

Perceived Discrimination Mediates Racial Differences in Impulsivity Among Adolescents from the ABCD Study

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Abstract

Objective: To investigate whether perceived racial and ethnic discrimination mediates the relationship between race and impulsivity, as measured by delay discounting, among adolescents aged 10–11 years.

Methods: Utilizing data from the Adolescent Brain Cognitive Development (ABCD) study release 5.1, we analyzed a sample of 3,857 participants who completed the delay discounting task and perceived discrimination measures at the year-one follow-up. Delay discounting was assessed through a hypothetical monetary choice task, with the area under the curve (AUC) serving as the primary measure of impulsivity—lower AUC scores indicate higher impulsivity. Perceived discrimination was measured using an adapted Perceived Discrimination Scale. Linear mixed-effects regression models examined the direct effects of race, socioeconomic factors, age, and gender on impulsivity, as well as the mediating effect of perceived discrimination.

Results: Black adolescents exhibited significantly lower AUC scores compared to White adolescents ($p < 0.05$), indicating higher impulsivity. When perceived discrimination was included in the model, the effect of being Black on impulsivity was no longer significant, suggesting mediation. Perceived discrimination was associated with lower AUC scores ($p < 0.05$), reflecting greater impulsivity. Males demonstrated higher impulsivity than females ($p < 0.001$), consistent across models.

Conclusion: Perceived racial and ethnic discrimination significantly mediates the relationship between being Black and higher impulsivity in early adolescence. These findings underscore the importance of addressing discrimination to reduce racial disparities in impulsivity and associated risk behaviors. Interventions focusing on both systemic factors contributing to discrimination and enhancing individual coping strategies are crucial for promoting equitable developmental outcomes among minority adolescents.

Background

Impulsivity is a complex trait characterized by actions that are poorly conceived, prematurely expressed, unduly risky, or inappropriate to the situation, often resulting in undesirable outcomes.¹ One widely used behavioral measure of impulsivity is delay discounting, which assesses the tendency to devalue rewards as the delay to their receipt increases.² Individuals who exhibit steeper delay discounting are more likely to prefer smaller immediate rewards over larger delayed rewards, reflecting difficulties in self-control and future-oriented decision-making.³ Steeper delay discounting has been associated with various maladaptive behaviors, including substance use, risk-taking, and externalizing psychopathology.^{4,5}

Adolescence is a critical period for the development of self-regulation and impulse control.⁶ During this time, significant neurodevelopmental changes occur in brain regions involved in reward processing and executive function.⁷ Understanding factors that influence impulsivity during adolescence is essential for identifying at-risk populations and informing interventions aimed at promoting healthy development.⁸

Research indicates that racial and ethnic disparities exist in measures of impulsivity and related outcomes.⁹ For example, some studies have found that Black adolescents exhibit higher levels of impulsivity compared to their White counterparts.⁹⁻¹¹ These disparities may contribute to differences in risk behaviors and mental health outcomes. Socioeconomic factors, such as family income and educational opportunities, partially explain these differences; however, they do not fully account for the observed disparities.¹² Perceived racial and ethnic discrimination is a chronic stressor that adversely affects mental health and behavioral outcomes among adolescents.¹³⁻¹⁵ Experiences of discrimination have been linked to increased psychological distress, substance use, and engagement in risky behaviors.¹⁶⁻¹⁹ The stress resulting from discrimination may impair self-regulatory capacities, leading to greater impulsivity.²⁰ The allostatic load model posits that chronic exposure to stressors like discrimination can disrupt physiological systems, potentially affecting cognitive functions involved in decision-making.²¹

The transactional model of stress and coping suggests that discrimination influences behavior by affecting cognitive appraisal and coping strategies.²² Adolescents who perceive discrimination may adopt maladaptive coping mechanisms, including impulsive decision-making, as a means to manage stress.²³ Furthermore, the burden of discrimination may exacerbate existing vulnerabilities related to socioeconomic disadvantages, amplifying their impact on impulsivity.²⁴

Despite evidence linking perceived discrimination to negative behavioral outcomes, few studies have examined its role in mediating racial disparities in impulsivity, particularly using objective measures like delay discounting. Understanding whether perceived discrimination contributes to racial differences in impulsivity could inform targeted interventions aimed at mitigating its effects.

The present study aims to address this gap by investigating whether perceived racial and ethnic discrimination mediates the relationship between race and delay discounting among adolescents. Using data from the Adolescent Brain Cognitive Development (ABCD) study, a large and diverse cohort across the United States,^{25,26} we examine associations between race, perceived discrimination, and impulsivity as measured by delay discounting. We hypothesize that Black adolescents will exhibit steeper delay discounting rates compared to White adolescents and that this relationship will be mediated by experiences of perceived discrimination.

Methods

Study Population

This study used data from the Adolescent Brain Cognitive Development (ABCD) study, a longitudinal investigation of child and adolescent brain development across the United States. The study's baseline sample included 11,868 participants aged 9-10 years. For the current analysis, we used data from ABCD release 5.1, focusing on participants who were re-assessed at the year-one follow-up (ages 10-11). Demographic data were collected at baseline, while delay discounting and perceived discrimination measures were collected at the year-one follow-up.

Participants were included in the analysis if they passed the Johnson-Bickel criteria, which ensures the internal validity of responses on the delay discounting task. A total of 4211 participants passed the criteria, and after accounting for missing data on predictor variables and outcomes, the final sample consisted of 3857 participants.

Delay Discounting Task

Delay discounting, a measure of impulsivity, was assessed using a hypothetical monetary choice task in which participants chose between smaller immediate rewards and larger delayed rewards. The ABCD delay discounting task presents seven delay periods: 6 hours, 1 day, 1 week, 1 month, 3 months, 1 year, and 5 years. Participants

completed six trials for each delay period, with the choice options adjusting based on previous responses. For instance, if a participant selected the immediate reward, the value of the immediate option decreased in the next trial; if they selected the delayed reward, the value of the immediate option increased.

This process identified the "indifference point," which is the immediate amount that participants deemed equivalent to receiving \$100 after a specified delay. The area under the curve (AUC) of the indifference point versus delay curve was used as the primary summary metric of delay discounting. A lower AUC score indicates steeper discounting, which is associated with greater impulsivity. The unweighted AUC, which assigns equal weight to each delay period, was used in this study as the primary measure of delay discounting.

To ensure high-quality data, participants were excluded if their responses were inconsistent, based on the Johnson-Bickel criteria. This criterion excludes cases where indifference points fail to follow a logical, monotonically decreasing pattern across delay periods, thereby retaining only participants whose responses reflect consistent decision-making patterns.

Perceived Discrimination Measure

Perceived racial and ethnic discrimination was assessed at the year-one follow-up using an adaptation of the Perceived Discrimination Scale. Participants were asked a series of eight questions to determine if they had experienced discrimination based on their race, ethnicity, or color in the past 12 months. The first question was:

1. In the past 12 months, have you felt discriminated against because of your race, ethnicity, or color?

Participants who answered "Yes" to this question were categorized as having experienced discrimination.

Additionally, seven follow-up questions asked participants to assess the frequency of unfair treatment based on their ethnic background across different contexts, such as interactions with teachers, other students, and adults outside of school. These items were rated on a 5-point Likert scale (1 = "Almost Never" to 5 = "Very Often").

Responses of 3 ("Sometimes"), 4 ("Often"), or 5 ("Very Often") were coded as "Yes" for perceived discrimination.

The follow-up questions were:

2. How often do teachers treat you unfairly or negatively because of your ethnic background?
3. How often do other adults outside of school treat you unfairly or negatively because of your ethnic background?
4. How often do other students treat you unfairly or negatively because of your ethnic background?
5. I feel that others behave in an unfair or negative way toward my ethnic group.

- 85 6. I feel that I am not wanted in American society because of my ethnic background.
- 86 7. I don't feel accepted by other Americans because of my ethnic background.
- 87 8. I feel that other Americans have something against me because of my ethnic background.

88 Participants who answered "Yes" to any of these follow-up questions or the initial question were categorized as
89 having experienced perceived discrimination. Those who responded "No" to all questions or who rated all items
90 as 1 or 2 ("Almost Never" or "Rarely") were categorized as not perceiving discrimination. Participants with null
91 or non-responsive answers were excluded from the analysis.

93 **Statistical Analysis**

94 We conducted linear mixed-effects regression models to explore the relationships between race, socioeconomic
95 factors, perceived discrimination, and delay discounting. These models examined direct effects as well as the
96 mediating role of perceived discrimination on the relationship between race and impulsivity, measured by delay
97 discounting AUC scores. The following models were specified:

- 98 • **Model 1 (Direct Effects without Mediator):**

99 This model evaluated the direct effects of race, family income, Hispanic ethnicity, age, and gender on
100 delay discounting AUC scores. $AUC = \beta_0 + \beta_1*(Race) + \beta_2*(Income) + \beta_3*(Hispanic) + \beta_4*(Age)$
101 $+ \beta_5*(Gender) + u_{Family} + u_{Site} + \varepsilon$, where β_0 is the intercept, β_1 through β_5 are fixed effects for
102 race, family income, Hispanic ethnicity, age, and gender, respectively, and u_{Family} and u_{Site} are the
103 random effects for Family ID and Site ID to account for clustering. ε is the residual error.

- 104 • **Model 2 (Mediator Effect):**

105 To test for mediation, we modeled perceived discrimination as a binary outcome (Yes/No), using race and
106 other demographic variables as predictors in a logistic regression framework. $\text{logit}(\text{Perceived}$
107 $\text{Discrimination}) = \beta_0 + \beta_1*(Race) + \beta_2*(Income) + \beta_3*(Hispanic) + \beta_4*(Age) + \beta_5*(Gender) +$
108 $u_{Family} + u_{Site} + \varepsilon$

- 109 • **Model 3 (Direct Effects with Mediator):**

110 This model included perceived discrimination as a mediator to assess its impact on the direct effect of
111 race on delay discounting. $AUC = \beta_0 + \beta_1*(Race) + \beta_2*(Income) + \beta_3*(Hispanic) + \beta_4*(Age) +$
112 $\beta_5*(Gender) + \beta_6*(\text{Perceived Discrimination}) + u_{Family} + u_{Site} + \varepsilon$

Race was treated as a categorical variable, with White participants as the reference group. Family income was categorized into three groups: <\$50,000, \$50,000-\$99,999 (reference), and >\$99,999. Gender was coded as a binary variable (Male vs. Female, with Female as the reference). Age was treated as a continuous variable but centered on age 10 for interpretability.

All models included random intercepts for **Family ID** and **Site ID** to account for potential non-independence of observations within families and research sites. Restricted maximum likelihood (REML) was used for linear models (Model 1 and Model 3), while the Akaike Information Criterion (AIC) was used to assess model fit for the logistic regression (Model 2).

Analyses were conducted in **R** using the **lme4** package for mixed-effects models and the **lmerTest** package for obtaining p-values for fixed effects. Model diagnostics were performed to ensure proper convergence, and no issues with multicollinearity or model specification were observed.

Results

In this analysis, we investigated the relationships between race, socioeconomic factors, age, gender, and perceived racial or ethnic discrimination in predicting delay discounting scores, measured by the area under the curve (AUC). Delay discounting is a behavioral measure often associated with impulsivity, with lower AUC scores reflecting higher impulsivity. The models tested include both direct effects of race and other predictors (Models 1 and 3) and the mediating role of perceived discrimination (Model 2). Results are presented in the Table.

Model 1: Direct Effects without the Perceived Discrimination Mediator

In the first model, which examines the direct effects of race, socioeconomic factors, age, and gender on AUC scores, we observed several significant findings. The intercept of the model is large (Estimate = 78,126, SE = 2,045, *** $p < 0.001$), indicating the baseline AUC score across the full sample. Being categorized as Black, compared to White, is associated with significantly lower AUC scores (Estimate = -5,580, SE = 2,528, * $p < 0.05$), suggesting higher impulsivity among Black participants. The Asian racial category, however, did not yield a significant difference compared to White participants (Estimate = -78, SE = 5,263, * $p > 0.05$).

In terms of socioeconomic status, both lower income (<\$50,000) and higher income (>\$99,999) relative to the reference category (\$50,000-\$99,999) were non-significant predictors (Estimates = -3,715 and 3,054, SE =

2,328 and 1,687, respectively, $*p > 0.05$). Hispanic ethnicity was a significant predictor, with non-Hispanic individuals having higher AUC scores (Estimate = -4,154, SE = 2,312, $*p < 0.05$), indicating that Hispanic individuals tend to have lower AUC scores, reflecting greater impulsivity.

Age and gender were also influential predictors in this model. Specifically, older age groups (11, 12, and 9 years of age) demonstrated higher AUC scores relative to the 10-year-old reference group, though these differences were not statistically significant (Estimates = 1,992, 3,927, 4,006, SE = 1,663, 2,107, 4,595, respectively, $*p > 0.05$). Gender showed a highly significant effect, with males having significantly lower AUC scores than females (Estimate = -10,508, SE = 1,547, $***p < 0.001$), indicating higher impulsivity among males.

Model 2: Independent Mediator Effect of Perceived Discrimination

In the second model, we evaluated the role of perceived racial or ethnic discrimination as a mediator. The perceived discrimination variable was modeled as a binary outcome (Yes/No). Race (Black vs. White) was a significant predictor of perceived discrimination (Estimate = 1.03, SE = 0.13, $***p < 0.001$). Other racial categories, such as Asian and Multiracial, did not significantly predict perceived discrimination (Estimates = -0.21 and 0.40, SE = 0.47 and 0.43, respectively, $*p > 0.05$).

Income was inversely related to perceived discrimination, with both lower and higher income groups showing a tendency toward reporting less discrimination compared to the reference category, though these effects were non-significant (Estimates = -0.67 and -0.47, SE = 0.47 and 0.34, $*p > 0.05$). Hispanic individuals were significantly less likely to report discrimination compared to non-Hispanic individuals (Estimate = -0.33, SE = 0.12, $**p < 0.01$). Age and gender were non-significant predictors in this model.

Model 3: Direct Effects with Mediator Included

In the third model, perceived discrimination was added as a predictor, allowing us to assess its impact on the direct effects of race and other covariates. The inclusion of perceived discrimination substantially altered the predictive power of the Black racial category. Specifically, the effect of being Black was no longer statistically significant (Estimate = -4,855, SE = 2,552, $*p > 0.05$), suggesting that the relationship between being Black and lower AUC scores (higher impulsivity) is mediated by perceived discrimination.

Perceived discrimination itself was a significant predictor of AUC scores, with participants who reported experiencing discrimination showing lower AUC scores (Estimate = -3,903, SE = 1,970, $*p < 0.05$), indicating that perceived discrimination is associated with higher impulsivity.

Other predictors such as Asian race, income, and Hispanic ethnicity remained largely unchanged. Age and gender maintained similar patterns, with males continuing to exhibit significantly lower AUC scores than females (Estimate = -10,188, SE = 1,555, *** $p < 0.001$), consistent with higher impulsivity among males.

Random Effects and Model Fit

Across all three models, random effects for Family ID and Site ID were included to account for clustering in the data. Family ID accounted for the majority of variance in both Models 1 and 3, while Site ID accounted for a smaller, though notable, proportion of variance. The variance components associated with Family ID and Site ID were similar between Models 1 and 3 (1.988e+08 and 5.18e+06 in Model 1; 1.888e+08 and 5.113e+06 in Model 3, respectively). Model 2, which examined perceived discrimination as an outcome, had significantly lower variance components, indicating that the binary outcome of discrimination is less variable than the continuous AUC scores. Model fit statistics (REML for Models 1 and 3, AIC for Model 2) indicated that all models converged successfully, with lower AIC values in Model 2 suggesting a better fit for the mediation model.

The results highlight that the association between Black race and impulsivity, as measured by delay discounting, is significantly mediated by perceived racial or ethnic discrimination. The findings underscore the importance of accounting for experiences of discrimination when interpreting racial differences in impulsivity-related outcomes. Additionally, gender remains a strong predictor across models, with males consistently showing greater impulsivity than females. Overall, these results suggest that both demographic factors and perceived discrimination play a critical role in shaping behavioral outcomes like impulsivity.

Discussion

The present study examined the mediating role of perceived racial and ethnic discrimination in the relationship between race and impulsivity, as measured by delay discounting, among adolescents aged 10-11 years. Consistent with our hypotheses, we found that Black adolescents exhibited steeper delay discounting rates compared to their White counterparts, indicating higher impulsivity. Importantly, this relationship was mediated by experiences of perceived discrimination; when perceived discrimination was included in the model, the direct effect of being Black on impulsivity was no longer significant. These findings suggest that perceived discrimination contributes significantly to racial disparities in impulsivity during early adolescence.

Our results align with previous research indicating that racial and ethnic minorities, particularly Black adolescents, experience higher levels of impulsivity and related risk behaviors.⁹⁻¹¹ Prior studies have suggested that these disparities may stem from socioeconomic disadvantages and differential exposure to stressors.^{12,24} However, our findings highlight the specific role of perceived discrimination as a mediator, extending the literature by demonstrating that the psychological stress associated with discrimination experiences can impair self-regulatory capacities, leading to greater impulsivity.^{20,23}

The mediating effect of perceived discrimination is consistent with the allostatic load model, which posits that chronic exposure to stressors like discrimination disrupts physiological systems, affecting cognitive functions involved in decision-making.²¹ Adolescents who perceive discrimination may experience heightened stress responses, such as increased cortisol levels, which can impair prefrontal cortex functioning and executive control.²⁷ This impairment may manifest as difficulties in delaying gratification and increased preference for immediate rewards.²⁸

Moreover, the transactional model of stress and coping suggests that discrimination influences behavior by affecting cognitive appraisal and coping strategies.²² Adolescents who perceive discrimination may develop maladaptive coping mechanisms, including impulsive decision-making, as a way to manage negative emotions.²³ These coping strategies can become habitual, further entrenching impulsivity and associated risk behaviors.²⁹

Gender differences observed in our study, with males exhibiting higher impulsivity than females, are consistent with existing literature.³⁰ Males are often found to engage more in risk-taking behaviors and show steeper delay discounting rates.^{9,30} This gender disparity may be due to differences in socialization, hormonal influences, or neurodevelopmental trajectories.

Interestingly, socioeconomic factors such as family income did not significantly predict impulsivity in our sample. This finding contrasts with some studies suggesting that lower socioeconomic status is associated with higher impulsivity and risk behaviors.³¹ One possible explanation is that the effects of socioeconomic status may be attenuated in early adolescence or that the ABCD study sample, which is relatively socioeconomically diverse, may not capture the extremes of income disparity.²⁵

There are multiple research and policy implications from our findings. First, they underscore the importance of addressing perceived discrimination as a means to reduce racial disparities in impulsivity and related outcomes. Interventions aimed at reducing discrimination in schools and communities could have positive

effects on adolescents' self-regulation and decision-making.³² Second, incorporating strategies to bolster coping mechanisms and resilience in the face of discrimination may help mitigate its impact on impulsivity, albeit public health administrators and clinicians should be aware of the long-term implications of racialized stress coping.³³ Programs that promote emotional regulation, stress management, and positive identity formation could be particularly beneficial for minoritized adolescents.³⁴

Our study has several limitations that warrant consideration. The cross-sectional design limits our ability to infer causality between perceived discrimination and impulsivity. Longitudinal analysis of ABCD and other longitudinal studies are needed to establish temporal relationships and causal pathways.³⁵ Additionally, the reliance on self-reported measures of perceived discrimination may introduce bias due to social desirability or recall inaccuracies.³⁶ Incorporating objective measures or reports from multiple informants could enhance the validity of the findings.³⁷ Furthermore, while the ABCD study provides a large and diverse sample, it may not be fully representative of all U.S. adolescents, potentially limiting the generalizability of the results.²⁵

Future research should explore the mechanisms underlying the relationship between perceived discrimination and impulsivity. For instance, examining the role of neurobiological factors such as stress hormone levels, brain imaging markers of executive function, and genetic predispositions could provide deeper insights.³⁸ Investigating other potential mediators or moderators, such as social support, cultural identity, and community resources, may also enhance our understanding of protective factors that buffer against the negative effects of discrimination.^{39,40}

In conclusion, our findings highlight the significant role of perceived racial and ethnic discrimination in mediating racial disparities in impulsivity during early adolescence. Addressing discrimination and its psychological impacts is crucial for promoting equitable developmental outcomes. By targeting both systemic factors that contribute to discrimination and individual coping strategies, interventions can work toward reducing impulsivity and associated risk behaviors among minority adolescents.

Variable	Model 1: Direct (Without Mediator)	Model 2: Mediator Effect	Model 3: Direct (With Mediator)
Fixed Effects	Estimate (Std. Error)	Estimate (Std. Error)	Estimate (Std. Error)
Intercept, Total N=3857	78,126 (2,045) (***)	-1.76 (.14) (***)	78,778 (2,069) (***)
Black [n=471] (vs. White [n=2827])	-5,580 (2,528) (*)	1.03 (.13) (***)	-4,855 (2,552)
Asian [n=86] (vs White [n=2827])	-78 (5,263)	.03 (.33)	-52 (5,259)
Non-Black Multiracial [n=473] or Other (vs. White [n=2827])	-1,953 (2,489)	.40 (.13) (**)	-1,714 (2,490)
<\$50,000 [n=787] (vs \$50,000-\$99,999 [n=1115])	-3,715 (2,328)	.41 (.12) (***)	-3,394 (2,333)
>\$99,999 [n=1955] (vs \$50,000-\$99,999 [n=1115])	3,054 (1,827)	-.67 (.11) (***)	2,706 (1,834)
Hispanic [n=629] (vs non-Hispanic [n=3228])	-5,164 (2,312) (*)	.33 (.12) (**)	-4,958 (2,312) (*)
Age 11 [n=1883] (vs 10 [n=1663])	1,992 (1,608)	-.18 (.09)	1,893 (1,608)
Age 12 [n=195] (vs 10 [n=1663])	7,041 (3,629)	-.17 (.21)	6,947 (3,626)
Age 9 [n=115] (vs 10 [n=1663])	4,006 (4,595)	-.04 (.26)	3,973 (4,594)
Male [n=2102] (vs Female [n=1744])	-10,508 (1,547) (***)	.58 (.09) (***)	-10,188 (1,555) (***)
Mediator Effect	N/A	N/A	Perceived Discrimination -3,903 (1,970) (*)
Random Effects			
Family ID (Intercept), n=3577	Variance: 1.988e+08	Variance: 0.2624	Variance: 1.888e+08
Site ID (Intercept), n=21	Variance: 5.180e+06	Variance: 0.02653	Variance: 5.113e+06
Model Fit/Convergence	REML: 93770.5	AIC: 3659.3	REML: 93749.6

Table: *Racial disparities in delay discounting scores partially mediated by racial discrimination.* Delay discounting area under the curve (AUC) scores are presented (lower AUC scores generally interpreted as correlate of greater impulsivity). Subjects passing Johnson-Bickel validity check⁸ included (total N = 3857, Black-racialized n = 471). Predictors are race, combined family income, Hispanic ethnicity, age, and gender. Estimates are presented as regression coefficients with standard errors in parentheses. Significant effects are highlighted with asterisks (*p < 0.05, **p < 0.01, ***p < 0.001). Model 1 and Model 3 present linear mixed effects models accounting for the direct effects of predictors on AUC before and after including the mediator, allowing comparison of changes in effect sizes. Model 2 presents a binary logistic regression model with the mediator (Yes or No to perceived ethnic or racial discrimination) as the outcome. Random effects are summarized by variance components to indicate the contribution of each grouping variable (Family ID and Site ID) to the overall variance. Black racial subject categorization is no longer significant predictor in Model 3. Transgender and gender non-binary subjects also included in model building, but not reported for privacy, given low number of subjects (no significant predictors).

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Author Contributions:

- **Christopher Fields:** Conceptualization, data analysis, drafting of the manuscript, and interpretation of results.
- **Damla Aksen:** Data preprocessing, methodology, and revisions to the manuscript.
- **Robert Kohler:** Data analysis, interpretation of the results, supervision.

Data Availability: The data supporting the findings of this study were obtained from the Adolescent Brain Cognitive Development (ABCD) Study. Due to restrictions, the data are available upon reasonable request from the corresponding author or from the ABCD Study Data Access portal. The source data used in this study were

openly available prior to its initiation. The ABCD data used in this report came from the fast track data release 5.1, which is accessible to qualified researchers through the NIMH Data Archive (NDA). The raw data are available at <https://nda.nih.gov/study.html?id=2313>, and the data dictionary for ABCD can be found at <https://data-dict.abcdstudy.org/>. Additional details about the measures assessed for the ABCD study are provided at <https://wiki.abcdstudy.org/release-notes/start-page.html>. Instructions for obtaining NDA data use certification are available at <https://nda.nih.gov/nda/access-data-info>.

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