



Measuring Adolescents' Self-injurious Thoughts and Behaviors: Comparing Ecological Momentary Assessment to a Traditional Interview

Erika C. Esposito¹ · Annie M. Duan¹ · Jaclyn C. Kearns¹ · Evan M. Kleiman² · Yeates Conwell³ · Catherine R. Glenn^{1,3,4}

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Abstract

The purpose of this study was to compare adolescents' reports of self-injurious thoughts and behaviors (SITBs) between ecological momentary assessment (EMA) and a traditional, retrospective interview. Adolescents were recruited following recent discharge from acute psychiatric care for a suicidal crisis (as part of a larger study). Participants completed: (1) EMA surveys assessing SITBs multiple times daily over a 28-day follow-up period, and (2) a follow-up phone interview to evaluate SITBs retrospectively at the end of the same 28-day follow-up period. Forty-one adolescents completed the final follow-up interview ($M_{\text{age}} = 14.9$ years; 78.0% White; 61.0% female). Adolescents' reports of SITB presence (vs. absence) and frequency, collected via EMA and retrospective interview over follow-up, were compared. Preliminary differences in SITB endorsement (presence/absence) were observed between reporting methods with more adolescents endorsing suicide ideation (SI; $n = 30$) and nonsuicidal self-injury (NSSI; $n = 15$) in EMA compared to retrospective interview (SI: $n = 17$; NSSI: $n = 10$). Reasons for withholding SITBs from EMA reports (gathered during a final qualitative interview) included not wanting to answer additional EMA questions and concerns about EMA-reporting consequences. There were no statistically significant differences in SITB frequency by report method. Further investigation is warranted in a larger sample to elucidate frequency patterns. Given the growing research using this method, these findings are important to help clarify the utility of EMA methods for studying SITBs in youth.

Keywords Adolescents · Ecological momentary assessment · Self-injurious thoughts and behaviors · Nonsuicidal self-injury

Introduction

Nonfatal self-injurious thoughts and behaviors (SITBs) among adolescents are a major public health concern. SITBs range from nonsuicidal self-injury (NSSI; i.e., intentional self-harm *without* any intent to die), to suicide ideation (SI;

i.e., thoughts about wanting to kill oneself) and suicide-related behaviors (SRBs; i.e., behaviors with at least *some* intent to die, including aborted, interrupted, and full suicide attempts; Nock et al., 2008; Silverman et al., 2007). SITBs are relatively rare during childhood but increase significantly during the transition to adolescence and throughout this developmental period (Nock et al., 2008) and are associated with significant academic and social impairment for youth (Goldman-Mellor et al., 2014). Furthermore, SITBs confer risk for suicide (Ribiero et al., 2015)—the second leading cause of death among adolescents ages 12 to 18 (Centers for Disease Control and Prevention [CDC], 2019b).

Most research on SITBs has used aggregated reporting methods (e.g., retrospective report) assessed over long periods of time (e.g., past year; CDC, 2019a). These methods may be limited by recall biases (Deming et al., 2021; Shiffman et al., 2008) and fail to capture the transient nature of SITBs, particularly for SI which has been shown to fluctuate in

✉ Erika C. Esposito
erika.esposito@rochester.edu

¹ Department of Psychology, University of Rochester, 355 Meliora Hall, Box 270266, Rochester, NY 14627, USA

² Department of Psychology, Rutgers, the State University of New Jersey, Piscataway, NJ, USA

³ Department of Psychiatry, University of Rochester Medical Center, Rochester, NY, USA

⁴ Department of Psychology, Old Dominion University, Norfolk, VA, USA

frequency, intensity, and duration from day-to-day among youth (Czyz et al., 2019; Nock et al., 2009) and *within* day among adults (e.g., Kleiman et al., 2017). To address these limitations, research is increasingly using intensive longitudinal methods, including daily diary (once daily surveys; Gunther & Wenzel, 2012) and ecological momentary assessment (EMA; multiple surveys daily; Shiffman et al., 2008), to assess SITB fluctuations with greater temporal resolution. EMA assesses experiences (thoughts, feelings, behaviors) in “real time” (i.e., as they occur or close to when they occur) through multiple daily self-report assessment points in the “real world” (i.e., in an individual’s naturalistic environment; Shiffman et al., 2008), thus reducing recall biases in self-report. EMA is particularly useful for capturing within-day fluctuations that may otherwise go unreported via retrospective and aggregated methods (Gratch et al., 2020; Kleiman et al., 2018; Wang et al., 2021), and allows for greater exploration of how time-varying factors influence clinical outcomes prospectively (e.g., Wang et al., 2021), on the order of hours or minutes (Russell & Gajos, 2020; Shiffman et al., 2008). Notably, EMA has been identified as a feasible and reliable longitudinal design for collecting a range of physical and behavioral health data among adolescents (Gee et al., 2020; Heron et al., 2017; Russell & Gajos, 2020; Wen et al., 2017), including adolescent SITBs (Czyz et al., 2018; Glenn et al., 2022; Nock et al., 2009).

Although EMA is hypothesized to facilitate more accurate SITB reporting compared to retrospective assessment aggregated over time, only three studies have examined this empirically. First, Gratch et al. (2020) examined differences in reporting any SI (i.e., presence vs. absence) over a 7-day period by comparing adult EMA to an aggregated, retrospective self-report measure (Beck Scale for Suicide Ideation, administered by phone; Beck et al., 1979). Results highlighted that adults ($n = 51$) were more likely to endorse any SI when assessed multiple times daily via EMA (98% reported any SI) than during retrospective report (41% reported any SI; Gratch et al., 2020). SRBs were not examined in this study. Second, Czyz et al. (2018) compared adolescent reporting of any SI (i.e., presence vs. absence) in daily diary to an aggregated, retrospective interview (Columbia-Suicide Severity Rating Scale; Posner et al., 2011) over a 28-day period. Adolescents ($n = 32$) were more likely to report any SI via daily diary (71%) as compared to the interview (45%; Czyz et al., 2018). SRBs were verified at follow-up (i.e., not reassessed), thus yielding only one unique assessment point and prohibiting the comparison of reported SRBs across the two methods (Czyz et al., 2018). Third, Czyz et al. (2021) compared adolescent NSSI reporting (i.e., presence vs. absence) in daily diary to an aggregated, retrospective interview (Columbia-Suicide Severity Rating Scale; Posner et al., 2011) over a 28-day period. Adolescents ($n = 75$) were more likely to report any NSSI

via daily diary (41%) compared to the interview (28%), and only two adolescents reported NSSI in the interview without also endorsing NSSI via daily diary (Czyz et al., 2021). Collectively, these results indicate that more frequent SITB assessment (via daily diary and EMA) may offer advantages compared to traditional retrospective reporting methods, particularly when assessing SI. However, advantages of using EMA to assess SITBs have not been empirically examined among adolescents specifically.

The current study examined differences between adolescents’ self-report of SITBs longitudinally via EMA and a traditional interview (i.e., aggregated, retrospective report) at the end of the follow-up period. Consistent with prior adult EMA and adolescent daily diary findings, it was hypothesized that NSSI endorsement and SI endorsement and frequency would be greater via EMA report as compared to retrospective interview report among adolescents. To date, there has not been an empirical examination comparing EMA to retrospective interview report of SRBs and NSSI frequency; therefore, these analyses were exploratory, without any a priori hypotheses.

Method

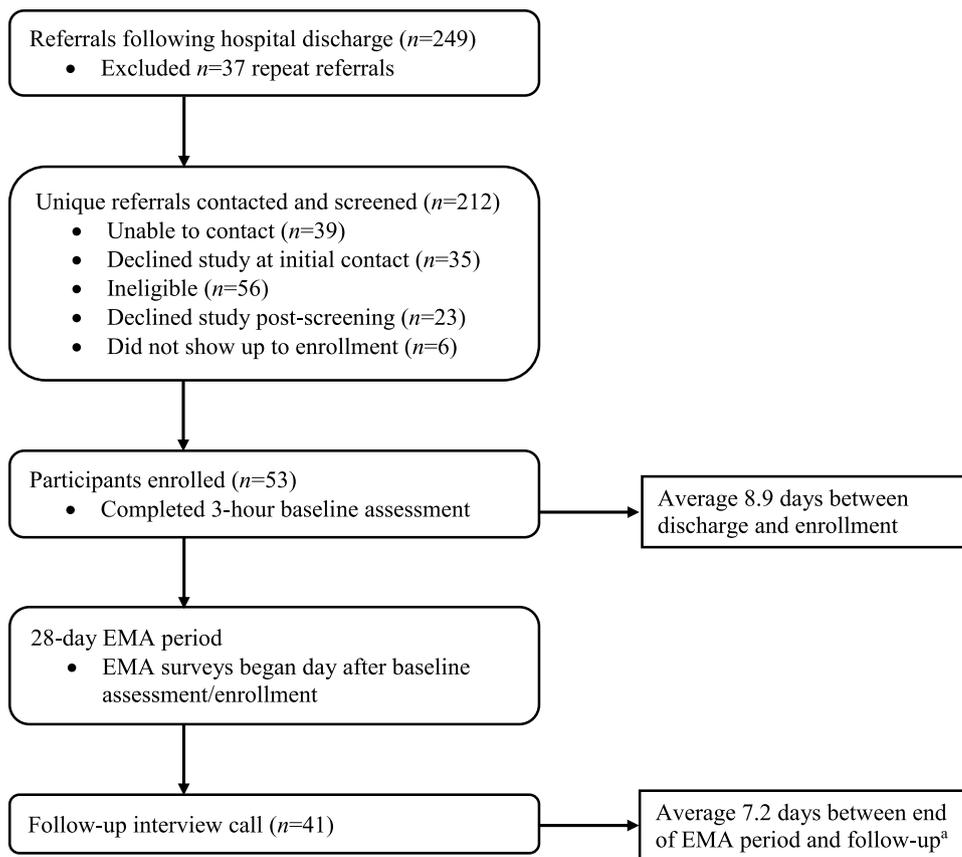
Participants

Fifty-three adolescents (25% of all unique referrals) were recruited (via email and phone) following acute psychiatric care at an urban academic medical center to examine short-term risk factors for SITBs. Results and detailed methods are reported in Glenn et al. (2022). Eligible adolescents were: (1) 12–18 years old, (2) recently discharged (within two weeks) from acute psychiatric care (i.e., emergency room visit, inpatient unit, partial hospitalization) for a suicidal crisis (i.e., SI with intent and/or a plan or SRB), (3) transitioning to the same medical center’s outpatient mental health service (for risk and safety monitoring purposes), (4) able to assent/consent to study procedures, (5) deemed safe to participate (i.e., not at imminent risk of harming themselves/others), (6) did not have a sibling participating in the study, and (7) had a parent willing to participant.

Measures and Procedure

The study included a baseline assessment, as well as follow-up assessments of adolescent SITBs: (1) over a 28-day period using EMA with multiple daily assessments, and (2) retrospectively at the end of the 28-day period using a semi-structured interview assessing SITBs (aggregated) over the follow-up period (see Fig. 1). Adolescents were compensated \$25 weekly for completing 75% of their EMA

Fig. 1 Flowchart of Study Timeline. Pre-enrollment details adapted from Glenn et al. (2022) (Fig. 1)



surveys and received an additional \$25 for completing the final follow-up interview.

EMA

During the EMA phase, participants were asked to complete several brief surveys daily on a personal or loaned smartphone¹ via an EMA application (MetricWire), including: 3–6 signal-contingent surveys (SCs) occurring randomly throughout the day (outside of school hours), and 1

interval-contingent survey each evening (ICPM). Adolescent availability over the follow-up period was collected during baseline to optimize EMA survey completion and to avoid disruption during school and other activities. Adolescents had 30 min to complete SCs and 2 h to complete ICPMs. EMA adherence was defined as completing 5 surveys per day (3 SCs, 1 ICPM, and 1 additional survey not used in the current analyses and described elsewhere; Glenn et al., 2022) throughout the 28-day follow-up period. SITBs were assessed at each survey timepoint. In all surveys, SITB items assessed presence and frequency with questions adapted from prior EMA studies of SITBs (e.g., Kleiman et al., 2017, Nock et al., 2009; see Table 1). In addition to examining the presence and frequency of SI, SI severity was assessed on a scale from 0 (“No desire present”) to 5 (“Extremely intense”). SCs assessed SITBs both at the moment of survey completion and since completing their last survey, while ICPMs assessed any unreported SITBs that day. Participants were also encouraged to complete a user-initiated event-contingent survey (ECs) if a SITB occurred between assessment points. Unique SITBs reported in any survey type (i.e., SC, ICPM, or ECs) were included in analyses. There was

¹ To minimize recruitment bias on the basis of socioeconomic status, adolescents who did not have their own smartphone device were provided with a temporary, inexpensive smartphone and limited data plan for the duration of the follow-up period (approximately 1 month; n=8). Among the 8 adolescents with a loaned smartphone, n=3 were due to technical issues with their own smartphone device, n=2 were due to lost personal smartphone privileges, and the reasons for the remaining n=3 were not recorded. All loaned smartphone devices were provided to the adolescent with parental consent and returned to study staff at the end of the follow-up period. More details can be found in Glenn et al. (2022).

Table 1 Items Assessing Self-Injurious Thoughts and Behaviors using Ecological Momentary Assessment and a Traditional Follow-up Interview

		EMA Item ^a	Interview Item ^b
Nonsuicidal Self-Injury	Presence/Absence	Did you actually hurt yourself without wanting to die?	... have you done anything to purposely hurt yourself without wanting to die?
	Frequency	^c	... how many times?
Suicide Ideation	Presence/Absence	Have you been thinking about attempting suicide (hurting yourself to die)?	... have you actually had any thoughts of killing yourself?
	Frequency	^c	... how many days?
Suicide-Related Behaviors	Presence/Absence		
	<i>Actual SA</i>	Did you attempt suicide?	... have you actually made a suicide attempt?
	<i>Aborted SA</i>	Were you close to killing yourself and at the last minute someone or something else stopped you?	...has there been a time when you started to do something to end your life but someone or something else stopped you?
	<i>Interrupted SA</i>	Were you close to killing yourself and at the last minute decided not to kill yourself?	... has there been a time when you started to do something to try to end your life, but you stopped yourself before you did anything?
	Frequency		... how many times?

EMA ecological momentary assessment, SA suicide attempt

^aParticipants were asked to reply to EMA items in three different survey types: signal-contingent (SC), event-contingent (EC), and interval-contingent (IC). SCs occurred randomly throughout the day and ECs were self-initiated surveys in response to self-injurious thoughts and behaviors (SITBs; e.g., nonsuicidal self-injury, suicide ideation). SC and EC SITB items began “*Are you right now (or were you recently)...*” and were designed to capture momentary SITBs at the time of the survey. ICs occurred each evening and began with “*Today, ...*” and prompted adolescents to report any unlogged SITBs

^bInterview items began with “*During the follow-up period...*” and adolescents were oriented to the specific number of days of their follow-up period

^cFrequency was calculated by generating a cumulative total from all available EMA survey response data across the follow-up period to calculate a total number of instances for nonsuicidal self-injury and suicide-related behaviors and a total number of days of suicidal ideation. Responses were compared across EMA surveys to ensure that reporting instances were not double counted

no missing SITB data across submitted EMA surveys (i.e., EMA data was missing at the survey-level, only).

Interview

The final follow-up phone interview was conducted using a modified Columbia Suicide Severity Rating Scale (C-SSRS; Posner et al., 2011) to assess SITBs collectively over the 28-day follow-up period. The C-SSRS is a validated semi-structured interview of adolescent SI and SRBs (Posner et al., 2011) and was modified by limiting the period of inquiry to converge with the EMA follow-up period and including items from the Self-Injurious Thoughts and Behaviors Interview (Nock et al., 2007) to more fully assess adolescent NSSI. SITB data collected via interview were adjusted to reflect the period of EMA enrollment for each adolescent prior to analyses. As the final component of the follow-up assessment, participants also were asked to provide qualitative feedback ($n = 22$) on a range of study features, including whether they chose not to report a SITB via EMA (yes or no) and why (open ended). Notably, questions about SITB reporting behaviors were added to the qualitative feedback survey after enrollment began. Adolescent privacy was established at the outset of the follow-up phone call.

Risk and Safety Monitoring

Adolescent suicide risk and safety were assessed at each phase of the research study (baseline assessment, EMA, follow-up interview). Consent to inform the adolescent’s current outpatient mental health therapist of their participation was obtained, and therapists were contacted to establish preferred method of contact for safety concerns (e.g., email, pager). At the end of the baseline session, the study team completed a formal risk assessment examining the adolescent’s risk state and status (Pisani et al., 2016), reinforced the adolescent’s pre-existing safety plan, and reviewed EMA data monitoring and safety procedures with the adolescent and their parent. Twice daily, raw EMA data was reviewed for critical safety items to determine whether further follow-up was indicated to maintain adolescent safety (see Glenn et al., 2022 for more details). When indicated, an attempt was always made to contact the adolescent first to complete a more thorough risk assessment of their risk state before contacting their parent or therapist. Parents and therapists were contacted whenever an adolescent reported an SRB, if an adolescent was determined to be at high-risk based on their risk assessment, or if an adolescent could not be reached (see Glenn et al., 2022 for more details). Finally,

the research team completed a formal risk assessment at the end of the follow-up interview.

Data Analysis

Categorical comparisons (e.g., presence/absence) between EMA and interview reports of SITBs were examined using a Chi-square test. The resulting 2x2 contingency table reports expected number of observations for each cell. For SITBs with expected cell counts less than five, significance from a two-sided Fisher’s exact test is reported. Odds ratios and associated 95% confidence intervals (95% CI) were calculated as a measure of effect size. For SITBs where one or more of the observed cells was equal to zero, a Haldane-Anscombe correction (i.e., adding 0.5 to all cells; Anscombe, 1956; Haldane, 1940) was applied to compute the effect size and 95% CIs (Lawson, 2004; Ruxton & Neuhäuser, 2013).

Paired samples *t* tests were used to examine differences in continuous SITB constructs (i.e., frequency) between EMA and interview methods. For paired samples *t* tests, Hedges’ *g* values indicate effect size and were reported in lieu of Cohen’s *d* due to small sample sizes. In addition to SI presence and frequency, severe SI was computed based on reported instances of suicidal desire over one standard deviation above the adolescent’s own mean suicide desire (i.e., relative SI severity) during the EMA follow-up period.

Results

Of the 53 adolescents enrolled in the larger study, 41 (77%) completed the final follow-up assessment at the end of the EMA follow-up period ($M = 32.41$ days, $SD = 6.42$, Range = 10–49 days) and are the subsample reported here² (see Table 2). Among the 41 adolescents, average EMA adherence rate of 62%, consistent with prior daily diary and EMA work with clinical adolescent samples (e.g., Heron et al., 2017; Van Roekel et al., 2019; Wen et al., 2017). However, 7 adolescents (17%) completed less than 28 days of EMA ($M = 25.22$ days, $SD = 6.63$, Range = 5–28 days) due

² Reasons for not completing the last follow-up call included: adolescent rehospitalization ($n = 4$), adolescent declined participation due to low mood ($n = 2$), or unknown reason but unable to schedule call or lost to contact ($n = 6$). There were no statistical differences ($p > 0.05$) in demographics (age, gender identity, sexual orientation, racial identity, ethnicity, or parent-reported annual household income) between participants who completed their follow-up call ($n = 41$) and those that did not ($n = 12$). Adolescents who completed the follow-up were more likely to have engaged in NSSI over their lifetime ($t(51) = -2.37$, $p = 0.021$, $d = 0.38$) and were less likely to have reported SRBs in the month prior to enrollment ($t(47) = 2.80$, $p = 0.007$, $d = 0.47$) when compared to those who did not complete the final follow-up assessment.

Table 2 Adolescent Sociodemographic Factors and Clinical Severity at Baseline

	Adolescents ($n = 41$)
Age (years): <i>Mean (SD)</i>	14.9 (1.5)
Gender Identity: % (n)	
Female	61% (25)
Male	17% (7)
Nonbinary ^a	22% (9)
Racial Identity: % (n)	
White	78% (32)
Black/African American	7% (3)
Multi-racial	7% (3)
American Indian/Alaskan Native	2% (1)
Other/Do not wish to answer	5% (2)
Ethnicity: % (n)	
Hispanic/Latinx ^b	12% (5)
Sexual Orientation: % (n)	
Heterosexual	39% (16)
Gay or Lesbian	7% (3)
Bisexual	32% (13)
Pansexual	5% (2)
Asexual	5% (2)
Unsure	12% (5)
Annual Household Income ^c : % (n)	
<\$29,000	5% (2)
\$30,000–\$69,000	34% (14)
\$70,000–\$99,000	29% (12)
>\$100,000	20% (8)
Prefer not to report	12% (5)
Lifetime Self-Injurious Thoughts and Behaviors: % (n)	
Nonsuicidal self-injury	88% (36)
Active suicide ideation	100% (41)
Suicide-related behaviors:	98% (40)
Aborted suicide attempts	68% (28)
Interrupted suicide attempts	27% (11)
Suicide attempts	78% (32)
Past-Month Self-Injurious Thoughts and Behaviors: % (n)	
Nonsuicidal self-injury	63% (26)
Active suicide ideation	93% (38)
Suicide-related behaviors ^d :	37% (15)
Aborted suicide attempts	20% (8)
Interrupted suicide attempts	7% (3)
Suicide attempts	22% (9)

SD standard deviation

^aNonbinary includes adolescents identifying as transgender, agender, and nonbinary

^bThree adolescents preferred not to report ethnicity

^cAnnual household income reported by parent during baseline assessment

^dSuicide-related behaviors, including aborted suicide attempts, interrupted suicide attempts, and full suicide attempts, were not mutually exclusive (i.e., adolescents could endorse any or all behaviors)

Table 3 Adolescent Self-Injurious Thoughts and Behaviors by Reporting Method (mutually exclusive categories)

	EMA report, only	Interview report, only	EMA & Interview (both)
Nonsuicidal Self-Injury ($n=17$)	41% ($n=7$)	12% ($n=2$)	47% ($n=8$)
Suicide Ideation ($n=30$)	43% ($n=13$)	-	57% ($n=17$)
Suicide-Related Behavior ^a ($n=9$)	33% ($n=3$)	33% ($n=3$)	33% ($n=3$)

Columns are mutually exclusive such that each adolescent reporting a self-injurious thoughts and behavior (SITB) during follow-up is accounted for as having reported a particular SITB via EMA only, interview only, or reported in both the EMA and interview (i.e., rows add to 100%)

Total sample $N=41$

EMA ecological momentary assessment

^aSuicide-related behavior includes aborted, interrupted, and full suicide attempts

to rehospitalization ($n=3$), early withdrawal from EMA ($n=2$), or having their phone taken away ($n=2$). ICPM-report uniquely identified 5 adolescents who engaged in NSSI (21 unique instances) and 1 adolescent who reported SRBs (6 unique SRBs) over adolescent SC- and EC-report. ICPM-report did not yield unique instances of SI. Twenty-two (54%) adolescents completed at least one EC (Range = 1–9) over the follow-up period. Further, 11 (27%) were contacted for EMA safety concerns during the EMA follow-up period, with 5 adolescents (12%) contacted more than once and 7 (17%) requiring follow-up conversations with their parent ($n=6$) and/or therapist ($n=5$). Though 3 adolescents were rehospitalized over the follow-up period, this was not a consequence of study safety monitoring procedures.

SITB Presence/Absence

Collectively, 17 (42%) adolescents reported NSSI (any), 30 (73%) reported SI (any), and 9 (22%) reported SRBs (any) over the EMA follow-up period (see Table 3). All adolescents reporting SI via EMA reported at least one instance of severe SI (i.e., a desire to kill themselves at a severity over one standard deviation above their own mean).

Results revealed that the number of adolescents identified as having engaged in a SITB over follow-up differed by reporting method (see Fig. 2). Specifically, among the 17 adolescents reporting NSSI, more reported NSSI via EMA ($n=15$) than during the follow-up interview ($n=10$; two-tailed Fisher's exact test, $p=0.006$, OR = 12.00, 95% CI [2.04, 70.44]). In addition, among adolescents reporting SI, more reported SI via EMA ($n=30$) than in the follow-up interview ($n=17$; two-tailed Fisher's exact test, $p=0.009$, OR = 19.44, 95% CI [1.02, 371.30]). All adolescents reporting SI via EMA also reported at least one instance of severe SI (i.e., one SD greater than their mean SI). However, these results did not appear to be driven by more severe SI; results did not change when focusing

on the number of adolescents with at least one instance of severe SI reported via EMA. Reporting of SRBs was equally distributed between methods (see Table 3),³ though statistical significance could not be reliably determined due to the small sample ($n=9$).

Qualitative feedback at the end of the study revealed that most adolescents (68%; $n=15$) did not withhold SITB reporting via EMA. Of the 32% ($n=7$) that endorsed withholding SITBs from their EMA responses, reported reasons included: did not want to answer additional SITB-specific EMA follow-up questions ($n=7$; 100%), concerns about rehospitalization ($n=3$; 43%), and concerns about informing parents ($n=3$; 43%). Notably, of the adolescents that endorsed underreporting SITBs, all reported at least one SITB via EMA, and the majority ($n=4$; 57%) reported SRBs via EMA during the study period.

SITB Frequency

Differences in adolescent SITB frequency are reported in Table 4. Among adolescents endorsing SITBs using both reporting methods, higher SI frequency was identified via EMA compared to the interview, while higher NSSI frequency was identified in the interview relative to EMA. However, these differences were not statistically different (SI: $t(16) = -1.30$, $p=0.211$, Hedges' $g = -0.31$; 95%

³ Of the six adolescents who reported SRBs via EMA, one adolescent reported at least one interrupted attempt, three adolescents reported at least one aborted attempt, and four adolescents reported at least one full suicide attempt. Of the six adolescents reporting SRBs via interview, there were no adolescents identified as having made an interrupted attempt, four adolescents reported at least one aborted attempt, and five adolescents reported at least one full suicide attempt that was not reported via EMA. Among the adolescents that reported their SRBs in both reporting methods (EMA and interview; $n=3$), there was 100% convergence in the types of SRBs reported across both methods. The sample size was too small to examine these differences empirically. These details are reported here for transparency.

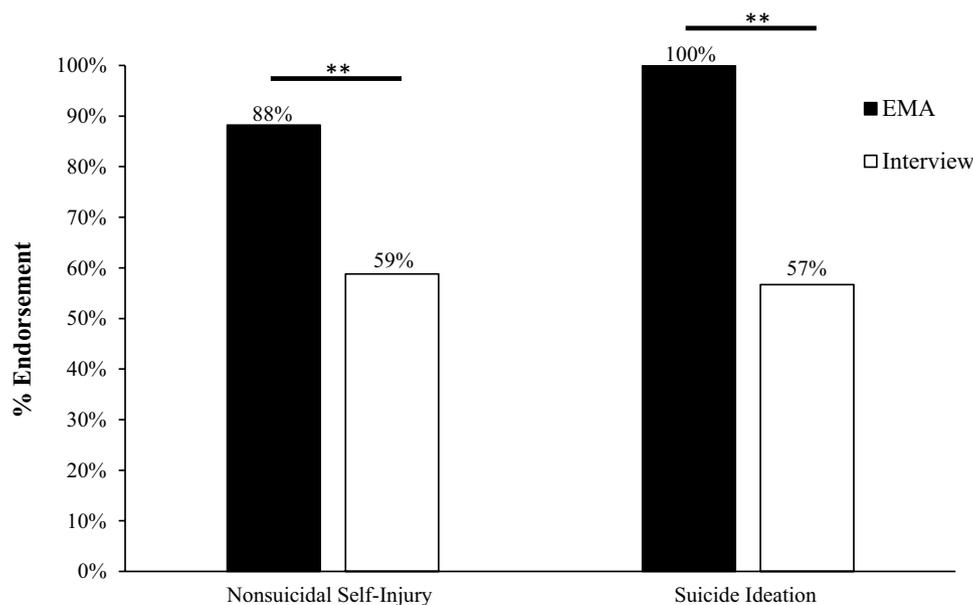


Fig. 2 Adolescent Endorsement of Self-Injurious Thoughts and Behaviors by Reporting Method. *EMA* Ecological Momentary Assessment. Among 41 adolescents, $n=17$ endorsed nonsuicidal self-injury and $n=30$ endorsed suicide ideation over the 28-day follow-up period in either EMA or retrospective interview. A two-sided Fisher's exact test was used to determine significance. Nonsuicidal self-injury reporting

differences between EMA and interview: two-tailed Fisher's exact test, $p=0.006$, OR=12.00, 95% CI (2.04, 70.44); suicide ideation reporting differences between EMA and interview: two-tailed Fisher's exact test, $p=0.009$, OR=19.44, 95% CI (1.02, 371.30). $^{***}p < 0.01$

CI [-0.78, 0.17]; NSSI: $t(7) = 2.31$, $p = 0.054$, Hedges' $g = 0.77$; 95% CI [-0.01, 1.52]). Notably, adolescents reported significantly more frequent SI during the interview ($M = 11.35$ days, $SD = 7.80$) compared to *severe* SI reported via EMA ($M = 6.41$ days, $SD = 4.30$; $t(16) = 2.42$, $p = 0.028$, Hedges' $g = 0.57$; 95% CI [0.06, 1.07]). Statistical significance of SRB frequency could not be reliably determined based on the particularly small sample ($n = 3$).⁴

Discussion

Findings from the current study support EMA's utility in capturing SITBs, particularly for SI, among adolescents. Regarding SITB presence or absence, more adolescents endorsed SI and NSSI via EMA than via interview, while an equal distribution of adolescents reported SRBs across EMA and interview report methods. Differences in SITB frequency were not statistically significant. However, preliminary results suggest a possible pattern in reporting of

SITB frequency, such that more frequent thoughts (i.e., SI) are reported via EMA and more frequent behaviors (i.e., NSSI and SRBs) via interview. These patterns are worth noting to facilitate transparency, support project development, and encourage examination in larger datasets.

Consistent with findings from a prior EMA study with adults (Gratch et al., 2020) and a daily diary study with adolescents (Czyz et al., 2018), results suggest that studies of adolescent SI may benefit from incorporating an EMA approach, as more adolescents endorsed SI via EMA and there was a pattern of reporting to suggest that EMA captured more frequent SI during the follow-up. Additionally, adolescents who denied SI during the interview but endorsed SI via EMA all experienced at least one instance of relatively severe SI per their EMA report. This is notable because evidence from other research domains (e.g., pain) support that more intense experiences may be more salient and subsequently overreported in retrospective interviews relative to EMA report, resulting in an overestimation of symptoms (Houtveen & Oei, 2007; Shiffman et al., 2008; Van den Brink et al., 2001). However, these results suggest reporting differences in adolescent SI by report method were not due to a focused recall of more severe SI.

EMA identified more adolescents as having engaged in any NSSI over follow-up (presence/absence), consistent with findings from an adolescent daily diary study (Czyz et al.,

⁴ Only one of the three adolescents reporting SRBs in both EMA and the interview diverged on their SRB frequency report. Specifically, this individual reported both more frequent aborted and full suicide attempts during their follow-up interview as compared to EMA.

Table 4 Frequency of Adolescent Self-Injurious Thoughts or Behaviors by Reporting Method (mutually exclusive categories)

	EMA report, only	Interview report, only	EMA & Interview report (both)	
	Median, (range)	Median (range)	EMA Median (range)	Interview Median (range)
Nonsuicidal Self-Injury ^a ($n=17$)	2.0 (1–3)	11.0 (2–20)	2.5 (1–6)	4.0 (1–8)
Suicide Ideation ^b ($n=30$)	12.0 (1–28)	-	12.0 (1–28)	10.0 (1–27)
Suicide-Related Behaviors ^c ($n=9$)	1.0 (1–3)	3.0 (1–7)	2.0 (1–3)	3.0 (1–13)

EMA ecological momentary assessment

^aNumber of episodes of nonsuicidal self-injury

^bNumber of days of suicide ideation

^cNumber of suicide-related behaviors, including aborted, interrupted, and full suicide attempts

2021). While adolescent reported NSSI frequency did not statistically differ by report method ($p=0.054$), the median NSSI frequency via interview was higher than EMA. One possible explanation for the trend of increased NSSI frequency via interview is that logging NSSI behavior via EMA may increase self-awareness of the behavior throughout the follow-up period, which may have artificially inflated their recall during follow-up interview (i.e., paying attention to the behavior daily over an extended period may have resulted in retrospective reporting bias). Alternatively, adolescents may have similar hesitations in reporting NSSI via EMA as they do for reporting SRBs. These concerns may even be enhanced by a fear that adults would misperceive their NSSI as *suicidal* behavior, possibly leading to stronger adult reactions and unnecessary hospitalization. This fear may be reduced by including follow-up questions during EMA and follow-up risk assessment that make it clear to the adolescent that the study team understands that there are differences between NSSI and SRBs in form and function, including the use of NSSI as coping mechanism for SI (Czyz et al., 2021).

Due to the low rate of SRBs over the follow-up across reporting methods, statistical analyses of reporting differences for SRBs could not be determined. However, exploratory review of the data suggests assessing SRBs via EMA identified an additional third of adolescents that would not have been captured via interview alone. Similarly, the traditional follow-up interview also uniquely identified a third of adolescents as having engaged in SRBs over follow-up. Given that SRBs are low base-rate behaviors, many studies of suicidal behavior are often underpowered to answer important questions about risk, resilience, and underlying mechanisms (present study included). Although preliminary, this descriptive information may suggest that the addition of EMA to traditional interview reporting methods may be useful for capturing SRBs, however, further investigation is warranted.

A small portion of adolescents ($n=7$) felt dissuaded from reporting all SITBs via EMA given the necessary safety

monitoring procedures, including informing their parents. Adolescents expressed concern about the possibility of hospitalization or even punishment. However, such safety monitoring of SITBs during EMA studies is essential and widely agreed upon for ethical data collection, particularly among youth (Bai et al., 2020; Nock et al., 2020). The most common reason adolescents chose not to report a SITB was to avoid answering subsequent follow-up questions. In this study (consistent with prior work, Czyz et al., 2018, 2021; Gratch et al., 2020; Kleiman et al., 2017; Nock et al., 2009), follow-up questions assessed details about the specific SITBs (e.g., behaviors, intent) to allow the study team to 1) accurately classify the single event instead of double counting across SITBs, 2) increase understanding of SITB severity, antecedents, and consequences, and 3) facilitate safety monitoring. While fewer and shorter EMA questions have been shown to increase EMA engagement among adults (Smyth et al., 2021), single-item measures of SITBs have been shown to result in higher instances of misclassification (Millner et al., 2015). Additionally, gaining follow-up information directly during EMA report is recommended to enhance study safety monitoring and to minimize study burden and unnecessary intervention (e.g., calling the adolescent or parent) during an observational study phase (Bai et al., 2020; Nock et al., 2020). However, these results suggest it is important to limit follow-up questions to only what is necessary to increase the likelihood of accurate EMA SITB reporting, particularly for youth. EMA study designs may consider an initial, limited set of EMA SITB questions followed by an assessment of willingness to answer additional items about the endorsed SITB. This will allow the study team the opportunity to gather more information about the endorsed SITB, while not artificially decreasing SITB endorsement due to a desire to avoid follow-up questions (particularly among adolescents concerned about privacy and consequences of reporting details of their experience).

Although examining SITBs via EMA is both feasible and acceptable without compromising safety or increasing SITB risk broadly (e.g., Coppersmith et al., 2021) and

among adolescents specifically (e.g., Czyz et al., 2018; Glenn et al., 2022; Nock et al., 2009), longitudinal EMA studies include complexities that traditional follow-up interviews do not. These can include the financial cost of the EMA software, time- and labor-intensive safety monitoring protocols, releases of information for care providers and/or other trusted adults for safety, among others (Bai et al., 2020; Glenn et al., 2022; Nock et al., 2020). Given these real-world constraints, it is important to consider the degree to which the research question necessitates an intensive methodology such as EMA or if traditional reporting methods suffice. For researchers considering EMA report as the sole method for longitudinal data collection, there needs to be careful consideration for the balance between gathering information for safety monitoring purposes and obtaining sufficient and honest report of experiences. Regular (e.g., daily) safety and adherence monitoring will be important not only to ensure adolescent safety (Bai et al., 2020; Bentley et al., 2021; Nock et al., 2020), but to also ensure sufficient data quality. However, as EMA study designs become more popular and larger in scale, individualized follow-up for SITB endorsement (as was done in this study) may not be feasible. In those instances, alternative safety strategies could include providing an immediate reference to emergency/support services or sending an automated alert to a designated support person (e.g., parent/caregiver, trusted adult, mental health provider), though the latter may dissuade some youth from reporting.

Limitations of this study suggest important future research directions. First, the study sample was small and predominantly White and female (not unlike other youth samples examining SITB self-report method convergence (e.g., Czyz et al., 2018), which may limit generalizability. However, the sample was diverse based on gender identity and sexual orientation, including 22% identifying as non-cisgender and 61% identifying as non-heterosexual. There is a critical need for rigorous SITB research among larger, more diverse adolescent samples across a range of geographical and socioeconomic contexts. Second, there was a low rate of SRBs reported over the 28-day follow-up period, making statistical analysis and interpretation of SRB results difficult. It is possible that the knowledge of study safety procedures for SRB reporting (e.g., notifying parent) may have similarly impacted adolescent interview reporting as it did for EMA reporting. However, such procedures are necessary to facilitate responsible and ethical research of youth SITBs (Nock et al., 2020). Future qualitative research could enhance understanding of the different reporting patterns between EMA and interview methods. Third, the present study examined two primary features of SITBs, (1) presence/absence and (2) frequency. Therefore, results cannot speak to reporting differences between EMA and interview measures for other SITB properties (e.g., severity/intensity, duration) that may have clinically meaningful implications

for understanding SITB function and risk. Of note, while SI severity was assessed via EMA report in the current sample, the follow-up interview did not have a comparable item to allow for a direct, one-to-one comparison. Large-scale, multisite collaborations capitalizing on intensive, longitudinal reporting (e.g., EMA) in addition to traditional, retrospective interview methods may be best suited to further examine the optimal measurement of adolescent SITBs (Glenn & Nock, 2014). Possible advantages to such studies include: (1) increased knowledge of adolescent SITBs among understudied and underserved populations, (2) capturing more low base rate behaviors (e.g., SRBs), and (3) examining moderator effects to develop and refine effective adolescent intervention and prevention efforts. The current results highlight a need to continue to examine accuracy of reporting a variety of SITB properties to enhance our understanding of adolescent SITBs.

In sum, research using EMA to explore and understand SITBs is increasing (Kleiman & Nock, 2017). The current study highlights the utility of EMA to bolster traditional SITB reporting methods for youth, particularly for SI. Future research in more diverse and younger samples is warranted, particularly given the increasing rates of SITBs among younger youth of color (Sheftall et al., 2016).

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Compliance with Ethical Standards

Ethical Approval and Informed Consent Adolescents aged 12–17 provided assent and required parental consent to participate, while 18-year-olds consented for themselves. All study procedures were approved by University of Rochester's Institutional Review Board (RSRB00066408).

Conflicts of Interest The other authors have no conflicts of interest to disclose.

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