

# Nonsuicidal Self-Injury in Adolescence: Longitudinal Course, Trajectories, and Intrapersonal Predictors

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**Abstract** Although prevalence rates of nonsuicidal self-injury (NSSI) has been established throughout adolescence, little is known about the progression of NSSI, and consequently, about the risk factors for youth NSSI engagement. This study aimed to describe the overall longitudinal course of NSSI and the latent trajectory classes of NSSI in a population-based sample of adolescents using multi-wave data. Moreover, this study examined whether sex, lifetime history of depression, rumination, and negative attributional style predicted the longitudinal course of NSSI and trajectory group membership. Participants were 617 Chinese adolescents in Grades 10 through 12 (51.4 % girls). NSSI was assessed across eight waves of data. History of depression, rumination, and negative attributional style were assessed at baseline. Latent growth curve modeling revealed that only lifetime depression predicted the longitudinal course of NSSI from Grades 10 to 12, with depressed adolescents showing greater and more stable NSSI engagement over time than non-depressed adolescents. Group-based trajectory modeling yielded three distinct trajectory classes of NSSI engagement: low (69.2 %), moderate (26.1 %), and chronic (4.7 %). Negative attributional style distinguished adolescents in the chronic vs. low and moderate NSSI trajectory classes. Sex, rumination, and lifetime depression predicted

membership in the chronic and/or moderate vs. low NSSI trajectory class. NSSI trajectory classes, based on frequency of NSSI, exist and are differentiated by sex, depression history, rumination, and negative attributional style. This study suggests that during this period of adolescence NSSI may be a relatively stable behavior, especially for some adolescents. Negative attributional style may be a salient risk factor for chronic NSSI engagement.

**Keywords** NSSI · Adolescents · Latent trajectory classes · Depression · Attributional style · Rumination

Nonsuicidal self-injury (NSSI) is a specific form of self-injurious behaviors involving the destruction of one's body tissue without the intent to die (Nock and Favazza 2009). NSSI is associated with a number of different psychological symptom domains (e.g., personality disorders, externalizing and internalizing disorders; Nock et al. 2006), and has been shown to be a strong risk factor for suicidal thoughts and behaviors (e.g., Guan et al. 2012). NSSI is a prevalent phenomenon among nonclinical individuals, with adolescence being a high-risk period for NSSI engagement. Whereas past year rates of NSSI are about 6 % in adult samples (Klonsky 2011), approximately 14–24 % of adolescents report engaging in NSSI yearly (e.g., Giletta et al. 2012; Muehlenkamp and Gutierrez 2004). Research also suggests that NSSI is a cross-cultural phenomenon in youth, with comparable rates of NSSI in Western countries (e.g., USA and Europe; Giletta et al. 2012) and in East Asian countries (e.g., China; Muehlenkamp et al. 2012).

To date, the NSSI literature has mainly been dominated by cross-sectional studies and studies using two-time-point designs, which are unable to provide information on the course of this behavior (Curran and Willoughby 2003). In addition to the lack of research on the general trajectory of NSSI engagement, no research has attempted to classify subgroups of

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individuals (youth or adult) following different courses of NSSI engagement. Only studies employing longitudinal designs with multiple assessments offer the opportunity to examine the progression of NSSI and to identify trajectory classes of NSSI (e.g., chronic NSSI). This also has implications for the study of NSSI precursors. Indeed, although several NSSI correlates have been identified, little is known regarding factors that may contribute to change and maintenance of NSSI over time (Hankin and Abela 2011; Heilbron and Prinstein 2008). This multi-wave study addressed this gap in NSSI literature by examining the longitudinal course of adolescent NSSI across eight assessment points between Grades 10 and 12. Specifically, this study aimed to investigate (a) the general course of NSSI (i.e., growth), (b) whether specific NSSI trajectory classes could be identified, and (c) what intrapersonal risk factors predicted longitudinal course of NSSI and trajectory classes.

### Longitudinal Course of NSSI

Cross-sectional research examining rates of NSSI has documented that the onset of NSSI commonly occurs between 13 and 15 years old (see Rodham and Hawton 2009) and NSSI generally becomes more prevalent and rises during middle adolescence (e.g., Barrocas et al. 2012). Yet, due to the paucity of longitudinal research little is known about how NSSI progresses and is maintained during adolescence. Findings from a recent longitudinal study examining NSSI in a high-school sample suggest that rates and frequency of NSSI engagement in the past months overall tended to decrease from Grades 9 to 11 (Giletta et al. 2013). To our knowledge, research has yet to assess intraindividual changes in NSSI engagement over time. Therefore, it remains unknown how, on average, NSSI changes during adolescence. NSSI engagement may increase, decline, or remain stable over time. Beginning to map the general course and patterning of NSSI during adolescence, when this behavior is highly prevalent, may contribute to provide preliminary information on which specific periods of adolescence pose the highest risk for NSSI engagement. This study employed latent growth curve modeling to examine the longitudinal course of NSSI over 2 years from Grades 10 to 12. This approach allows the general course of NSSI to be determined by estimating latent growth factors representing the initial average level of NSSI engagement and the rate of change over time. This analytic approach also provides information about quantitative interindividual differences in the initial level of engagement and in the rate of change of NSSI by estimating random effects around the latent growth factors (Sterba and Bauer 2010).

### Trajectory Classes of NSSI

Similarly to other problematic behaviors (e.g., antisocial behaviors, depressive symptoms; Dekker et al. 2007; Moffitt 1993), heterogeneity may exist in the course of NSSI, with subgroups of adolescents showing qualitatively different longitudinal patterns of NSSI (i.e., different shapes of the course). Notably, examining only the general course of NSSI does not allow identifying these subgroups. Prior work provides preliminary evidence supporting the hypothesis that distinct NSSI trajectories could potentially be identified in adolescence, and, in particular, that some adolescents engage in NSSI in a chronic manner while others do not. First, prior studies have differentiated between episodic and repeated NSSI (e.g., five or more times in the last year) based on frequency of single assessment (e.g., Brunner et al. 2007; You et al. 2011). This work additionally demonstrates that adolescents who engage in NSSI chronically show higher levels of psychological maladjustment (e.g., emotional distress) as compared to adolescents who engage in NSSI at lower levels of chronicity (You et al. 2011). Second, other studies employing person-centered approaches (i.e., latent class analyses, cluster analyses) have documented that distinct subgroups of youth who engage in NSSI can be empirically identified based on several characteristics (e.g., forms of NSSI, functions of NSSI; Bjärehed et al. 2012; Klonsky and Olino 2008; Whitlock et al. 2008). Specifically findings from these studies indicated that adolescents belonging to different NSSI subgroups endorsed NSSI at different frequencies. Finally, few recent studies using two-time-point designs have revealed that whereas some adolescents desisted from engaging in NSSI over time, some others consistently endorsed NSSI across the two assessment points (e.g., Andrews et al. 2013; Hamza and Willoughby 2013; Hankin and Abela 2011). Again, different psychological risk factors (e.g., internalizing symptoms) emerged to differentiate these subgroups of self-injurious youth.

Altogether, findings from this research highlight the importance of differentiating between subgroups of NSSI, suggesting that while for some adolescents NSSI may be a transient phenomenon, for others it may be a stable behavior. However, due to the shortcomings in the designs of prior work, it remains unknown whether subgroups of adolescents following distinct trajectories of NSSI exist empirically. Specifically, it remains unclear whether there may be a subgroup of adolescents who engage in NSSI in a chronic manner. To answer these questions, this study used group-based trajectory modeling. This approach allowed examining qualitative, rather than quantitative, interindividual differences in the course of NSSI (Sterba and Bauer 2010). Therefore it allowed empirically testing whether some adolescents engage in NSSI chronically while others do not.

## Predictors of NSSI Engagement

Nock (2009) proposed an integrative theoretical model of the development and maintenance of NSSI, in which both inter- and intrapersonal factors play a role in the onset and continuity of NSSI engagement. Preliminary work in this area suggests that both psychological symptoms and symptom-related cognitive styles may be especially relevant predictors of NSSI (e.g., Hankin and Abela 2011). It has been theorized that most adolescents engage in NSSI to regulate emotions, in particular to reduce negative emotional states (Nock and Prinstein 2005). As such, NSSI engagement is often seen along with a diagnosis of major depression (e.g., Nock et al. 2006). The emotion-regulation function of NSSI suggests that not only negative feelings but also maladaptive cognitive processes may contribute to NSSI development and continuity. Specifically, the emotional cascade theory (Selby et al. 2008) proposes the importance of trait rumination (Nolen-Hoeksema and Morrow 1991) for onset and maintenance of NSSI episodes. That is, engaging in NSSI may relieve the distress associated with such cognitive processes. While emerging literature has begun to show an association between rumination and NSSI (e.g., Hoff and Muehlenkamp 2009; Selby et al. 2009), little support exists for the role of rumination as a potential prospective risk factor for later NSSI (see Selby et al. 2013 for exception) due to the paucity of longitudinal research on NSSI.

Similarly, a negative attributional style (Abramson et al. 1989) may operate as vulnerability for NSSI. Prior longitudinal research has shown that a negative attributional style differentiated youth who engaged in NSSI from those who did not 2 1/2 years later (Hankin and Abela 2011), suggesting the possible importance of attributional style for change and stability of NSSI engagement. Note that although rumination and negative attributional style have similarities (e.g., both are cognitive processes, relate to hopeless thinking, predict depressive symptoms), they are distinct processes (Hankin et al. 2007; Robinson and Alloy 2003). Specifically, rumination refers to the process of repetitively focusing attention on one's, often negative, thoughts and emotions (Nolen-Hoeksema and Morrow 1991), whereas a negative attributional style refers to the tendency to generate pessimistic causal attributions about negative events and subsequently infer negative consequences and self-implications (Abramson et al. 1989). In sum, despite existing theoretical accounts, little evidence has documented cognitive vulnerability factors as precursors of NSSI, and no research has examined whether these factors, as well as depression, may contribute to understanding differences in the average course of NSSI over

time and to identifying youth at greater risk for chronic NSSI.

Finally, the literature regarding the role of sex on NSSI engagement has shown mixed results for sex differences in NSSI (see Barrocas et al. 2011). In general, both girls and boys engage in NSSI. Some research suggests that girls report engaging in NSSI at higher rates than boys do (e.g., Giletta et al. 2012; Muehlenkamp and Gutierrez 2007; Ross and Heath 2002), whereas other studies do not (e.g., Muehlenkamp and Gutierrez 2004; Hilt et al. 2008). Further, it has recently been demonstrated that gender differences in NSSI engagement might emerge during adolescence (see Barrocas et al. 2012). Therefore, research examining adolescent NSSI, should pay particular attention to the role of sex.

## The Present Study

This longitudinal multi-wave study aimed to determine the general patterning of NSSI and the latent trajectory classes of NSSI among a community sample of adolescents from Grades 10 to 12, using latent growth curve modeling and group-based trajectory modeling. Using both of the analytic approaches allowed for examination of the overall progress of NSSI during middle adolescence as well as examination of subgroups of adolescents with distinct NSSI longitudinal patterns. The predictive effects of intrapersonal vulnerability factors were evaluated on the general patterning of NSSI and on NSSI latent trajectory classes. Based on prior work (Giletta et al. 2013), we expected a general decline in NSSI engagement from Grades 10 to 12. Moreover, based on prior theoretical conceptualizations and preliminary evidence suggesting that distinct groups of youth endorsing NSSI at different frequencies may exist (i.e., episodic/moderate vs. repetitive/chronic; Brunner et al. 2007; Whitlock et al. 2008), we expected to find at least three distinct groups of adolescents following different trajectory classes of NSSI over time. Specifically, we hypothesized that most adolescents would report none (or few) NSSI instances across the 2-year period. We also expected two distinct groups of adolescents who endorsed NSSI at different levels: one group of adolescents showing a stable chronic NSSI engagement across time and a second group who engage in NSSI yet not at a stable chronic level. Moreover, we hypothesized that sex, depression, and cognitive vulnerabilities (i.e., rumination and negative attributional style) would predict the general longitudinal course of NSSI as well as differentiate adolescents' membership in the latent NSSI trajectory classes. As girls tend to report higher rates of depression as well as greater levels of cognitive vulnerabilities (e.g., Hankin and Abramson 2001), including negative attributional style and rumination, we also explored the moderating role of sex on the relation between vulnerability factors and NSSI course.

## Method

### Participants and Procedure

Participants were 617 adolescents (51.4 % girls) enrolled at baseline in Grade 10 (99.5 % of the participants aged between 15 and 17 years;  $M_{age}=16.02$ ,  $SD=0.61$ ) of an urban school in Changsha and a rural school in Liuyang, in Hunan province (Mainland China). Hunan ranks 23rd (10,336 RMB) out of the 34 provinces in China in terms of annual gross domestic product placing it well below the national provincial average ( $\mu=29,719$  RMB;  $SD=47,462$  RMB; National Bureau of Statistics of China 2006). Approval for this study was obtained from both McGill University's Institutional Review Board and Peking University Health Sciences Center's Institutional Review Board prior to commencing the study. This study has been approved by the Institutional Review Boards at the University of Denver and the University of North Carolina as well, in order to conduct analyses of the data that have been previously collected. Consent forms were sent to the parents of all students in participating classes. Consent rates were greater than 95 % in all the classes. Researchers met with participating students after collecting consents. Written consent was obtained from each adolescent at the beginning of the assessment. No student who received parental consent chose not to give personal consent for participation. During the initial baseline assessment, students completed self-report questionnaires to assess rumination and negative attributional style and interviews to diagnose depression. Thereafter, youth completed a NSSI measure for eight waves of prospective assessments, at 3-month intervals, over 2 years. Of the 624 adolescents who participated at the initial assessment, seven (1.1 %) did not take part in any of the follow-up assessments; therefore, these participants were not included in the analytic sample.

### Measures

The Chinese version of all measures was developed using the back-translation method. Original English versions were translated into Chinese by a bilingual translator from the Psychology Department at Second Xiangya Medical College of Central South University, Hunan. Translated Chinese versions were then back-translated into English by another bilingual translator from the Psychology Department at McGill University, Quebec. Original versions were compared with the back-translation. If inconsistencies were found in the back-translation, translators worked together to make corrections to the final Chinese versions. No items from any of the measures were removed or significantly altered during the translation process.

*Nonsuicidal Self-Injury (NSSI)* NSSI was assessed every 3 months for the 2 years of follow-up (eight measurements) through a self-report measure (Prinstein et al. 2008). Adolescents were asked to report how often, in the previous 3 months, they engaged in five different forms of nonsuicidal self-injurious behaviors (i.e., cutting or carving skin, burning skin, self-hitting, self-biting, scrapping skin to draw blood) without intending to die. Each item was NSSI trajectories rated on a 5-point scale (0 = never, 1 = a few times, 2 = a couple of times a month, 3 = about once a week, 4 = almost every day). As in previous work (e.g., Prinstein et al. 2010), at each follow-up assessment, a global measure of NSSI frequency was computed by summing adolescents' responses to the five items. NSSI frequency could range from 0 to 20, with higher scores indicating higher frequencies in the last 3 months. Although this composite NSSI measure did not distinguish across different NSSI forms, it allowed examining the patterning and course of NSSI over time. Excellent psychometric properties provided support for combining the different NSSI forms into an overall measure. Internal consistency was very high, with Cronbach's alphas ranging between 0.92 and 0.97 across the eight follow-up assessments. Similarly, item-total correlations (median  $r=0.92$ ) ranged from 0.82 (for "self-biting" at follow-up 1) to 0.97 (for "burning skin" at follow-up 5) and inter-item correlations (median  $r=0.81$ ), ranged from 0.58 (between "burning" and "biting" at follow-up 1) to 0.93 (between "burning" and "scrapping skin to draw blood" at follow-up 6). This scale has been previously used to assess NSSI among non-clinical adolescents (e.g., Giletta et al. 2012), and its concurrent validity has been demonstrated (Prinstein et al. 2008).

*Depression Diagnosis* The Schedule for Affective Disorders and Schizophrenia for School-Age Children, Present Version (K-SADS; Kaufman et al. 1996) was administered to assess depression. The K-SADS is a semi-structured clinical interview designed to arrive at *DSM-IV* diagnoses and has been shown to yield reliable diagnoses of depressive disorders. This interview reliably assesses depression in youth (Chambers et al. 1985) and has been frequently used in clinical studies of youth depression (Klein et al. 2005). Diagnostic interviewers completed an intensive training program for administering the K-SADS interview and for assigning *DSM-IV* diagnoses. The training program consisted of attending a minimum of 40 h of didactic instruction, listening to audiotaped interviews, conducting practice interviews, and passing regular diagnostic exams (85 % or above) to ensure reliability and consistency in interviewing and coding. John R. Z. Abela, as primary investigator of this project, held regular supervision sessions for the interviewers and oversaw local clinical supervisors in China. He also reviewed interviewers' notes and tapes to confirm the presence or absence of a diagnosis. The K-SADS was administered to the adolescent

privately by reliable, trained diagnosticians (see Hong et al. 2010 for more information). In the current study, both current and past history of clinically significant Major Depressive Disorder were assessed. In this sample 2.3 % of adolescents met criteria for current and 2.6 % for past depression. Thus, at baseline 4.9 % of adolescents were diagnosed as having a lifetime history of depression ( $n=30$ ).

**Rumination** Adolescents completed the Ruminative Response Scale (RRS) of the Response Style Questionnaire (RSQ; Nolen-Hoeksema and Morrow 1991). This measure includes 22 items assessing the tendency to ruminate in response to negative emotions (e.g., sadness, depressed mood). Each item was rated on a 4-point scale (1 = *almost never*, 4 = *almost always*), and a global sum score was computed across items (Cronbach's  $\alpha=0.89$ ). The psychometric properties of this scale with adolescents have been shown (Abela and Hankin 2011).

**Negative Attributional Style** The Adolescent Cognitive Style Questionnaire (ACSQ; Hankin and Abramson 2002) was used to assess attributional style. Participants were presented with a total of 12 hypothetical *negative* scenarios involving achievement and interpersonal events. For each scenario adolescents reported to what extent they attributed the negative event to internal (versus external), stable (versus unstable) and global (versus specific) causes on a scale from 1 to 7. For the present study, in line with prior work (e.g., Hankin 2008), only items on the stability and globality subscales were averaged (i.e., generality subscale) with higher score indicating higher negative attributional styles (Cronbach's  $\alpha=0.88$ ).

### Statistical Analysis

Two main sets of analyses were conducted. First, latent growth curve modeling (LGM) was employed to examine the overall patterning of NSSI engagement. NSSI measurements at the eight follow-up assessments were used to estimate latent growth factors that represent the average initial level of NSSI engagement (i.e., intercept) and the average rate of change in NSSI engagement from follow-up 1 to 8 (i.e., slopes). Inter-individual differences were modeled using random effects around these latent growth factors. A series of unconditional LGMs including different growth factors (e.g., linear slope vs. quadratic slope) were estimated to identify the model that best fit the average NSSI longitudinal course. LGMs were estimated using a censored-normal distribution to account for the considerable proportion of adolescents who did not engage in NSSI (i.e., floor effect). Because such models do not yield traditional fit indices (e.g., comparative fit index, CFI), chi-square difference tests based on log-likelihood values were employed to compare models. Once the best fitting model was identified, a conditional LGM was

conducted to simultaneously examine the unique effects of baseline predictors on the course of NSSI. To do so, the latent growth factors (e.g., intercept and slope) were regressed on the baseline predictors. The interaction effects between baseline predictors and sex on NSSI latent growth factors also were explored.

Second, group-based trajectory modeling (GBTM; Nagin 2005) was used to identify latent trajectory classes of NSSI. This approach aims at identifying the smallest number of trajectory classes approximating the continuous distribution of trajectories within a given population (see Nagin and Odgers 2010). As compared to growth mixture modeling (GMM), in GBTM random effects (i.e., variances around the intercept and slope factors) are not estimated. As a result, although GBTM tends to yield a higher number of trajectory classes than GMM, trajectories derived from GBTM are more clearly distinguishable (Nagin 2005). Different from person-centered approaches in which several indicators are used to classify individuals in different subgroups (e.g., latent class analysis), in GBTM distinct subgroups of individuals are identified based on a single indicator assessed at multiple time points (see Muthén and Muthén 2000).

The best-fitting LGM was used as starting model for GBTM. Similarly to LGMs, a censored-normal distribution was employed to model NSSI frequency in GBTMs. Criteria to determine the optimal number of trajectory classes were: Bayesian information criteria (BIC) and sample size adjusted BIC (aBIC), Lo-Mendell-Rubin ratio likelihood test (LMR-LRT), entropy ( $>0.70$ ), and the usefulness of the classes. The usefulness of the identified classes was evaluated based on the theoretical value of additional classes. Models were fitted using 100 random perturbations of starting values to ensure replication of the best likelihood and avoid local maxima.

Once the optimal class solution was identified, adolescents were assigned to their most likely NSSI trajectory class based on their highest posterior probability. Multivariate multinomial logistic regressions were conducted in SPSS (version 21) in which the unique effects of baseline predictors on NSSI trajectory classes were examined. Given the imprecise nature of participants' assignment to trajectory classes, in line with prior work (e.g., Otten et al. 2010), these models were conducted weighting data by participants' probability to fall in the assigned trajectory class. This approach allowed accounting for the uncertain assignment of adolescents to trajectory classes and allowed maintaining the continuous nature of classification. The interaction between sex and each predictor variable was also examined.

Participants with at least one out of eight follow-up measure of NSSI were included in the analyses ( $n=617$ ). Of the 617 adolescents in the analytic sample, 95.1 % had available data for at least four follow-ups and 84.3 % had data for seven

out of eight waves of follow-up. Missing data were handled using full information maximum likelihood (FIML) estimation. All LGMs and GBTMs were carried out in M-plus version 6.0 (Muthén 1998–2010).

## Results

### Descriptive Statistics

Table 1 reports rates and frequencies of NSSI across the eight waves for the whole sample and by sex. A decrease in the rates of NSSI was observed over time for both boys and girls, with approximately 24 % of adolescents reporting NSSI in the previous 3 months at the first assessment and 11 % at the last. Over the eight assessments, 46.4 % of the adolescents reported at least one NSSI episode. Across multiple follow-ups, sex differences were observed both on the rate and frequency of NSSI, such that boys reported higher prevalence and mean scores than girls (see Table 1).

**Table 1** Rate and frequency of NSSI at each follow-up assessment in the total sample and by sex

Follow-up	Boys % (n) <i>M (SD)</i>	Girls % (n) <i>M (SD)</i>	Total % (n) <i>M (SD)</i>
1	26.0 (76) <sup>a</sup>	21.7 (68) <sup>a</sup>	23.8 (144)
	1.28 (3.02) <sup>a</sup>	0.70 (2.08) <sup>b</sup>	0.98 (2.59)
2	19.2 (51) <sup>a</sup>	16.3 (50) <sup>a</sup>	17.6 (101)
	0.98 (3.00) <sup>a</sup>	0.74 (2.38) <sup>a</sup>	0.85 (2.69)
3	20.0 (56) <sup>a</sup>	14.7 (45) <sup>a</sup>	17.2 (101)
	1.13 (2.88) <sup>a</sup>	0.70 (2.31) <sup>b</sup>	0.90 (2.61)
4	14.3 (39) <sup>a</sup>	8.8 (27) <sup>b</sup>	11.4 (66)
	0.91 (2.93) <sup>a</sup>	0.42 (1.79) <sup>b</sup>	0.65 (2.41)
5	17.1 (43) <sup>a</sup>	11.1 (33) <sup>b</sup>	13.8 (76)
	1.42 (3.63) <sup>a</sup>	0.51 (1.79) <sup>b</sup>	0.92 (2.82)
6	13.0 (33) <sup>a</sup>	11.1 (32) <sup>a</sup>	12.2 (66)
	0.84 (2.89) <sup>a</sup>	0.51 (2.01) <sup>a</sup>	0.67 (2.46)
7	14.4 (35) <sup>a</sup>	8.9 (24) <sup>b</sup>	11.5 (59)
	1.02 (3.06) <sup>a</sup>	0.45 (2.00) <sup>b</sup>	0.72 (2.57)
8	15.2 (37) <sup>a</sup>	7.6 (21) <sup>b</sup>	11.1 (58)
	1.05 (3.02) <sup>a</sup>	0.41 (1.80) <sup>b</sup>	0.71 (2.46)

<sup>a, b</sup> Different subscriptions indicate significant differences. For each follow-up assessment, the top row presents NSSI rate (i.e., percentage of adolescents engaging in NSSI on at least one occasion in the previous 3 months), the bottom row presents the mean and standard deviation of NSSI frequency (i.e., sum score of frequency across five items). NSSI frequency ranged between 0 and 20 at follow-up 1, 2, 4, 6, and 7, between 0 and 16 at follow-up 3, and between 0 and 15 at follow-up 5 and 8

### Longitudinal Course of NSSI from Grades 10 to 12

*Unconditional Latent Growth Curve Models* A model including a linear slope fit the data better than an intercept-only model,  $\Delta\chi^2(3)=79.91, p<0.001$ . The addition of a quadratic slope also improved the model fit,  $\Delta\chi^2(4)=28.37, p<0.001$ . Thus, a model including both linear and quadratic slopes was selected for the subsequent analyses. A significant negative linear slope ( $b=-3.31, p<0.001$ ) and a positive quadratic slope ( $b=0.30, p<0.001$ ) indicated a curvilinear trend of NSSI engagement with an initial decline followed by a slight re-emergence. Significant variances were observed around the intercept and both the slope factors, suggesting inter-individual differences in NSSI engagement at the first follow-up assessment as well as in the progression of NSSI from Grades 10 to 12.

*Baseline Predictors of Longitudinal Course of NSSI* Results from the conditional LGM are presented in Table 2. Significant effects were observed on the intercept factor for most baseline predictors. Specifically, boys reported higher NSSI frequency than girls at the first follow-up. Moreover, adolescents with higher levels of rumination and negative attributional styles at baseline additionally reported higher levels of NSSI frequency 3 months later at follow-up 1. A marginally significant trend was also revealed for depression, indicating that adolescents with a lifetime history of depression reported somewhat higher NSSI frequency at 3-month follow-up.

Only lifetime depression predicted the slope factors. As compared to non-depressed adolescents, adolescents with a history of lifetime depression showed a higher and more stable pattern of NSSI engagement over time, characterized by a less steep decline and a subsequent less marked reemergence. Conversely, sex and baseline differences in cognitive vulnerabilities (i.e., rumination and negative attributional styles) did not predict the longitudinal course of NSSI over the eight assessments between Grades 10 and 12.

The LGM examining the moderating role of sex revealed only one significant interaction effect between sex and lifetime depression on the intercept factor ( $b=6.42, p<0.05$ ; effect not presented in Table 2). Follow-up analyses indicated that a lifetime history of depression was associated with higher NSSI engagement at 3-month follow-up among girls but not boys.

### NSSI Latent Trajectory Classes from Grades 10 to 12

*Unconditional Group-based Trajectory Models* Unconditional GBTMs were estimated including both linear and quadratic slopes. Table 3 shows the criteria used to decide on the best-class solution for NSSI trajectories. The aBIC and BIC both consistently decreased for 1- through 4-class solution, although a substantially smaller decrease was observed with

**Table 2** Unstandardized parameter estimates for predictors of NSSI latent growth factors

Predictors	Intercept Estimate (SE)	Linear slope Estimate (SE)	Quadratic slope Estimate (SE)
Sex	-1.78 (0.75)*	-0.33 (0.55)	-0.02 (0.08)
Lifetime depression	2.65 (1.56)†	1.88 (0.72)**	-0.20 (0.10)*
Rumination	0.13 (0.05)**	0.03 (0.04)	-0.004 (0.01)
Negative attributional style	1.15 (0.40)**	-0.22 (0.33)	0.02 (0.05)

Sex was dummy-coded as boys = 0 and girls = 1

†  $p < 0.10$ ; \*  $p < 0.05$ ; \*\*  $p < 0.01$

the addition of a fourth class. The LMR-LRT suggested that the 3-class solution significantly improved the model fit as compared to the 2-class solution, whereas the 4-class solution did not fit the data better than the 3-class solution. Moreover, the 4-class solution yielded two classes showing a highly similar trend. Although entropy decreased from the 2-class to the 3-class solution, the value higher than 0.70 indicated an appropriate classification of adolescents into the three trajectory classes. Therefore, a 3-class solution was chosen.

The quadratic slope emerged to be significant only for one trajectory class. A chi-square difference test showed that fixing at zero the quadratic slope for the other trajectory classes did not worsen the model fit,  $\Delta\chi^2(2) = 0.89, p = 0.65$ ; therefore this more parsimonious model is presented. Latent trajectory classes of NSSI are shown in Fig. 1. The trajectory with the majority of adolescents (69.2 %) was the low NSSI trajectory. This class included adolescents who reported no, or few, incidences of NSSI, and revealed a slight curvilinear trend as indicated by the negative linear slope ( $b = -3.28, p < 0.001$ ) and positive quadratic slope ( $b = 0.31, p < 0.01$ ). A second class consisted of adolescent who followed a moderate NSSI trajectory (26.1 %). This group of adolescents engaged in some NSSI episodes, which tended to decrease over time, as indicated by the negative linear slope ( $b = -0.84, p < 0.01$ ). Finally, the third class (4.7 %) was comprised of adolescents with chronically high engagement in NSSI across the eight waves of follow-up (linear slope:  $b = 0.30, p = 0.47$ ).

*Baseline Predictors of NSSI Latent Trajectory Classes* Results from the multivariate multinomial logistic regression

examining the effects of baseline predictors on NSSI trajectory classes are presented in Table 4. Predictors measured at baseline differentiated the three NSSI trajectory classes. Specifically, sex, lifetime depression and rumination clearly distinguished between the low and moderate trajectory classes. That is, boys and adolescents with a lifetime history of depression were more likely to follow the moderate than the low NSSI trajectory class as compared to girls and non-depressed adolescents. Moreover, reporting higher levels of rumination increased adolescents' odds of being in the moderate versus the low NSSI trajectory class.

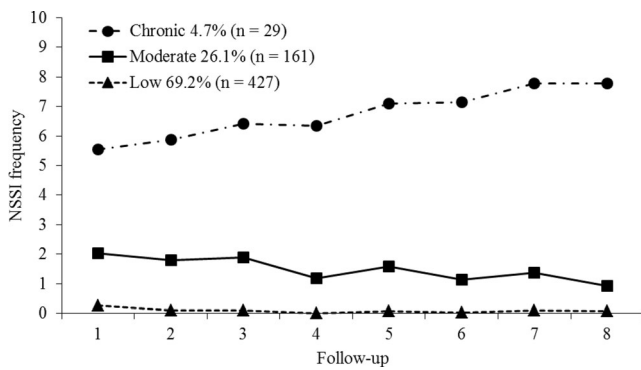
Two predictors differentiated the chronic from low trajectory class. Adolescents with a lifetime diagnosis of depression and those reporting higher levels negative attributional styles had a significantly higher probability of being in the chronic as compared to the low NSSI trajectory class. A trend was also observed for sex, suggesting that boys had a somewhat higher probability than girls to fall in the chronic versus the low trajectory class.

Finally, only negative attributional style distinguished the chronic from the moderate trajectory class, such that adolescents exhibiting greater negative attributional styles were increasingly more at risk to follow the chronic versus the moderate NSSI trajectory class. Adolescents in the chronic trajectory class did not significantly differ from those in the moderate one on either rumination or their history of depression.

None of the interactions between sex and the other predictors emerged to significantly predict NSSI trajectory classes.

**Table 3** Criteria to determine NSSI trajectory classes

Number of classes	Log likelihood	aBIC	BIC	Entropy	LMR-LRT
1	-3,639.58	7,314.92	7,349.84		
2	-3,355.69	6,760.14	6,807.76	0.85	< 0.001
3	-3,318.87	6,699.48	6,759.80	0.75	0.04
4	-3,301.52	6,677.79	6,750.81	0.78	0.23
5	-3,290.94	6,669.64	6,755.36	0.81	0.06



**Fig. 1** Latent trajectory classes of adolescent NSSI across the eight follow-up assessments from Grades 10 to 12

## Discussion

NSSI in adolescence is a significant problem as self-harming youth experience high levels of negative emotions (e.g., Adrian et al. 2011), have frequent interpersonal problems and high rates of psychiatric disorders (e.g., Nock 2009; Nock et al. 2006), and are at increased risk for engaging in suicidal behaviors (Guan et al. 2012). However, knowledge on NSSI during adolescence has been limited by an overreliance on cross-sectional designs. As a result, the overall longitudinal course of NSSI from middle to late adolescence, and whether there exist distinct classes of youth engaging in NSSI, stand as substantial gaps in the NSSI literature. This study aimed to address these gaps by empirically identifying and predicting the general course of NSSI, via latent growth curve modeling, and distinct trajectory classes of NSSI engagement over time, via group-based trajectory modeling. Taken together, findings from this multi-wave longitudinal study demonstrated an overall decrease in average NSSI engagement over time. At the same time, this general declining trend for the whole sample obscured significant latent trajectory classes of youth NSSI engagement. We discuss each of these findings, in turn, along with predictors of the general longitudinal course of NSSI and trajectory classes. We emphasize the importance of

considering both the overall declining pattern in concert with the existence of distinct classes of NSSI patterning as essential to understanding and predicting this serious mental health problem.

First, growth curve analyses revealed an overall decline in NSSI engagement over the eight waves of data. Intrapersonal risk factors predicted NSSI engagement at the initial time-point; however, only a diagnosis of depression predicted the course of NSSI engagement over time. Second, consistent with hypotheses, group-based trajectory analyses revealed three distinct groups of NSSI engagement: one group of adolescents who did not engage in NSSI (low NSSI trajectory class; 69.2 %), a second group of adolescents who showed a moderate and declining engagement in NSSI (moderate NSSI trajectory class; 26.1 %), and a final group of adolescents who had chronically high levels of engagement in NSSI (chronic NSSI trajectory class; 4.7 %). Adolescent's sex, depression history, and cognitive vulnerabilities differentiated adolescents belonging to the different NSSI latent trajectory classes. Overall, this study provides an important first step to advance knowledge of longitudinal course and prediction of NSSI during adolescence. Importantly, this study also suggests that NSSI engagement may be well developed by Grade 10 for adolescents who report engaging in NSSI.

Findings from the growth curve analyses suggest that for a general population of adolescents, NSSI might be a transient phenomenon that decreases across the middle to late adolescent period. Analyses also showed a slight increase in NSSI engagement toward the later time-points in this study. Yet, given the relatively short developmental period covered in this study, this effect should be interpreted with caution. Only studies covering a longer time span could clearly reveal whether NSSI follows a quadratic trend characterized by a decline from middle to late adolescence and a subsequent reemergence beginning in late adolescence. Moreover, it should also be acknowledged that the general trend of NSSI engagement could represent a methodological artifact, such that participants were less likely to report their NSSI engagement throughout the course of the longitudinal study as they

**Table 4** Multivariate multinomial logistic regression of baseline predictors on NSSI trajectory classes

Predictors	NSSI trajectories		
	Moderate vs. Low OR (95 % CI)	Chronic vs. Low OR (95 % CI)	Chronic vs. Moderate OR (95 % CI)
Sex	0.53 (0.35–0.80)**	0.45 (0.19–1.03) <sup>†</sup>	0.84 (0.35–2.00)
Lifetime depression	2.43 (1.02–5.81)*	4.72 (1.40–15.88)*	1.94 (0.57–6.61)
Rumination	1.04 (1.01–1.06)**	1.03 (0.98–1.08)	0.99 (0.94–1.04)
Negative attributional style	1.09 (0.86–1.37)	1.81 (1.11–2.95)*	1.67 (1.00–2.77)*

The number of adolescents in the three NSSI trajectory classes was 427, 161 and 29 for the low, moderate and chronic trajectory class respectively

<sup>†</sup>  $p < 0.10$ ; \*  $p < 0.05$ ; \*\*  $p < 0.01$



were at the beginning. Similar trends have been found for longitudinal research on depressive symptoms (Twenge and Nolen-Hoeksema 2002). Despite this possibility, providing an empirical account of this overall longitudinal course of NSSI is important, as this has not been documented to date.

Moreover, this study identified distinct trajectory classes of NSSI across 2 years of adolescence. Most importantly, there was a group of adolescents with chronically high levels of NSSI engagement over 2 years. Findings provide empirical support for the existence of two distinct groups of adolescents who reported considerable and relatively stable levels of NSSI engagement over time. This study builds upon previous literature on the presence of subgroups of NSSI engagement (e.g., Bjärehed et al. 2012; Klonsky and Olin 2008; Whitlock et al. 2008), showing that there are also distinct trajectory classes of NSSI over time. Specifically, findings from this study extend existing work that conceptually differentiated between episodic (or moderate) and stable (or chronic) NSSI engagement (e.g., Brunner et al. 2007; You et al. 2011), and expand upon previous cross-sectional research identifying latent classes of individuals with different frequencies of NSSI engagement (Whitlock et al. 2008; Klonsky and Olin 2008).

Notably, while in the overall sample NSSI engagement slightly decreased over time, the group-based trajectory analyses revealed more stability in NSSI engagement. That is, the three NSSI trajectory classes mainly differed in the severity of NSSI engagement (e.g., chronically high and moderate levels of NSSI engagement), rather than in the qualitative shape of the longitudinal course of NSSI. The stability of the trajectory classes suggests that, during this developmental period, adolescents who engage in NSSI at higher levels at an earlier point in time are especially likely to do so later on. Due to the stable nature of their NSSI, these adolescents may additionally be at an especially high risk for suicidal behaviors (Joiner 2005). By examining the presence of specific latent trajectory classes, we were able to detect this chronic, high risk NSSI group, which was essentially invisible in analyses on the general growth of NSSI.

All of the cognitive vulnerability factors investigated in this study were important for understanding NSSI engagement. When examining the general course of NSSI in the overall sample, adolescents with higher levels of cognitive vulnerabilities reported higher initial levels of NSSI engagement. However, depression diagnosis was the only factor to predict changes in NSSI over the 2-year period: depressed adolescents showed more stable and elevated NSSI engagement from Grades 10 to 12 compared to non-depressed adolescents. Additionally, the group-based latent trajectory models extended these findings by showing that rumination differentiated the moderate from the low trajectory class, and negative attributional style differentiated the chronic from the low and

moderate trajectory classes. Most significantly, results supporting the role of negative attributional style are consistent with previous longitudinal research on NSSI in adolescents (Hankin and Abela 2011) showing that negative attributional style (and not rumination) predicts NSSI engagement. Hopelessness theory of depression and suicidality (Abramson et al. 1989; Cornette et al. 2000) posits that a negative attributional style confers greater risk for hopelessness (Joiner 2001) and suicidality (Priester and Clum 1992). Thus, negative attributional style should be considered a potent diathesis that may put individuals at greater risk for NSSI as well. Although findings from this study highlight the importance of cognitive vulnerabilities, in particular negative attributional style, for understanding adolescent NSSI, results from both growth curve models and group-based trajectory models together suggest that cognitive vulnerabilities may associate with different levels of NSSI engagement in middle adolescence but may not necessarily predict changes in NSSI engagement from middle to late adolescence.

Adolescents' sex played a role in predicting initial levels of NSSI as well as trajectory group membership, although the direction of these effects was unexpected. Boys reported higher initial levels of NSSI engagement as well as a higher probability to follow a moderate or chronic (marginal effect) NSSI trajectory class as compared to a low one. Literature on sex and NSSI among youth has been mixed (see Barocas et al. 2011); yet research on NSSI in adolescent samples from Western European and American cultures mainly suggests that adolescent girls tend to engage in NSSI more often or frequently than boys do. Although NSSI seems to be a common phenomenon across different countries, including China (see Muehlenkamp et al. 2012), and a body of emerging literature supports that NSSI is a cross-cultural phenomenon (e.g., Madge et al. 2008; Plener et al. 2009), it is possible that cultural differences exist in the role of sex on NSSI between East Asian (e.g., Chinese) and Western youth. This seems plausible given that although girls broadly tend to experience internalizing disorders at higher rates than boys, this gender gap seems to disappear in Asian countries (Hopcroft and Bradley 2007; Weissman et al. 1996).

Studying self-injurious thoughts and behaviors, including NSSI, in China is important in its own right, as internalizing disorders (e.g., depression; see Kessler et al. 2007), somatic presentation of distress (Ryder et al. 2008), and suicide (Phillips et al. 2002) have recently shown an increase in prevalence in eastern countries such as China. Yet, less attention has been given specifically to NSSI. Historically, China has been a prototypical collectivist culture, favoring family and community over the individual (Triandis 1995). In recent years, however, China has experienced marked shifts with a very quickly increasing middle class, along with urbanization and modernization, which has been accompanied by growing individualistic tendencies. It seems plausible that along with the rise of China's middle class has

come a spike in expectations and subsequent pressure on the youth in China. Yet, these youth may not be equipped to emotionally handle this pressure, possibly explaining the raise in internalizing disorders, including NSSI. Limited research has examined cross-cultural differences in NSSI, and the finding that being a boy from China confers higher risk for greater levels of NSSI engagement suggests that future research should aim to better understand cross-cultural sex differences in NSSI in adolescence and attempt to better define how these cultural differences might fit with the larger literature on NSSI in westernized cultures.

Findings from this study have implications for the treatment of youth NSSI. For adolescents engaging in NSSI, high levels of negative attributional style may be suggestive of severe levels of NSSI engagement. It would be useful for clinicians to not only assess NSSI engagement but also attributional style to determine client's risk. In addition to assessing negative attributional style as evidence for elevated NSSI risk, our data also indicate that attributional style may be an important target for treatment. Meta-analytic reviews suggest that negative attributional style can be improved via cognitive behavioral therapy (CBT; e.g., Jacobson et al. 1996; Reinecke et al. 1998).

It is important to consider strengths and limitations of this study. This was the first study to empirically test longitudinal growth and latent trajectory classes of adolescent NSSI engagement. We utilized a sample of 617 adolescents in Grades 10 through 12 and assessed NSSI engagement every 3 months for 2 years, totaling eight waves of NSSI engagement data. Moreover, this study used theoretically driven distal factors in predicting risk for NSSI engagement over time. Despite these strengths, some limitations must be considered. First, this study was conducted in China, and relatively less research has classified NSSI in China (see You et al. 2012; You et al. 2011 for exceptions). It is possible that findings from this study are specific to Chinese adolescents and do not generalize to other cultures. Future research should aim to replicate these findings in other cultures. Second, NSSI was measured using a self-report questionnaire. Although self-report questionnaires are not inherently problematic (Haeffel and Howard 2010), clinical interviews provide a more recognized gold-standard approach to assessing NSSI in youth samples. The use of a self-report questionnaire possibly allowed for participants in the study to confidentially report NSSI engagement, yet this failed to allow researchers to clarify that participants clearly understood the definition of NSSI as well as to clarify the nature of reported NSSI engagement that an interview would afford. Third, despite the longitudinal design including multiple assessments, NSSI trajectories were examined only within a relatively limited developmental period, from Grades 10 to 12. Future studies are warranted to examine the developmental course of NSSI across a broader life-span. For example, it is possible that other NSSI trajectory classes exist

outside of this time-frame, including a group of youth who desist from engaging in NSSI before Grade 10. Fourth, predictors were assessed only at baseline. However, it is possible that idiographic changes in the predictor variables (vs. nomothetic, trait-level differences) are more relevant for determining change in NSSI engagement over time. Last, given the focus on NSSI longitudinal patterning and latent trajectory classes, the present report did not examine suicidal thoughts and behaviors along with NSSI, although these can often co-occur and have similarities in their etiology and outcomes. Importantly, some adolescents concurrently report NSSI as well as suicidal thoughts or behaviors, and NSSI may also put youth at risk for later suicidality (e.g., Guan et al. 2012).

In summary, findings from this study revealed that the general longitudinal course of NSSI engagement showed a slight decrease over a 2-year follow-up from middle to late adolescence. However, this general decline in NSSI may mask important differences in the longitudinal course of NSSI. Indeed, three groups of adolescent NSSI engagement were unearthed, including a trajectory class of no/low NSSI engagement, moderate NSSI engagement, and chronic NSSI engagement. Baseline predictors distinguished NSSI trajectory classes. Most importantly, negative attributional style predicted chronic NSSI trajectory class membership. This study suggests that not only may two distinct groups of adolescents exist (i.e., those who do or do not engage in NSSI), but also distinct trajectory classes may exist with varying frequencies of engagement in NSSI over time. These groups may show differential etiological or prognostic patterns.

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**Conflict of Interest** The authors of this manuscript have no conflicts of interest or financial interests relevant to the subject of this manuscript. The authors of this manuscript take responsibility for the integrity of the data and the accuracy of the data analysis, and all authors had full access to all the data in the study.

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