ( $\alpha$ ) was .74. Four items adapted from the Attachment to Parents Scale<sup>34</sup> were used to assess teenager-perceived parental relationship quality. Two questions were used to assess closeness ("Do you feel close to your (1) female caregiver and (2) male caregiver?") and sharing ("Do you share your thoughts and feelings with your (3) mother and (4) father?"), respectively. The internal consistency of this scale was .72. Both scales were assessed at baseline.

### Family Violence

Maltreatment was assessed via the Childhood Trauma Questionnaire-Short Form (CTQ-SF)<sup>35</sup> when adolescents turned 18 years old. The CTQ consists of 5 subscales (5 items each) for physical abuse, sexual abuse, emotional abuse, physical

**TABLE 2** Logistic Regression and AUC Statistics for TDV-P Risk Factors

	Measures	$\beta$	SE <sub>LogReg</sub>	W	AUC	SE <sub>AUC</sub>	D
Baseline model	TDV-P lifetime	.75	0.09	64.53**	0.64**	0.02	0.51 <sup>a</sup>
Parenting	TP parental relationship quality	.13 <sup>b</sup>	0.05 <sup>b</sup>	8.76 <sup>b,**</sup>	0.56 <sup>b,**</sup>	0.02 <sup>b</sup>	0.21 <sup>b,c</sup>
	TP parental monitoring	.01	0.04	0.02	—	—	—
Family violence	Maltreatment	.02 <sup>b</sup>	0.00 <sup>b</sup>	20.05 <sup>b,**</sup>	0.60 <sup>b,**</sup>	0.02 <sup>b</sup>	0.36 <sup>b,c</sup>
	DV exposure	.19 <sup>b</sup>	0.06 <sup>b</sup>	11.04 <sup>b,**</sup>	0.60 <sup>b,**</sup>	0.02 <sup>b</sup>	0.36 <sup>b,c</sup>
Poverty exposure	Material poverty exposure	-.03	0.09	0.09	—	—	—
	Parental education	-.06	0.10	0.37	—	—	—
	TP family income	.34	0.16	4.79 <sup>b,*</sup>	0.55 <sup>b</sup>	0.02 <sup>b</sup>	—
Friend environment	Friend TDV perpetration	.07	0.04	3.85	—	—	—
	Friend substance use	.12 <sup>b</sup>	0.04 <sup>b</sup>	10.14 <sup>b,**</sup>	0.59 <sup>b</sup>	0.02 <sup>b</sup>	0.32 <sup>b,c</sup>
Mental health	Depression	.01	0.03	0.16	—	—	—
	GAD	.02	0.03	0.28	—	—	—
	PTSD	-.02	0.10	0.03	—	—	—
	Substance use	.10	0.09	1.30	—	—	—
Sociocognitive factors	Hostility	.05 <sup>b</sup>	0.02 <sup>b</sup>	6.60 <sup>b,*</sup>	0.60 <sup>b,**</sup>	0.02 <sup>b</sup>	0.36 <sup>b,c</sup>
	Conflict resolution	.13 <sup>b</sup>	0.04 <sup>b</sup>	9.58 <sup>b,*</sup>	0.60 <sup>b,**</sup>	0.02 <sup>b</sup>	0.36 <sup>b,c</sup>
	Attitude toward women	-.01	0.02	0.32	—	—	—
	TDV acceptance	.01	0.02	0.75	—	—	—
Dating history	Number of partners	.07	0.07	1.01	—	—	—
	Age started dating	-.06	0.08	0.65	—	—	—
	TDV-P victim	-.21	0.22	0.93	—	—	—
	TDV-S victim	.29	0.18	2.51	—	—	—
	TDV-S lifetime	.12	0.20	0.30	—	—	—
	TDV emotional perpetration	.20 <sup>b</sup>	0.05 <sup>b</sup>	20.32 <sup>b,**</sup>	0.69 <sup>b,**</sup>	0.02 <sup>b</sup>	0.70 <sup>b,a</sup>

Index tests for TDV-P: TDV-P lifetime: baseline CADRI measurement, physical perpetration lifetime; TP parental relationship quality: adapted Attachment to Parents Scale; teenager-perceived parental monitoring: adapted Parental Supervision Scale; maltreatment: scores on the CTQ-SF; DV exposure: scores from items asking adolescents if they witnessed a caregiver physically assault the opposite-sex caregiver; material poverty exposure: sum of how many cars, televisions, and computers the family had growing up; parental education: highest degree earned by a caregiver (0 = some high school; 1 = graduated high school; 2 = some college; 3 = graduated college; 4 = graduate school); TP family income: rating of adolescents' perceptions of whether parents were poor (0 = "money was always a concern"; 1 = "money was sometimes a concern"; 2 = "money was rarely a concern"); friend TDV perpetration: how many friends perpetrated TDV (1 U equals a form of perpetration or multiple friends committing a single form of TDV perpetration); friend substance use: how many friends used alcohol or drugs; depression: CESD-10; GAD: SCARED-GAD Subscale; PTSD: Primary Care PTSD; substance use: Monitoring The Future-Substance Use Subscale; hostility: Symptom Checklist-90-Revised, Hostility subscale; attitude toward women: Attitudes Toward Women Scale; TDV acceptance: Acceptance of Couples Violence Scale; number of lifetime dating partners; age started dating: the age one started dating at baseline; TDV-P lifetime: baseline CADRI measurement, physical perpetration lifetime; TDV-S lifetime: baseline CADRI measure, sexual perpetration lifetime; TDV-P victim: baseline CADRI measurement, physical victimization lifetime; TDV-S victim: baseline CADRI measurement, sexual victimization lifetime; TDV emotional perpetration: baseline CADRI measurement, threatening, relational aggression, and psychological aggression perpetration subscales, standardized scores. Statistics:  $\beta$ :  $\beta$  weights for each index test derived from logistic regression analyses in which lifetime experiences for physical TDV perpetration were entered in as covariates and prospective physical forms of TDV were the criteria; SE<sub>LogReg</sub>: SEs for  $\beta$  weights; W: Wald statistic for each  $\beta$  weight; AUC: AUC for each index test; SE<sub>AUC</sub>: SE for the AUC statistic; D: Cohen's D statistic for each index test. Cells with a dash indicate that these variables did not achieve significance in the previous step (eg, AUC statistics for parental education are not available because of nonsignificant findings for logistic regression).

<sup>a</sup> Medium effect size.

<sup>b</sup> Clinically significant predictor of outcome above and beyond lifetime history.

<sup>c</sup> Small effect size.

\*  $P < .05$ .

\*\*  $P < .01$ .

neglect, and emotional neglect. In the current study, a composite score across all 5 subscales was used ( $\alpha = .80$ ). Meanwhile, DV exposure was assessed at baseline by asking adolescents if they witnessed a (1) male and/or (2) female caregiver physically assault the opposite-sex caregiver.

### Poverty Exposure

At wave 4, adolescents were asked to rate whether their parents were poor ("money was always a concern"), average ("money was sometimes a

concern"), or well-off ("money was rarely a concern") as an indicator of teenager-perceived family income. In addition, parental education and the sum of (1) how many cars, (2) televisions, and (3) computers the family had growing up (ie, material poverty exposure) served as poverty exposure indices.

### Friend Environment

For friend TDV perpetration, adolescents reported how many of their friends (1 = none of them; 5 =

all of them) perpetrated (1) physical, (2) sexual, or (3) psychological TDV or (4) threatened physical violence. For friend substance use, we asked how many of their friends (1 = none of them; 5 = all of them) (1) used alcohol or (2) used drugs.

### Mental Health

Depression was assessed via the Center for Epidemiologic Studies Depression Scale-10 (CESD-10)<sup>36</sup> ( $\alpha = .85$ ). Generalized anxiety disorder (GAD) was assessed with the GAD subscale of the Screen for Child

**TABLE 3** Logistic Regression and AUC Statistics for TDV-S Risk Factors

	Measures	$\beta$	SE <sub>LogReg</sub>	W	AUC	SE <sub>AUC</sub>	D
Baseline model	TDV-S lifetime	1.49	0.21	49.16**	0.60**	0.02	0.36 <sup>a</sup>
Parenting	TP parental relationship quality	0.13 <sup>b</sup>	0.05 <sup>b</sup>	7.15 <sup>b</sup> **	0.56 <sup>b</sup> **	0.02 <sup>b</sup>	0.21 <sup>b,a</sup>
	TP parental monitoring	0.05	0.04	1.56	—	—	—
Family violence	Maltreatment	0.01 <sup>b</sup>	0.00 <sup>b</sup>	7.86 <sup>b</sup> **	0.60 <sup>b</sup> **	0.02 <sup>b</sup>	0.36 <sup>b,a</sup>
	DV exposure	0.14 <sup>b</sup>	0.06 <sup>b</sup>	6.05 <sup>b</sup> **	0.57 <sup>b</sup> **	0.02 <sup>b</sup>	0.25 <sup>b,a</sup>
Poverty exposure	Material poverty exposure	0.18	0.10	3.30	—	—	—
	Parental education	−0.05	0.11	0.22	—	—	—
	TP family income	0.53 <sup>b</sup>	0.17 <sup>b</sup>	9.39 <sup>b</sup> **	0.57 <sup>b</sup> *	0.02 <sup>b</sup>	0.25 <sup>b,a</sup>
Friend environment	Friend TDV perpetration	0.11 <sup>b</sup>	0.04 <sup>b</sup>	8.98 <sup>b</sup> **	0.61 <sup>b</sup> **	0.02 <sup>b</sup>	0.40 <sup>b,a</sup>
	Friend substance use	0.03	0.04	0.34	—	—	—
Mental health	Depression	0.02	0.03	0.62	—	—	—
	GAD	0.01	0.03	0.09	—	—	—
	PTSD	−0.04	0.08	0.27	—	—	—
	Substance use	0.10	0.08	1.82	—	—	—
Sociocognitive factors	Hostility	0.04	0.02	3.49	—	—	—
	Conflict resolution	11.64 <sup>b</sup>	4.30 <sup>b</sup>	7.31 <sup>b</sup> **	0.58 <sup>b</sup> **	0.02 <sup>b</sup>	0.29 <sup>b,a</sup>
	Attitude toward women	0.03	0.02	2.01	—	—	—
	TDV acceptance	0.05 <sup>b</sup>	0.02 <sup>b</sup>	9.17 <sup>b</sup> **	0.61 <sup>b</sup> **	0.02 <sup>b</sup>	0.40 <sup>b,a</sup>
Dating history	Number of partners	−0.09	0.07	1.42	—	—	—
	Age started dating	−0.01	0.09	0.03	—	—	—
	TDV-P victimization	0.29	0.19	2.21	—	—	—
	TDV-S victimization	0.48 <sup>b</sup>	0.21 <sup>b</sup>	4.97 <sup>b</sup> *	0.60 <sup>b</sup> **	0.02 <sup>b</sup>	0.36 <sup>b,a</sup>
	TDV-P-lifetime	0.28 <sup>b</sup>	0.08 <sup>b</sup>	12.36 <sup>b</sup> **	0.58 <sup>b</sup> *	0.02 <sup>b</sup>	0.29 <sup>b,a</sup>
	TDV emotional perpetration	0.16 <sup>b</sup>	0.04 <sup>b</sup>	19.74 <sup>b</sup> **	0.66 <sup>b</sup> **	0.02 <sup>b</sup>	0.58 <sup>b,c</sup>

Index tests for TDV-P: TDV-P lifetime: baseline CADRI measurement, physical perpetration lifetime; TP parental relationship quality: adapted Attachment to Parents Scale; teenager-perceived parental monitoring: adapted Parental Supervision Scale; maltreatment: scores on the CTQ-SF; DV exposure: scores from items asking adolescents if they witnessed a caregiver physically assault the opposite-sex caregiver; material poverty exposure: sum of how many cars, televisions, and computers the family had growing up; parental education: highest degree earned by a caregiver (0 = some high school; 1 = graduated high school; 2 = some college; 3 = graduated college; 4 = graduate school); TP family income: rating of adolescents' perceptions of whether parents were poor (0 = "money was always a concern"; 1 = "money was sometimes a concern"; 2 = "money was rarely a concern"); friend TDV perpetration: how many friends perpetrated TDV (1 U equals a form of perpetration or multiple friends committing a single form of TDV perpetration); friend substance use: how many friends used alcohol or drugs; depression: CESD-10; GAD: SCARED-GAD Subscale; PTSD: Primary Care PTSD; substance use: Monitoring The Future-Substance Use Subscale; hostility: Symptom Checklist-90-Revised, Hostility subscale; attitude toward women: Attitudes Toward Women Scale; TDV acceptance: Acceptance of Couples Violence Scale; number of lifetime dating partners; age started dating: the age one started dating at baseline; TDV-P lifetime: baseline CADRI measurement, physical perpetration lifetime; TDV-S lifetime: baseline CADRI measure, sexual perpetration lifetime; TDV-P victim: baseline CADRI measurement, physical victimization lifetime; TDV-S victim: baseline CADRI measurement, sexual victimization lifetime; TDV emotional perpetration: baseline CADRI measurement, threatening, relational aggression, and psychological aggression perpetration subscales, standardized scores. Statistics:  $\beta$ :  $\beta$  weights for each index test derived from logistic regression analyses in which lifetime experiences for physical TDV perpetration were entered in as covariates and prospective physical forms of TDV were the criteria; SE<sub>LogReg</sub>: SEs for  $\beta$  weights; W: Wald statistic for each  $\beta$  weight; AUC: AUC for each index test; SE<sub>AUC</sub>: SE for the AUC statistic; D: Cohen's D statistic for each index test. Cells with a dash indicate that these variables did not achieve significance in the previous step (eg, AUC statistics for parental education are not available because of nonsignificant findings for logistic regression).

<sup>a</sup> Small effect size.

<sup>b</sup> Clinically significant predictor of outcome above and beyond lifetime history.

<sup>c</sup> Medium effect size.

\*  $P < .05$ .

\*\*  $P < .01$ .

Anxiety Related Emotional Disorders (SCARED)<sup>37</sup> ( $\alpha = .83$ ). Posttraumatic stress disorder (PTSD) was measured with the 4-item Primary Care PTSD questionnaire<sup>38</sup> ( $\alpha = .74$ ). Finally, we used the Monitoring the Future items<sup>39</sup> to assess for lifetime substance use (alcohol, marijuana, cocaine, amphetamines, inhalants, ecstasy, and prescription medication not prescribed by a physician).

### Sociocognitive Factors

Various social, cognitive, and emotional processes were assessed at baseline.

Hostility was assessed via a 6-item subscale of the Symptom Checklist-90-Revised<sup>40,41</sup> ( $\alpha = .82$ ). The 8-item Adolescent Interpersonal Competence Questionnaire<sup>42</sup> was used to assess conflict resolution ( $\alpha = .84$ ). The 11-item Acceptance of Couples Violence<sup>43</sup> was used to assess individual differences in TDV acceptance ( $\alpha = .88$ ). Attitudes toward women were assessed with the 12-item Attitudes Toward Women Scale for Adolescents measure<sup>44</sup> ( $\alpha = .72$ ).

### Dating History

At baseline, we used the physical and sexual dating violence subscales

of the CADRI to determine if teens previously perpetrated physical (TDV-P lifetime) or sexual (TDV-S lifetime) TDV or were victims of physical (TDV-P victim) or sexual (TDV-S victim) TDV. Dimensional scores on these measures were used as predictors (0–4) for TDV-P and TDV-S. The CADRI was also used to assess relational aggression, psychological violence, and threatening behavior. Dimensional scores for these 3 subscales were standardized and subsequently combined to form a composite variable (TDV emotional

**TABLE 4** Reclassification Tables for TDV-P and TDV-S

Iterative Reclassification Analyses											
TDV-P				TDV-S							
Baseline	Predictor	NRI	CI	Baseline	Predictor	NRI	CI				
TDV-P lifetime (TDV-P-L)	DV exposure (DV)	0.29**	0.14–0.44	TDV-S lifetime (TDV-S-L)	TDV acceptance	0.28**	0.11–0.45				
TDV-P-L, DV	Conflict resolution (CR)	0.23**	0.08–0.38	TDV-S-L, TDV acceptance	TDV-S victim (TDV-S-V)	0.41**	0.25–0.57				
TDV-P-L, DV, CR	Maltreatment	0.24**	0.09–0.39	TDV-S-L, TDV acceptance, TDV-S-V	TDV emotional perpetration	0.32**	0.16–0.49				
Final Model Summaries for Algorithms											
Predictors				NRI, %	95% CI	IDI, %	CI, %	<i>C'</i>	CI	H and L $\chi^2$	<i>P</i>
TDV-P final	TDV-P-L, DV, CR, maltreatment			44**	30–59	4**	3–6	0.71	0.65–0.77	10.00	.27
TDV-S final	TDV-S-L, TDV acceptance, TDV-S-V, TDV emotional perpetration			41**	24–58	3**	2–5	0.70	0.66–0.74	13.07	.11

Variable names: TDV-P-L: CADRI measurement, physical perpetration lifetime; TDV-S-L: baseline CADRI measurement, sexual perpetration lifetime; DV: asking adolescents if they witnessed a caregiver physically assault the opposite-sex caregiver; TDV acceptance: Acceptance of Couples Violence Scale; conflict resolution: Adolescent Interpersonal Competence Questionnaire; TDV-S-V: CADRI, TDV-S victimization subscale; TDV emotional perpetration: CADRI, composite of relational aggression, psychological violence, and threatening behavior perpetration. Statistics: IDI: integrated differentiation index; *C'*: bootstrapped AUC statistic for multiple predictors; H and L  $\chi^2$ : Hosmer-Lemeshow goodness-of-fit test  $\chi^2$  value; *P*: *P* value for Hosmer-Lemeshow goodness-of-fit test  $\chi^2$  value (higher *P* value equals better fit).

\*\* *P* < .01.

perpetration). Finally, number of partners and age started dating were used as independent indicators of dating history.

### Data Analytic Strategy

Initial logistic regression models were used to examine whether sex, race, or TDV perpetration history influenced the relation between risk factors and perpetration. Because of the number of analyses and the increased burden for having different algorithms for adolescent subpopulations, our significance value was set to .01 for these analyses ( $P \leq .05$  for all other analyses). Next, using logistic regression we examined which indicators predicted TDV-P or TDV-S independent of TDV-P lifetime and TDV-S lifetime, respectively. ROC analyses were used to generate AUCs for all significant risk factors. In the current study, AUCs were seen as statistically significant if the asymptotic 95% confidence interval (CI) did not include 0.50 and reached at least a small effect size (AUC = 0.56).<sup>45</sup> Following other recommendations,<sup>25,46</sup> we used a cutoff of 0.70 to determine clinical

significance. Hanley and McNeil's<sup>47</sup> method was used to identify significant differences between AUCs for our risk factors.

With regard to incremental validity, we used the net reclassification improvement (NRI) index to quantify improvement over our baseline models (TDV-P lifetime and TDV-S lifetime, respectively) by including additional risk factors. When multiple indicators had significant NRIs, the predictor that conferred the greatest model improvement was retained and entered into a new baseline model. Nonsignificant indicators were subsequently eliminated. In the final models we used the NRI, discrimination slope (ie, integrated discrimination index), bootstrapped *C'* statistic, and the Hosmer-Lemeshow goodness-of-fit statistic to provide complementary perspectives concerning the classification performance of our final models, including how misclassification from adding predictors may serve as a cost in our final algorithms.<sup>48</sup>

Finally, diagnostic likelihood ratios (DLRs)<sup>25,49</sup> were calculated as a metric of calibration. Dichotomous variables for each significant indicator were formed (1 = risk

factor present; 0 = risk factor absent) and a composite risk score was summed. In addition to DLRs, positive predictive values (PPVs) and negative predictive values (NPVs) were calculated for all possible scores on the algorithms. DLRs, PPVs, and NPVs were collectively used to provide recommendations concerning whether scores represented minimal risk, subthreshold risk (ie, exceeded the “wait-test” threshold), or surpassed the threshold for perpetration risk (ie, exceeded the “test-treat” threshold).<sup>49</sup> Reclassification analyses were conducted by using R (v3.4.1) and all other analyses used SPSS 24.0 software (IBM SPSS Statistics, IBM Corporation, Armonk, NY).

### RESULTS

Descriptive statistics are presented in Table 1. Risk indicators for TDV-P or TDV-S did not vary as a function of sex, race, or perpetration history ( $P > .01$ ). Thus, algorithms were calculated for the entire sample. Results from our logistic regression and ROC analyses are presented in Tables 2 and 3

**TABLE 5** DLRs and Recommendations for TDV-P and TDV-S Algorithms

Thresholds for Final Algorithms							
Number of Risk Factors for TDV-P				Number of Risk Factors for TDV-S			
0	1	2	3 or 4	0	1	2	3 or 4
DLRs for TDV-P				DLRs for TDV-S			
0.50	0.69	1.27	2.01	0.48	0.79	1.75	3.05
PPVs for TDV-P thresholds				PPVs for TDV-S thresholds			
0.24	0.30	0.44	0.55	0.13	0.21	0.36	0.50
NPVs for TDV-P thresholds				NPVs for TDV-S thresholds			
0.76	0.70	0.56	0.45	0.87	0.79	0.64	0.50
Threshold interpretation				Threshold interpretation			
Minimal risk		Wait-test	Test-treat	Minimal risk		Wait-test	Test-treat
Examples of Screening Cases							
Exemplars	Pretest Probability, %	TDV-P Score Profile	TDV-S Score Profile	DLRs	Posttest Probability, %		
Boy	TDV-P: 20.10 TDV-S: 24.60	TDV-P-L: Y DV: Y CR: N CTQ: Y	TDV-S-L: Y Accept: N TDV-S-V: Y TDV emotional perpetration: Y	TDV-P: 2.01 TDV-S: 3.05	TDV-P: 33.40 TDV-S: 49.90		
Girl	TDV-P: 48.00 TDV-S: 23.20	TDV-P-L: N DV: Y CR: N CTQ: N	TDV-S-L: Y Accept: N TDV-S-V: Y TDV emotional perpetration: Y	TDV-P: 0.79 TDV-S: 3.05	TDV-P: 42.17 TDV-S: 47.95		
Recommendations for Exemplar Screening Cases							
<p>Boy: for both physical and sexual forms of TDV, this boy falls in the “test-treat” range on the basis of the DLR. The PPVs suggest a 50% or greater chance of this individual perpetrating dating violence in the future. Examining the posttest probability, this individual is 50% more likely to perpetrate physical dating violence compared with the base rate sample for adolescent boys (ie, pretest probability) and over 200% more likely to perpetrate sexual forms of dating violence. Available preventive protocols should be targeted toward an individual with this screening profile as soon as possible.</p> <p>Girl: preventive protocols specifically aimed at reducing sexual forms of TDV perpetration should be targeted toward this individual as soon as possible. On the basis of the DLR, we determine that she is at minimal risk for physically perpetrating TDV. Specifically, this individual is at slightly less risk to perpetrate any physical forms of TDV compared with the base rate for adolescent girls (ie, pretest probability). However, similar to the example above, this individual is over 200% more likely to perpetrate sexual forms of TDV perpetration. On the basis of the DLR, we determine that this individual is 3 times more likely to perpetrate TDV than not, and therefore she falls into the “test-treat” category for sexual forms of TDV perpetration.</p>							

Thresholds for final algorithms: number of risk factors for TDV-P and TDV-S are the number of indicators one tests positive for with regard to each form of TDV. For TDV-P and TDV-S lifetime, DV, TDV exposure, and TDV emotional perpetration, the variable was coded as “1” if they reported any history of violence. For maltreatment, it was coded as “1” if the adolescent was above the published cutoffs on any of the 5 subscales on the CTQ. For TDV acceptance and conflict resolution, there are no published cutoffs. Thus, conflict resolution was considered at risk if they rated themselves less than “OK” (ie, <24) and for acceptance of couples violence either agreed with at least 1 form of TDV being acceptable or did not “strongly disagree” with multiple examples of TDV being “unacceptable.” Because none of the indicators in our final models for TDV-P and TDV-S were significantly different ( $P > .05$ ), there was no need to distinguish between risk factors in our final model (eg, scoring positive for maltreatment was treated the same as scoring positive for conflict resolution deficits). DLRs are calculated by the ratio of positive cases for each score over the total number of positive cases divided by the ratio of negative cases for each score over the total number of negative cases. PPVs are the total number of positive scores for each score divided by the total number of people reporting that scoring profile. NPVs are the total number of negative scores for each score divided by the total number of people reporting that scoring profile. Threshold interpretation consists of the recommended thresholds for translational research recommended by Straus et al; being at or above the “test-treat” threshold suggests that services should be delivered immediately, whereas being at or above the “wait-test” threshold suggests subthreshold scores and ongoing monitoring. Minimal risk suggests that prevention resources may not be necessary in the future for individuals with these scoring profiles because of the decreased risk. In the examples of screening cases, the exemplars are of 2 hypothetical screening cases. Pretest probability is the likelihood that one perpetrates violence in the future based on prevalence estimates from our database. Prevalence estimates were derived separately for boys and girls. TDV-P score profile indicates whether individuals scored positive (Y) or negative (N) on individual index tests within the TDV-P screening algorithm. TDV-S score profile indicates whether individuals scored positive (Y) or negative (N) on individual index tests within the TDV-S screening algorithm. DLRs are based on how many risk factors were present. Posttest Probability represents the new likelihood for perpetration once accounting for the pretest probability and DLRs. Recommendations for exemplar screening cases include potential interpretations of the screening profiles described above.

(TDV-P and TDV-S). In addition to lifetime perpetration, 8 and 11 significant predictors emerged for TDV-P and TDV-S, respectively. TDV emotional perpetration better forecasted TDV-P than any other TDV-P indicator ( $P < .05$ ). No other indicator of TDV-P or any TDV-S indicators were significantly different ( $P > .05$ ).

Results from our reclassification analyses are displayed in Table 4.

Although all significant indicators were tested in the model, we only present the highest NRI in each step of the model. For TDV-P, family violence (DV exposure, maltreatment) together with conflict resolution incrementally improved our forecast above and beyond TDV-P lifetime. Interestingly, TDV emotional perpetration, our best indicator of TDV-P based on AUC did not emerge as a significant predictor,

suggesting that TDV-P lifetime significantly attenuated the relation. Meanwhile, a violent dating history (TDV-S victimization, TDV emotional perpetration) and TDV acceptance incrementally improved our model for TDV-S. For both TDV-P and TDV-S, our final models represented ~40% improvement in classifying future TDV perpetration above and beyond past perpetration. Furthermore, our models exceeded our benchmark

for clinical significance ( $C' > 0.70$ ), whereas screening only for lifetime perpetration did not, suggesting that our multi-indicator algorithms were necessary to effectively discriminate between adolescents at risk for TDV perpetration.

DLRs, PPVs, and NPVs are presented in the top panel of Table 5, along with our interpretation of these statistics using “wait-test” and “test-treat” thresholds. In the bottom panel of Table 5, 2 exemplar cases are presented along with further interpretation to illustrate how our algorithms can be used to calculate the likelihood of future perpetration (ie, the posterior probability).

## DISCUSSION

TDV perpetration research has moved “beyond correlates” of risk<sup>6</sup> and validated a wide range of theoretically informed vulnerabilities for prospective TDV perpetration. Yet methodological and analytical approaches typically used in basic research make it challenging for prevention research to capitalize on these gains. In the current study, we sought to stem this fundamental translational gap by identifying which risk factors confer the greatest vulnerability for TDV perpetration during the transition from adolescence to emerging adulthood in a diverse, epidemiologic sample.

With our findings we support screening initiatives for previous TDV perpetration to understand prospective functioning, including future risk of TDV perpetration.<sup>50</sup> Across physical and sexual TDV perpetration, youth who had previously perpetrated TDV were significantly more likely to perpetrate again. In addition to past

perpetration, assessing a limited number of additional risk factors may be important for 2 reasons. First, we demonstrated a near 50% improvement for our prognostic models by including measures of family violence and conflict resolution strategies for physical forms of TDV perpetration and dating violence variables for sexual forms of TDV perpetration. Second, we were able to identify youth at elevated risk for perpetrating TDV for the first time during a high-risk period for this behavior.<sup>18,31</sup> By assessing unique risk factors, prevention researchers are able to calculate the likelihood of prospective TDV perpetration even in the absence of previous or concurrent violent, romantic behaviors.

Social learning theory<sup>51</sup> may provide a context for why family violence (ie, physical forms of DV and abuse) and conflict resolution were unique predictors in the TDV perpetration algorithm for physical violence. An intergenerational transmission hypothesis states that experiencing violence as a child, both directly and indirectly, teaches one to use violence as a means to express oneself, solve problems, or control and dominate another individual.<sup>52,53</sup> Supporting this hypothesis, past researchers found that exposure to harsh or violent parenting in childhood predicts the use of more aggressive strategies when resolving conflicts (ie, poor conflict-resolution skills) in romantic relationships during late adolescence.<sup>54</sup> Thus, both distal and proximal indicators of a social learning explanation incrementally predict repeated and first incidents of physical forms of TDV perpetration.

Importantly, family violence and conflict resolution were also associated with prospective sexual forms of TDV perpetration but did

not incrementally improve our prognostic models. Thus, although inclusion of these variables within developmental models for sexual forms of TDV perpetration is warranted, measuring these variables within screening protocols may not be optimal. Instead, indicators of previous TDV experiences were the strongest predictors. In past research it has been shown that sexual forms of TDV perpetration tend to emerge in middle-to-late adolescence, a later developmental period compared with other forms of TDV.<sup>55–57</sup> As youth exposed to maltreatment are more likely to have violent relationships in early adolescence,<sup>58,59</sup> these deleterious experiences may be stronger signals for sexual forms of TDV perpetration in these youth compared with family violence. Consequently, one’s dating history may not specifically confer risk for sexual forms of TDV perpetration but for later TDV perpetration more broadly. At the same time, that our findings were specific to sexual forms of TDV victimization as opposed to physical forms of TDV victimization suggests that youth may be learning these behaviors through victimization, begin to find them more acceptable, and begin perpetrating themselves. Because there are few studies in which researchers have differentiated between TDV perpetration subtypes, more research is necessary to determine if our findings are specific for TDV behaviors or the developmental timing of TDV more broadly.

Our results should be viewed within the context of some important limitations. First, we did not have temporal information for our risk indicators. Conceptualizations of family violence being more distal in nature is based on theoretical models that posit these adversities as being instrumental in the formation of more proximal risk



factors.<sup>11</sup> Second, we did not know (and therefore could not control for) whether the violence at baseline was perpetrated against the same partner at follow-up. Past researchers have shown that certain perpetrators may only commit violent behavior within the context of a specific relationship.<sup>60</sup> Finally, although a variety of risk factors were assessed, there were some (eg, media exposure<sup>55</sup>) that were not included. Therefore, our algorithms should serve as a baseline that future investigators can use when developing new screening protocols. Replicating our study within applied contexts is necessary for confirming the validity and translational promise of our algorithms.<sup>25</sup>

## CONCLUSIONS

The rise of empirically based TDV-prevention programs parallels the impressive gains of TDV risk factor research.<sup>43,61–63</sup> The majority of these prevention programs are universal, in which trained facilitators are used to deliver material concerning healthy relationships in adolescence.

Although inclusive, universal approaches may deplete important time and financial resources, preventing those at high risk for TDV perpetration from receiving the appropriate intervention dose. Instead, researchers conducting a selective program may be able to do more targeted work by allocating resources to those at highest risk.<sup>64</sup> Although there are significant ethical implications that must be considered when screening in vulnerable pediatric populations (see Keddell<sup>65</sup> for a discussion), the use of predictive risk algorithms is a recommended approach to improve preventive efforts for violence-exposed youth.<sup>66</sup> We believe that using our multi-indicator algorithms can improve selection criteria across preventive TDV programs. Furthermore, it is suggested in our findings that certain youth may be at disproportionate risk for specific TDV perpetration behaviors. Thus, our algorithms can be used for a more targeted approach at the screening stage and for tailoring material in existing prevention curriculums to physical and sexual forms of TDV perpetration.

## ABBREVIATIONS

AUC: area under the curve  
 CADRI: Conflict in Adolescent Dating Relationships Inventory  
 CESD-10: Center for Epidemiologic Studies Depression Scale–10  
 CI: confidence interval  
 CTQ-SF: Childhood Trauma Questionnaire–Short Form  
 DLR: diagnostic likelihood ratio  
 DV: domestic violence  
 GAD: generalized anxiety disorder  
 NPV: negative predictive value  
 NRI: net reclassification improvement  
 PPV: positive predictive value  
 PTSD: posttraumatic stress disorder  
 ROC: receiver operating characteristic  
 SCARED: Screen for Child Anxiety Related Emotional Disorders  
 TDV: teen dating violence  
 TDV-P: physical teen dating violence  
 TDV-S: sexual teen dating violence

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