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Original Article

Risk Factors Associated With Non-Suicidal Self-Injury and Development of a Risk Assessment Model in Adolescents With Depressive Disorders

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Abstract

Background: Non-suicidal self-injury (NSSI) is a clinically important behavior among adolescents with depressive disorders and is associated with adverse psychosocial outcomes and an increased risk of suicide. This cross-sectional study aimed to identify factors associated with NSSI in this population and to develop a clinical risk assessment model for identifying adolescents with depression who may require further safety evaluation. **Methods:** This cross-sectional study was conducted between January 2024 and January 2025. A total of 120 first-episode, treatment-naïve adolescents diagnosed with depressive disorders were enrolled at The Affiliated Xuzhou Oriental Hospital of Xuzhou Medical University. Participants were classified into an NSSI group (n = 82) and a non-NSSI group (n = 38). Demographic, clinical, family, school-related, sleep, and parenting variables were collected through clinical interviews and a structured questionnaire. Depression severity was assessed using the Children's Depression Inventory (CDI). Multivariable logistic regression was performed to identify factors associated with NSSI. Receiver operating characteristic (ROC) curve analysis and the Hosmer-Lemeshow test were used to evaluate the model's discrimination and calibration, respectively. **Results:** Multivariable logistic regression identified severe depression, childhood maltreatment, low family functioning, exposure to school bullying, sleep disturbances, and overprotective or intrusive parenting style as factors independently associated with NSSI (all $p < 0.05$). The risk assessment model showed excellent discrimination, with an area under the curve (AUC) of 0.917 (95% confidence interval (CI): 0.856–0.941). At the optimal predicted-probability cut-off of 0.490, sensitivity was 92.6%, specificity was 84.2%, the Youden index was 0.770, the positive predictive value was 92.8%, and the negative predictive value was 84.1% in the present sample. The Hosmer-Lemeshow test indicated acceptable calibration ($p = 0.819$). **Conclusions:** NSSI was common among adolescents with depressive disorders in this clinical sample. The proposed risk assessment model demonstrated excellent discrimination and acceptable calibration. However, because of the cross-sectional design and single-center sample, the model should be interpreted as a clinical risk-stratification tool rather than as evidence of temporal prediction or causality. External validation in larger, multicenter, longitudinal cohorts is required.

Keywords: adolescents; depressive disorder; non-suicidal self-injury; risk assessment model

Main Points

1. Non-suicidal self-injury (NSSI) was highly prevalent among adolescents with depressive disorders in this first-episode, treatment-naïve clinical sample.

2. Severe depression, childhood maltreatment, low family functioning, school bullying, sleep disturbances, and overprotective or intrusive parenting style were independently associated with NSSI.

3. The risk assessment model showed excellent discrimination and acceptable calibration, but external validation is required before routine clinical implementation.

1. Introduction

Depressive disorder is a prevalent mental health condition characterized by persistent low mood, diminished interest, psychomotor retardation, and reduced energy [1]. Adolescence is a particularly vulnerable developmental period because rapid neurodevelopment, identity formation, academic pressure, and changing family and peer relationships may increase susceptibility to depressive symptoms [2]. In China, depressive symptoms among children and adolescents have reached concerning levels. A recent meta-analysis of 439 studies including 1,497,524 participants reported a pooled prevalence of depressive symptoms of 26.17% (95% CI: 25.00–27.41%) in this population [3].

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Clinically, adolescents with depression frequently present with non-suicidal self-injury (NSSI), a maladaptive behavior that involves deliberate, self-inflicted damage to body tissue without suicidal intent [4,5]. The proposed Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) criteria emphasize repeated intentional self-injury, the absence of suicidal intent, associated interpersonal or emotional precipitants, and clinically significant distress or impairment [1]. NSSI may function as a short-term strategy for regulating overwhelming affect, communicating distress, or reducing feelings of numbness; however, it is also associated with greater psychiatric severity, impaired social functioning, and subsequent suicidal thoughts and behaviors [6,7]. A large-scale review of 256 studies across 28 provinces in China estimated the lifetime prevalence of NSSI among youth to be 24.7% (pooled sample N = 1,088,433) [6].

Because NSSI is commonly embedded in a broader network of individual, family, school, and sleep-related vulnerabilities, risk stratification in adolescents with depression requires variables that are clinically meaningful and feasible to assess. Previous studies have linked NSSI to emotional dysregulation, childhood maltreatment, poor family functioning, peer victimization or bullying, disturbed sleep, and parenting behaviors [8,9,10,11]. Therefore, the present study examined clinical severity, early adverse experiences, family functioning, school bullying, sleep disturbances, and parenting style, while also considering basic sociodemographic and clinical characteristics such as age, sex, duration of illness, residence, educational level, family structure, and family psychiatric history. Given the cross-sectional design, the model developed here is referred to as a risk assessment model rather than a temporal prediction model.

2. Materials and Methods

2.1 Study Subjects

This cross-sectional study enrolled 120 adolescents diagnosed with depressive disorder who received treatment at The Affiliated Xuzhou Oriental Hospital of Xuzhou Medical University between January 2024 and January 2025. A post-hoc power analysis was performed via G*Power, Version 3.1.9.2 (University of Kiel, Kiel, Schleswig-Holstein, Germany). Given w = 0.3 and a total sample of 120 participants, the statistical power reached 0.93. This value exceeds 0.8, confirming that the sample size is adequate. Inclusion criteria were as follows: (1) meeting the diagnostic criteria for depressive disorder according to the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5), confirmed independently by two psychiatrists; (2) first-episode depression with no prior psychiatric treatment; (3) age between 10 and 18 years; and (4) availability of complete clinical and sociodemographic data.

Exclusion criteria were as follows: (1) comorbid intellectual disability or developmental disorder; (2) severe physical illness, such as malignant tumors or chronic organ failure; and (3) a history of suicide attempts within the six months preceding enrollment. The exclusion of recent suicide attempts was intended to focus the analysis on NSSI without recent suicidal behavior and to reduce acute clinical risk during study assessment. Nevertheless, because NSSI and suicidal behavior frequently co-occur, this criterion may have introduced selection bias and is explicitly addressed in the Limitations section.

Written informed consent was obtained from all participants and their legal guardians. The study protocol was reviewed and approved by the Ethics Committee of Xuzhou Oriental People's Hospital (approval number: 20220725010), and the research was conducted in accordance with the Declaration of Helsinki. During assessment, participants who reported acute suicidal ideation, severe distress, or safeguarding concerns were referred for immediate clinical evaluation and crisis management according to institutional procedures.

2.2 Assessments and Variable Definitions

Participants were divided into the NSSI group and non-NSSI group according to the proposed DSM-5 criteria for NSSI, which include deliberate self-inflicted injury without suicidal intent and associated emotional or interpersonal precipitants [1]. Group assignment was based on psychiatric interview and review of clinical records. Data were collected using a structured questionnaire designed for this study and administered by trained research staff. The questionnaire covered demographic characteristics, clinical information, family and school experiences, sleep disturbance, and parenting style. Where standardized scales were not used for psychosocial variables, the operational definitions and binary coding rules are described below to improve reproducibility.

Depression severity was assessed using the Children's Depression Inventory (CDI) [12], which includes 27 items across five domains: low self-esteem, negative mood, interpersonal difficulties, anhedonia, and ineffectiveness. Each item is rated on a three-point scale from 0 to 2, yielding a total score from 0 to 54. In this study, scores <27 were coded as mild-to-moderate depressive symptoms and scores ≥27 were coded as severe depressive symptoms for univariate and multivariable analyses [13]. The Chinese version of the CDI has demonstrated acceptable reliability and validity in Chinese child and adolescent samples.

Childhood maltreatment was coded as present when the adolescent or guardian reported any history of physical abuse, emotional abuse, sexual abuse, neglect, or repeated exposure to domestic violence before the age of 18 years. Family functioning was coded as low when the structured interview indicated persistent family conflict, poor emotional support, or impaired parent-child communication; otherwise, it was coded as high. Exposure to school bullying was coded as present when the adolescent reported repeated verbal, relational, physical, or cyber victimization

by peers during the previous 12 months. Sleep disturbance was coded as present when the adolescent reported persistent insomnia, difficulty maintaining sleep, nightmares, or poor sleep quality lasting at least one month and causing daytime impairment. In this study, sleep disturbance was treated as a symptom domain rather than as a confirmed independent psychiatric comorbidity. Parenting style was classified according to the dominant caregiver pattern reported in the interview. Warm and supportive parenting referred to emotionally responsive and autonomy-supportive parenting, whereas overprotective or intrusive parenting referred to excessive control, restriction of autonomy, or intrusive monitoring. Other parenting patterns were not modeled separately because of the limited sample size, and this simplification is acknowledged as a limitation.

All 120 included participants had complete data for the variables analyzed in this study; therefore, complete-case analysis was performed and no imputation was applied.

2.3 Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics, version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables such as age and duration of illness were expressed as mean ± standard deviation and compared using independent-samples *t*-tests. Categorical variables were expressed as counts and percentages and compared using Pearson chi-square tests; Fisher's exact tests were used when expected cell counts were small. Univariate analyses were considered exploratory. Variables with $p < 0.10$ in univariate analysis and variables considered clinically relevant were considered for entry into the multivariable logistic regression model. The final model was fitted using simultaneous entry of the selected variables. Multicollinearity should be evaluated using tolerance and variance inflation factor (VIF) before final submission. All VIF values were <5.

Model discrimination was evaluated by receiver operating characteristic (ROC) curve analysis, with the area under the curve (AUC) and 95% confidence interval (CI) reported. The optimal cut-off was selected using the maximum Youden index. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated at this cut-off using the present sample. Model calibration was assessed using the Hosmer-Lemeshow goodness-of-fit test. All statistical tests were two-tailed, and $p < 0.05$ was considered statistically significant.

3. Results

3.1 General Demographic and Clinical Characteristics

Among the 120 adolescents with depressive disorders, 82 presented with NSSI behaviors (NSSI group) and 38 did not (non-NSSI group), corresponding to an NSSI prevalence of 68.3% in this clinical sample. No statistically significant differences were found between groups in age, sex, duration of illness, residence, educational level, single-parent family status, only-child status, left-behind experience, or family history of psychiatric disorders (all $p > 0.05$). In contrast, depression severity, childhood maltreatment, family functioning, exposure to school bullying, sleep disturbance, and parenting style differed significantly between the two groups (all $p < 0.05$) (Table 1).

3.2 Multivariable Logistic Regression Analysis

Multivariable logistic regression indicated that severe depression, childhood maltreatment, low family functioning, exposure to school bullying, sleep disturbance, and overprotective or intrusive parenting style were independently associated with NSSI among adolescents with depressive disorders (all $p < 0.05$) (Table 2).

3.3 Risk Assessment Model for NSSI

Based on the multivariable logistic regression coefficients, the following risk assessment model was constructed:

$$\text{Logit}(P) = -4.917 + 0.554X1 + 0.429X2 + 0.661X3 + 0.982X4 + 1.325X5 + 1.012X6$$

$$P(NSSI) = \exp[\text{Logit}(P)]/\{1 + \exp[\text{Logit}(P)]\}$$

where X1 = severe depression (1 = CDI ≥27, 0 = CDI <27), X2 = childhood maltreatment (1 = yes, 0 = no), X3 = low family functioning (1 = yes, 0 = no), X4 = exposure to school bullying (1 = yes, 0 = no), X5 = sleep disturbance (1 = yes, 0 = no), and X6 = overprotective or intrusive parenting style (1 = yes, 0 = warm/supportive parenting).

ROC curve analysis (Fig. 1) showed that the AUC was 0.917 (95% CI: 0.856–0.941), indicating excellent discrimination. The optimal predicted-probability cut-off was 0.490. At this threshold, sensitivity was 0.926, specificity was 0.844, the Youden index was 0.770, PPV was 0.928, and NPV was 0.841 in the present sample. Calibration (Fig. 2) assessed with the Hosmer-Lemeshow goodness-of-fit test yielded $p = 0.819$, indicating acceptable agreement between observed and model-estimated risk. Fig. 2 presents the observed versus predicted count plot for this model, which is not a conventional probability-scale calibration curve for binary logistic regression.

4. Discussion

In this cross-sectional clinical sample, 68.3% of adolescents with depressive disorders reported NSSI. This prevalence is close to that reported by Fan et al. [14], who found NSSI in 63.8% of 152 Chinese adolescents with major depressive disorder. The high proportion observed here may reflect the clinical severity of treatment-seeking ado-

Table 1. Univariate analysis of NSSI in adolescents with depressive disorders.

Variable	NSSI group (n = 82)	Non-NSSI group (n = 38)	t/chi-square	*p*
Age (years)	13.37 +/– 1.23	13.29 +/– 1.10	0.342	0.733
Sex: male	35 (42.68)	16 (42.11)	0.004	0.954
Sex: female	47 (57.32)	22 (57.89)		
Duration of disorder (years)	3.47 +/– 1.24	3.31 +/– 1.15	0.672	0.503
Residence: urban	56 (68.29)	27 (71.05)	0.093	0.761
Residence: rural	26 (31.71)	11 (28.95)		
Educational level: junior high school or below	28 (34.15)	12 (31.58)	0.077	0.781
Educational level: senior high school	54 (65.85)	26 (68.42)		
Depression severity: mild to moderate	19 (23.17)	28 (73.68)	27.808	<0.001
Depression severity: severe	63 (76.83)	10 (26.32)		
Single-parent family: yes	8 (9.76)	5 (13.16)	0.311	0.577
Single-parent family: no	74 (90.24)	33 (86.84)		
Only child: yes	50 (60.98)	20 (52.63)	0.744	0.388
Only child: no	32 (39.02)	18 (47.37)		
Left-behind experience: yes	34 (41.46)	15 (39.47)	0.043	0.837
Left-behind experience: no	48 (58.54)	23 (60.53)		
Childhood maltreatment: yes	25 (30.49)	4 (10.53)	5.646	0.017
Childhood maltreatment: no	57 (69.51)	34 (89.47)		
Family functioning: high	12 (14.63)	22 (57.89)	23.932	<0.001
Family functioning: low	70 (85.37)	16 (42.11)		
Family history of psychiatric disorders: yes	29 (35.37)	14 (36.84)	0.025	0.875
Family history of psychiatric disorders: no	53 (64.63)	24 (63.16)		
Exposure to school bullying: yes	69 (84.15)	18 (47.37)	17.617	<0.001
Exposure to school bullying: no	13 (15.85)	20 (52.63)		
Sleep disturbance: yes	54 (65.85)	16 (42.11)	6.025	0.014
Sleep disturbance: no	28 (34.15)	22 (57.89)		
Parenting style: warm and supportive	20 (24.39)	30 (78.95)	31.799	<0.001
Parenting style: overprotective or intrusive	62 (75.61)	8 (21.05)		

Abbreviations: NSSI, non-suicidal self-injury. Continuous variables are presented as mean ± standard deviation; categorical variables are presented as n (%). Percentages were calculated within each group. Pearson chi-square tests were used for categorical variables and independent-samples *t*-tests for continuous variables.

Table 2. Multivariable logistic regression analysis of factors associated with NSSI.

Variable	Regression coefficient (beta)	Standard error	Wald chi-square	*p*	OR	95% CI for OR
Constant (intercept)	–4.917	0.947	26.959	<0.001	—	—
Severe depression	0.554	0.214	6.730	0.009	1.741	1.145–2.647
Childhood maltreatment	0.429	0.169	6.452	0.011	1.535	1.103–2.137
Low family functioning	0.661	0.251	6.947	0.008	1.937	1.185–3.167
Exposure to school bullying	0.982	0.448	4.807	0.028	2.671	1.110–6.429
Sleep disturbance	1.325	0.380	12.136	<0.001	3.761	1.785–7.925
Overprotective or intrusive parenting style	1.012	0.281	13.023	<0.001	2.752	1.588–4.769

Abbreviations: CI, confidence interval; OR, odds ratio. Reference categories were mild-to-moderate depressive symptoms, no childhood maltreatment, high family functioning, no school bullying, no sleep disturbance, and warm/supportive parenting.

lescents and the inclusion of patients with first-episode depression who had not yet received psychiatric treatment. Nevertheless, because this was a single-center clinical sample, the prevalence should not be generalized directly to community adolescents.

Several demographic variables, including age, sex, residence, educational level, single-parent family status, only-child status, left-behind experience, and family history of psychiatric disorders, did not differ significantly between adolescents with and without NSSI. These null findings should be interpreted cautiously. They may indicate

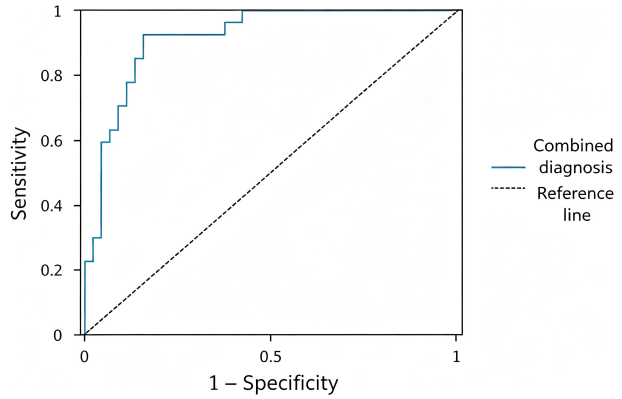


Fig. 1. ROC curve for the NSSI risk assessment model in adolescents with depressive disorders. ROC, receiver operating characteristic.

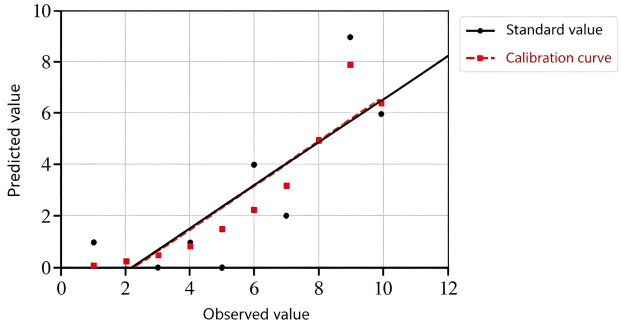


Fig. 2. Observed versus predicted count plot of the NSSI risk-assessment model in adolescents with depressive disorders. This count-based plot is not a conventional probability-scale calibration curve for binary logistic regression.

that, within a clinically depressed and relatively homogeneous sample, proximal clinical and psychosocial factors are more closely associated with NSSI than broad sociodemographic characteristics. Alternatively, the modest sample size may have limited power to detect smaller demographic effects.

The multivariable model identified severe depression as an important factor associated with NSSI. Adolescents with more severe depressive symptoms may experience stronger negative self-perceptions, self-blame, hopelessness, and affective instability [15]. Together with developmental vulnerability, reduced impulse control, and impaired emotion regulation, these features may increase the likelihood that self-injury is used as a maladaptive strategy for short-term affect regulation [16]. Because the present data are cross-sectional, however, this interpretation should be regarded as a plausible clinical pathway rather than a demonstrated causal mechanism.

Childhood maltreatment and school bullying were also associated with NSSI. Both experiences may reflect exposure to repeated interpersonal threat and invalidation, which can undermine self-esteem and increase emotional reactivity [9,17]. Adolescents with limited support may be more likely to use self-injury to manage distress or to express psychological pain. Similarly, low family functioning may indicate insufficient emotional support, poor communication, or chronic family conflict, all of which could contribute to psychological distress and vulnerability to NSSI [18]. These mechanisms were not directly tested in the present study and should be examined in future mediation or longitudinal analyses.

Sleep disturbance was independently associated with NSSI. Poor sleep quality, insomnia, and nightmares have been linked to self-harming behaviors in adolescents [10,19]. Sleep problems may reflect heightened arousal, emotional dysregulation, or greater psychiatric burden; they may also reduce adolescents' capacity to cope with academic and interpersonal stress. However, the directionality cannot be determined from cross-sectional data, and sleep disturbance may be both a correlate and a consequence of depressive symptoms and NSSI.

Overprotective or intrusive parenting style was associated with higher odds of NSSI compared with warm and supportive parenting. Excessive control and intrusion may restrict adolescents' autonomy development and adaptive coping, whereas supportive parenting may buffer stress and improve help-seeking [11]. The binary classification used in this study simplified a complex construct; therefore, future studies should apply validated parenting scales and examine additional parenting dimensions, including rejection, warmth, autonomy support, and behavioral control.

The risk assessment model demonstrated excellent discrimination, and the Hosmer-Lemeshow test indicated acceptable statistical calibration in the present sample. Clinically, the included variables are potentially useful because they capture symptom severity, adverse experiences, family context, school environment, sleep, and parenting. At the same time, several variables are subjective and may require structured assessment, which may limit rapid implementation in emergency or primary care settings. A simplified screening version and external validation are therefore needed before routine use.

Limitations

This study has several limitations. First, the cross-sectional design prevents inference regarding causality or temporal sequence; for example, sleep disturbance may precede, accompany, or follow NSSI. Second, the single-center clinical sample and relatively small sample size limit generalizability. Third, adolescents with recent suicide attempts were excluded. Although this exclusion reduced acute safety risk and allowed a clearer focus on NSSI without recent suicidal behavior, it may have underestimated the overlap between NSSI and suicidality and may limit applicability to high-risk adolescents. Fourth, several key psychosocial variables were measured using a structured questionnaire rather than validated instruments such as stan-

dardized childhood trauma, family functioning, bullying, sleep, or parenting scales; this may reduce measurement precision. Fifth, potentially important confounders, including comorbid anxiety, substance use, social support, neurocognitive function, and medication status, were not fully adjusted. Sixth, multiple univariate comparisons were conducted without formal correction, so the univariate results should be interpreted as exploratory. Seventh, although the events-per-variable ratio was acceptable, no bootstrap, cross-validation, or external validation was performed; therefore, model optimism and overfitting cannot be excluded. Eighth, Fig. 2 displays an observed versus predicted count plot rather than a conventional probability-scale calibration curve for binary logistic regression. This count-based plot cannot support visual evaluation of risk calibration on a 0–1 probability scale for NSSI outcomes, which restricts intuitive graphical assessment of model calibration. Future multicenter longitudinal studies should incorporate standardized assessments, broader covariates, internal validation, and independent external validation. Future multicenter longitudinal studies should incorporate standardized assessments, broader covariates, internal validation, and independent external validation.

Despite these limitations, the study provides clinically relevant evidence that NSSI among adolescents with depressive disorders is associated with symptom severity and modifiable psychosocial factors. Interventions targeting depressive symptoms, family functioning, bullying prevention, sleep problems, and parenting practices may be valuable components of NSSI prevention, but their effectiveness should be tested in prospective interventional studies.

5. Conclusions

NSSI was highly prevalent among adolescents with depressive disorders in this clinical sample. Severe depression, childhood maltreatment, low family functioning, exposure to school bullying, sleep disturbance, and overprotective or intrusive parenting style were independently associated with NSSI. The proposed risk assessment model showed excellent discrimination and acceptable calibration in the present sample. However, given the cross-sectional design and single-center sample, the model should be used cautiously for clinical risk stratification and requires external validation before routine implementation.

Abbreviations

NSSI, non-suicidal self-injury; ROC, receiver operating characteristic; AUC, area under the receiver operating characteristic curve; HL, Hosmer-Lemeshow; CDI, Children's Depression Inventory; CI, confidence interval; OR, odds ratio; PPV, positive predictive value; NPV, negative predictive value; VIF, variance inflation factor; DSM-5, Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition.

Availability of Data and Materials

The datasets generated and analyzed during the current study are available from the corresponding authors on reasonable request, subject to institutional ethics approval and protection of participant privacy.

Author Contributions

QZ; XZ; CZ contributed to the study conception and design. YL; CT collected and curated the data. YZ; ZG performed the statistical analyses. QZ; NJ interpreted the results and drafted the manuscript. All authors reviewed, revised, and approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

The study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of Xuzhou Oriental People's Hospital (approval number: 20220725010). Written informed consent was obtained from all participants and their legal guardians before study participation.

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Conflicts of Interest

The authors declare no conflicts of interest.

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