SUICIDE AND RELATED BEHAVIOUR

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SUICIDE AND RELATED BEHAVIOUR

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Editorial: Suicide and Related Behaviour

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Editorial on the Research Topic

Suicide and Related Behaviour

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Suicide claims almost 1 million lives globally every year. Understanding and preventing suicidal behaviors and death by suicide is a largely unmet need: despite substantial efforts, suicide remains the second leading cause of death among youth and, over the last two decades, suicide mortality rates have increased in several regions across the globe (1). For instance, in the United States, suicide is the only leading cause of death that has not diminished over the last two decades—alongside opioid overdose, an entity that is closely related to suicide (2). The impact of suicide is far-reaching and affects families and communities over generations. Advancing suicidology is an urgent public health challenge.

Understanding suicidal behaviors is complex, as they emerge in the context of a complex multilevel chain of causation that includes poorly clarified neurobiological pathways and dynamic individual- and group-level risk and protective factors, interacting in a nuanced balance. Accordingly, despite substantial efforts, advancement of suicide risk stratification, prevention, and treatment tools over the last decades has been limited. Key limitations driving this phenomenon have been pointed out elsewhere and include, among others, (i) the fact that most research on suicide comes from a relatively small number of high-income countries, even though most people who die by suicide live in low and middle-income countries (3), (ii) traditional ethical reasons to systematically exclude suicidal individuals from clinical studies (4), or (iii) technical limitations, such as a generalized lack of enough detailed information in large prospective cohorts or a poor uptake of modern causal mediation epidemiological methods.

In this special topic on Suicide and Related Behavior, we sought to overcome traditional limitations of suicide research by expanding our scope to innovative approaches, both in terms of methodological tools and study populations. Here we provide a brief overview of the contents and highlights of the special topic.

A set of six studies take a mediation/moderation causal analysis approach to suicidal behaviors. Dal Santo et al. examine the role of impulsivity as a mediator in the association between early traumatic experiences and suicidal behaviors in a sample of 190 depressed patients. Using a simple mediation approach, they find results suggesting that impulsivity may play a mediating role in the association, an important finding with substantial potential implications for individual-level prevention. Rubio et al. adopt Hayes's approach to mediation, based on structural equation modeling, to prove the hypothesis that negative affect and suicide attempts are mediated by suicidal ideation in a large representative sample of Chilean high school students. A large study including almost 500 Chinese students assessed 4 years after the Ya'an earthquake by Liu et al. also uses a structural equation modeling approach to study the association between self-compassion and suicide risk, finding that positive and negative self-compassion, respectively, reduce and increase suicide risk, and that gratitude and post-traumatic stress disorder may be salient mediators. Mészáros et al. examine a sample of 363 (202 suicidal and 163 non-suicidal) adolescents to examine another highly relevant and novel variable, namely pathological internet use, and test whether it is associated with non-suicidal self-injury directly or through a series of psychopathological domains, finding no apparent link between self-injury and pathological internet use. Examining a large sample of Chilean adolescents, Núñez et al. investigate the associations between depressive symptoms, psychotic experiences, and suicidal ideation, describing patterns of association between specific symptoms from each of the three domains. Last, also using a randomly selected sample of adolescents from Santiago de Chile, another study by Rubio, Oyanedel, Cancino et al. examines social support and substance (alcohol, marijuana, and other illicit drugs) use as moderators of the relationship between depressive symptoms and suicidal ideation. They report that social support, regardless of whether provided by peers, family, or school; and alcohol use both moderate the depression-ideation association.

Two studies build on the rich tradition of observational research to identify salient correlated of suicidal risk. Lin et al. also focus on impulsivity. Their ingenious experiment couples a two-choice oddball paradigm with emotional stimuli and electroencephalogram recording to characterize participants' psychophysiological profile. Suicidal ideation is found to be associated with certain specific changes in behavioral inhibitory control in response to emotional information. These results suggest that what the authors call an "emotion-impulsivity framework" in information processing may be associated with suicidal ideation. Harnod et al., using Taiwan's nationwide population-based databases, examine more than 600,000 adults with sleep-disordered breathing to examine the prospective association between head trauma and suicide risk. Their finding of a 2-fold increase in risk among individuals with a history of head trauma, after adjusting for a comprehensive set of potential confounders, is accompanied by detailed examination of other risk factors, including a potential synergistic effect with age, greatly enhancing understandability of potential implications.

Over the last years, evidence supporting brief interventions, including contact and psychotherapeutic interventions, has somewhat brought about a renovated hope in suicide prevention intervention research. Here, in a pilot study featuring 26 adolescents, Haruvi Catalan et al. examine the foundations of an ultra-brief crisis intervention based on Interpersonal Therapy for high-risk children and adolescents. Their preliminary results are promising and suggest treatment safety, feasibility, and acceptability. Also, the emerging role of people with lived experiences in discussions around mental health is changing the current paradigm of knowledge production in psychiatric research. Schilling et al. report qualitative assessments of a group of seven adolescents serving as research guides in the development of Project Clan, a technology-based intervention to reduce adolescent suicide in Chile. They provide critical insights to understand the specifics underlying adolescent suicide, emphasizing the importance of generating anonymous, secure spaces for self-expression online. Their experience adds to existing evidence supporting incorporation of people with lived experiences in every step of the development of mental health interventions. Last, a meta-research study by Bittar et al. reviews the wide range of studies related to suicide conducted using the Clinical Record Interactive Search, a large data repository from London. They provide a critical appraisal of studies using only structured information and highlight the most important milestones in the use of non-structured clinical records for epidemiological research using natural language processing and data mining techniques. This study should prompt discussion, as it covers in detail a hotly debated topic in research using electronic health records—namely use of automatized data extraction and analysis methods.

Suicide is preventable tragedy. We thank the research teams featured in this special topic for their work and encourage them to continue generating knowledge to critically enhance our understanding of suicide, its causes, and its prevention. We hope that readers of the Journal will find this special topic timely and interesting, and that the results included here help guide decision-making at several levels.

AUTHOR CONTRIBUTIONS

All authors conceived and developed the presented idea, and contributed to the writing of the final manuscript equally.

REFERENCES

1. Naghavi M. Global, regional, and national burden of suicide mortality 1990 to 2016: systematic analysis for the Global Burden of Disease Study 2016. *BMJ*. (2019) 364:l94. doi: 10.1136/bmj.l94
2. Martinez-Ales G, Hernandez-Calle D, Khauli N, Keyes KM. Why are suicide rates increasing in the United States? Towards a multilevel reimagination

of suicide prevention. In: Baca-Garcia E, editor. *Behavioral Neurobiology of Suicide and Self Harm. Current Topics in Behavioral Neurosciences.* Cham: Springer International Publishing (2020). p. 1–23. doi: 10.1007/7854_2020_158

3. Lopez-Castroman J, Blasco-Fontecilla H, Courtet P, Baca-Garcia E, Oquendo MA. Are we studying the right populations to understand suicide? *World Psychiatry*. (2015) 14:368–9. doi: 10.1002/wps.20261
4. Oquendo MA, Stanley B, Ellis SP, Mann JJ. Protection of human subjects in intervention research for suicidal behavior. *Am J Psychiatry*. (2004) 161:1558–63. doi: 10.1176/appi.ajp.161.9.1558

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Understanding the Relation Between Self-Compassion and Suicide Risk Among Adolescents in a Post-disaster Context: Mediating Roles of Gratitude and Posttraumatic Stress Disorder

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Background: The suicide risk among adolescents post-earthquake remains an important issue in trauma psychology. While existing studies and theories suggest that factors such as self-compassion, gratitude, and posttraumatic stress disorder (PTSD) play roles in the risk of suicide, few studies have combined these factors to explore the relationship between them.

Objective: This study examined the mediating roles of gratitude and PTSD in the relationship between self-compassion and suicide risk among Chinese adolescents after the Ya'an earthquake.

Methods: Four and a half years after the Ya'an earthquake, 499 middle school students in Lushan County were assessed using the following systems: Measures of Self-Compassion Scale, Gratitude Questionnaire, PTSD Checklist for DSM-5, and Child Behavior Problems Questionnaire.

Results: When we controlled for gender, age, and traumatic exposure, in the direct effect model, positive self-compassion had a negative effect on suicide risk, and negative self-compassion had a positive effect on suicide risk. In the indirect effects model, both positive self-compassion and negative self-compassion had no significant direct effect on suicide risk. Moreover, we found an indirect and negative effect of positive self-compassion on suicide risk via gratitude and PTSD, as well as via an indirect path from gratitude to PTSD. On the other hand, we also found an indirect and positive effect of negative self-compassion on suicide risk via gratitude and PTSD, as well as via an indirect path from gratitude to PTSD.

Conclusion: Positive self-compassion reduces the risk of suicide, while negative self-compassion increases the risk of suicide. Gratitude and PTSD play significant mediating role between self-compassion and suicide risk.

Keywords: self-compassion, gratitude, PTSD, suicide risk, adolescents

INTRODUCTION

Earthquake is a major traumatic disaster that causes huge property loss, death, and injuries to people and results in various psychological problems among victims (Fan et al., 2011). Suicide is a terminal outcome in the spectrum of potential major mental health issues spawned by severe earthquakes that can hinder victims' recovery to a normal life and further threaten people's lives (Mezuk et al., 2009). Previous empirical studies have also found a significant increase in suicide risk among survivors after earthquakes (Tang et al., 2010). Importantly, adolescents are sensitive to traumatic events and likely produce negative psychological outcomes (Good and Willoughby, 2008). Therefore, paying attention to the suicide risk of adolescents after earthquakes is important, and identifying malleable protective and risk factors is necessary to improve the development of targeted interventions to reduce suicide risk.

Self-Compassion Affects Suicide Risk

Previous research has focused on suicide risk in environmental, emotional, and cognitive factors (Dieserud et al., 2001; Esposito et al., 2003). According to the integrated motivational-volitional model of suicidal behaviors (O'Connor, 2011), self-attitude is an important influencing factor for the formation of suicidal ideation and development of suicidal behavior of individuals who have experienced negative events. However, research on suicide risk from the perspective of self-attitude remains lacking. Self-compassion, as a self-attitude, likely plays a role in the motivational phase of suicidal behavior among adolescents after earthquakes. Self-compassion means being kind and forgiving of oneself in the face of suffering, neither judgmental nor indifferent, and recognizing their suffering as a universal experience that all people can experience without feeling isolated and hopeless (Neff, 2003a). Self-compassion consists of six components (Neff, 2003b): *Self-kindness*, being positive and accepting of oneself; *common humanity*, seeing own suffering as something that can happen to anyone; *mindfulness*, looking at the situation with balance and clarity; *over-identification*, focusing on own negative emotions and flaws; *self-judgment*, being indifferent and rigorous of oneself; *isolation*, feeling lonely and helpless by making oneself as the center of suffering.

In previous studies, most scholars regard the six dimensions of self-compassion as a single structural variable, but other scholars divide self-compassion into positive and negative self-compassion; and this two-dimensional structure has been verified in certain studies (López et al., 2015; Montero-Marín et al., 2016). In general, self-kindness, common humanity, and mindfulness represent adaptive facets of self-compassion, that is, positive self-compassion; whereas self-judgment, isolation, and over-identification represent maladaptive facets of self-compassion, that is, negative self-compassion (Neff, 2003b). Certain studies have shown that positive and negative self-compassion has different effects on individual psychological outcomes (Montero-Marín et al., 2016). Specifically, positive self-compassion has a positive effect on positive psychological outcomes, whereas negative self-compassion has a positive effect on negative psychological outcomes (Gilbert et al., 2011; López et al., 2015; Muris and Petrocchi, 2017). Therefore, the present study also divides self-compassion into positive and negative self-compassion.

From the relationship between positive self-compassion and suicide risk, positive self-compassion may protect adolescents from engaging in suicide. Conceptually, positive self-compassion can be considered a positive self-attitude (Neff, 2003b). When individuals face negative events and overwhelming sufferings, positive self-compassion makes individuals care about their own feelings in a tolerant and gentle way and reduce negative thoughts about themselves (Raes, 2010; Krieger et al., 2013), thus reducing suicide risk. Moreover, positive self-compassion may help individuals obtains a clear and balanced mind and stay focused on the present without ruminating over and being stuck in overwhelming negative emotions (Selby et al., 2013; Heath et al., 2016). Chang et al. (2017) found that positive self-compassion can reduce suicide risk among American college students. In further exploring the underlying mechanisms by which positive self-compassion affects suicidal behavior, Rabon et al. (2019) argued that positive self-compassion can ultimately reduce suicide risk by alleviating individuals' depression and anger.

Conversely, negative self-compassion may increase individuals' suicide risk. The differential activation theory of suicidality (Lau et al., 2004) suggests that suicidal behavior is one of the most globally representative, negative self-related thought patterns. When negative emotions are activated by negative events related to individuals, such negative emotions further trigger individuals' hopelessness and powerlessness, thus activating suicidal ideation and ultimately increasing suicide risk. Negative self-compassion, as a negative factor related to the self, can make individuals immersed in painful emotions, which they cannot escape from and thus exacerbate their depression (Joeng and Turner, 2015). Individuals who are troubled by painful emotions can experience self-criticism, increase hopelessness and helplessness (Rogers et al., 2017), and ultimately increase suicide risk. Previous empirical studies have also demonstrated the relationship between negative self-compassion and suicide risk (Bonner and Rich, 1987; O'Connor, 2007; Joiner et al., 2009).

Although many theoretical and empirical studies have shown that self-compassion affects suicide risk, the predictive mechanisms of self-compassion in relation to suicide risk remain unclear. As a common post-traumatic negative psychological outcome, post-traumatic stress disorder (PTSD) is ubiquitous among post-traumatic adolescents and has a significant impact on their mental health (Zhou et al., 2017).

Mediating Role of PTSD

In terms of the relationship between self-compassion and PTSD, the risk factor model proposed by Freedy et al. (1992) has the most extensive influence. This model suggests that self-attitude, as a pre-disaster factor, may be a predisposition factor leading to individuals' psychosomatic response after trauma, which may have an impact on PTSD. Specifically, individuals with high levels of positive self-compassion tend to be caring and understanding to themselves in suffering and treat the frustration and guilt of traumatic events with a tolerant attitude, thus quickly adapting to the effects of trauma and ultimately helping alleviate PTSD

symptoms (Barnard and Curry, 2011). Empirical studies have also shown that among children who experience large fires, children with positive self-compassion have low levels of PTSD symptoms (Zeller et al., 2015). Hiraoka et al. (2015) found that positive self-compassion alleviates PTSD symptoms among Iraqi soldiers. By contrast, a positive relationship exists between negative self-compassion and PTSD. Cognitive model points out that individuals who pay too much attention to traumatic experiences and potential threats can form negative emotions and cognition, which may aggravate PTSD (Ehlers and Clark, 2000). Negative self-compassion, on the other hand, causes individuals to excessively focus on trauma cues, keeps them immersed in painful emotions, and forms negative cognition, which may aggravate PTSD symptoms (Dunmore et al., 2001). At the same time, individuals with negative self-compassion tend to feel guilt and have self-criticism after traumatic events. Self-criticism and associated guilt may be the central maintaining and motivating factors in many PTSD cases (Ehlers and Clark, 2000; Mayou et al., 2002; Cox et al., 2004; Wang et al., 2020).

Previous studies have found that an increase in the number and severity of PTSD symptoms is associated with suicidal risk, including ideation, attempts, and death by suicide (Freeman et al., 2000; Panagioti et al., 2011; Wang et al., 2018). The interpersonal theory of suicide (Joiner et al., 2009) suggests that the ability to commit suicide is determined by prior painful and traumatic experiences, which, in turn, result in habituation to the fear and pain of death. The habit of suffering and lack of fear of death are important factors leading to individual suicide. As a complex, heterogeneous disorder, PTSD can immerse people in constant emotional experiences of pain and fear and relive these traumatic experiences repeatedly, which makes people less afraid of death and likely commit suicide (Panagioti et al., 2009). Previous studies of survivors after traumatic events have also found a link between PTSD and suicide risk. Caldera et al. (2001) investigated survivors of hurricane disasters and found that individuals with high levels of PTSD have a significantly increased risk of suicide. Tarrier and Gregg (2004) observed patients with chronic PTSD symptoms and revealed that the higher the level of PTSD, the greater the risk of suicide. This finding is consistent with the results of other studies revealing a high level of suicide risk in clinical samples with PTSD (Amir et al., 1999; Kotler et al., 2001). Therefore, PTSD possibly mediates the relationship between self-compassion and suicide risk.

Mediating Role of Gratitude

After natural disasters, governments' vigorous construction and interpersonal support and help likely arouse victims' gratitude; thus, gratitude is a common positive emotional factor after traumatic events (McCullough et al., 2004). Gratitude can be defined as "a generalized tendency to recognize and respond with grateful emotion to the role of other people's benevolence in the positive experiences and outcomes that one obtains" (McCullough et al., 2002). According to McCullough et al. (2002), the gratitude is positively associated with positive emotions, life satisfaction, vitality, and optimism, and negatively associated with depression and stress. Further, grateful people have a positive attitude toward themselves and others and they generally think that life is meaningful, understandable, and manageable (Lambert et al., 2009). Certain researchers believe that positive emotional factors play roles in the influence of self-compassion on the negative psychological outcomes of post-trauma victims (Arimitsu and Hofmann, 2015). Therefore, gratitude may be another mediator between self-compassion and suicide risk.

So far, only few studies have directly focused on the relationship between self-compassion and gratitude. However, the correlation between both variables can be inferred on the basis of relevant theories and research results. According to emotional experience theory, a clear perception of the benefits and help of others is the decisive factor to generate gratitude (Lazarus and Lazarus, 1996). Positive self-compassion emphasizes a clear and balanced way for individuals to perceive their current emotions as they experience suffering, rather than over-amplify pain and sadness (Neff, 2003a). Thus, individuals with high levels of positive self-compassion are speculated to clearly perceive gratitude when they receive favor and help. Furthermore, Neff (2003a) argued that individuals with positive self-compassion can treat themselves with tolerance and kindness. When people treat themselves with tolerance, they also accept the kindness and help shown by others with an open and tolerant attitude, which likely stimulates gratitude. Rao and Kemper (2017) tested participants' scores for related positive emotions after training in a course to promote positive self-compassion. They found that individuals trained in positive self-compassion have significantly improved their gratitude scores. Rao and Kemper (2017) aimed to cultivate participants' ability of self-compassion in a course. The researcher measured participants' scores for related positive emotions after the course and found that individuals trained in positive self-compassion show significant increase in gratitude.

However, negative self-compassion may negatively affect gratitude. According to the disengagement hypothesis, when individuals are psychologically exposed to stress, excessive attention to traumatic cues can occupy their several cognitive resources that can make them focus on the negative aspects of traumatic events; experiencing positive emotions also becomes difficult for these adolescents (Koster et al., 2011). However, as a self-attitude that immerses individuals in painful emotions after trauma, negative self-compassion can magnify negative emotion and cognition, thus occupying several cognitive resources, which may be unconducive to the full feeling of gratitude when receiving help from others. Neff et al. (2007) observed that self-criticism triggered by negative self-compassion is significantly and negatively correlated with gratitude. Caputo (2015) also found a significant negative correlation between isolation and gratitude. On the basis of these findings, we can speculate that negative self-compassion may hinder the development of gratitude in adolescents after earthquakes.

The broaden-build theory of positive emotions (Fredrickson, 2004) suggests that gratitude can expand the cognitive schema and behavior pattern and provide sustained psychological resources for individuals (Folkman and Moskowitz, 2000). Consequently, individual happiness increases, and interpersonal relationship improves, which can promote growth and development in life (McCullough et al., 2002). Given that

suicide risk is an aspect of negative outcomes in adolescent development (Portes et al., 2002), we tentatively predict that adolescents with high levels of gratitude have low risk of suicide. This hypothesis has been supported in previous empirical studies. Li et al. (2012) investigated the suicide risk of 1,252 Chinese middle school students from Guangzhou and found that gratitude can significantly reduce the suicide risk of teenagers. Similarly, Rey et al. (2019) focused on school bullying among high school students and explored the causes of suicidal behavior among adolescents in the context of trauma. They found that gratitude is an important protective factor for suicidal behavior in adolescents.

Posttraumatic stress disorder and gratitude are two potential mediators of the relationship between self-compassion and suicide risk. A combined relationship also exists between them. Numerous studies have shown that gratitude is an important positive emotion that can effectively suppress PTSD (Fredrickson et al., 2003; Kashdan et al., 2006; Israel-Cohen et al., 2014). Research with adults overwhelmingly indicates that gratitude is strongly related to healthy psychological and social functioning because it focuses people on self-improvement and helps them maintain and build strong, supportive social ties (Emmons and McCullough, 2003). After a traumatic event, access to supportive resources is a critical factor in an individual's recovery from PTSD symptoms. Kashdan et al. (2006) focused on Vietnam veterans and revealed that participants with PTSD have significantly lower levels of gratitude than those without PTSD; the experience of gratitude also help veterans with PTSD recover daily functioning. Zheng et al. (2011) conducted a survey among 1,439 students who experienced the Wenchuan earthquake. The results showed that gratitude has a significant negative effect on PTSD.

Present Study

In summary, although the relationship between the three variables of self-compassion, namely, gratitude, PTSD, and suicide risk have been examined in previous studies, the roles of gratitude and PTSD in the impact of self-compassion on suicide risk have not been explored. In addition, previous studies have found that self-compassion is a protective factor for suicide, but most have not classified the types of self-compassion (López et al., 2015; Montero-Marín et al., 2016). Therefore, the present study explores the effects of positive and negative self-compassion on suicide risk in adolescent survivors and examines the mediating roles of gratitude and PTSD.

MATERIALS AND METHODS

Participants and Procedures

Four and a half years after the Ya'an earthquake, we selected two middle schools in Lushan County, Sichuan Province for investigation. Before conducting the investigation, we fully communicated with the local education bureau, informed relevant departments of our research content and methods, and obtained the approval.

With the assistance of the school leaders and head teachers of the two middle schools, we selected first and second grades of both junior high school and senior high school to conduct the investigation. Within these grades, we issued a total of 520 questionnaires, of which 21 questionnaires were screened out due to excessive missing values or failure to submit on time. A total of 499 valid questionnaires were recovered. All of the students who participated in the survey took a collective test during their classes on the same day. The mean age of the adolescents at the time of measurement was 14.94 (standard deviation = 1.58) years, and the range was from 12.0 to 20.0 years. Of the 499 students, 230 (46.1%) were male, and 264 (52.9%) were female; five participants did not report their gender. All participants had experienced the earthquake.

This study was approved by the Research Ethics Committee of the Beijing Normal University and conducted with the permission of the relevant leaders of the participating schools. All the participants signed a written informed consent. Considering that all our participants were juveniles under the age of 18, a written informed consent was also obtained from their parents before conducting the survey.

In this study, graduate students majoring in psychological counseling were given a collective test with uniform instructions. In the guidance of the questionnaire, we emphasized that the purpose of this survey is to explore the impact of the Jiuzhaigou earthquake experience on the participants' current psychological responses. Before filling out the questionnaire, ask the participants to carefully read the guideline of the topic and fill out the questionnaire as required. All questionnaires were immediately recalled after completion.

Measurements

Traumatic Exposure Questionnaire

The traumatic exposure questionnaire developed by Wu et al. (2013) was used in this study. The questionnaire consists of 18 items. The questions involved whether the participants had either witnessed or heard of others injured or killed in the earthquake. Each item was rated on a three-point Likert scale, ranging from 1 (*did not experience the situation above*) to 3 (*saw it myself*). Finally, the scores of all participants were added up as indicators of the degree of traumatic exposure. The internal reliability of the questionnaire in this study was acceptable (Cronbach's $\alpha = 0.65$).

Self-Compassion Scale

Participants were given the 26-item Self-Compassion Scale (Neff, 2003b), which has six components and is divided into positive and negative self-compassion. Positive self-compassion includes common humanity, self-kindness, and mindfulness. Negative self-compassion includes isolation, self-judgment, and over-identification. All the items were rated on a five-point Likert scale ranging from 1 (*completely disagree*) to 5 (*completely agree*). In this study, the internal consistency of positive self-compassion (Cronbach's $\alpha = 0.96$) and negative self-compassion ($\alpha = 0.96$) was good.

Gratitude Questionnaire

We adopted the gratitude scale compiled by McCullough et al. (2002) and revised by Zhou and Wu (2017). This questionnaire consists of six items, among which the third and sixth items are

reverse scoring questions. Each item was rated on a seven-point Likert scale ranging from 0 (*completely disagree*) to 6 (*completely agree*). In this study, the Chinese-revised gratitude questionnaire had good internal consistency (Cronbach's $\alpha = 0.81$).

PTSD Checklist for DSM-5

The PTSD checklist for DSM-5 was designed by Weathers (2013) and is a well-known instrument to assess post-traumatic stress symptoms. This checklist consists of 20 items and four subscales: intrusions, negative cognition and emotion alteration, avoidance, and hyper-arousal. Each item was rated on a four-point Likert scale ranging from 0 (*completely disagree*) to 3 (*completely agree*). The internal reliability of the questionnaire in this study was good (Cronbach's $\alpha = 0.93$).

Child Behavior Problem Questionnaire

The Youth Risk Behavior Survey Questionnaire prepared by Brener et al. (2004) was used to assess the suicide risk of adolescents. This questionnaire contains 19 items, and we adopted one of the subscales incorporating three items to measure suicide risk. The three items assessed participants' suicidal ideation, plans, and attempts over the past six months. Each item was rated on a three-point Likert scale ranging from 1 (*not at all*) to 3 (*always*). The Chinese version of the questionnaire has achieved good reliability and validity among Chinese adolescents after earthquakes (Ying et al., 2015; Zhou and Wu, 2017), and the internal consistency reliability in this study was acceptable (Cronbach's $\alpha = 0.84$).

Data Analysis Strategies

We adopted the self-report method. All data used were continuous variables, and full-information maximum likelihood estimates were used to fill in missing data. All analyses were performed using software SPSS 24.0 and Amos 17.0. In the structural equation modeling (SEM), we used the following indicators to evaluate the model fitting: chi-square test of model fit (χ^2/df), comparative fit index (CFI), Tucker–Lewis index (TLI), and root mean square error of approximation (RMSEA).

We then established SEM to examine the following models: (a) a direct effect model with structural paths from positive and negative self-compassion to suicide risk; (b) an indirect effect model with mediators (e.g., gratitude and PTSD) inserted between self-compassion (e.g., positive and negative self-compassion) and suicide. Given that gender, age, and trauma exposure may be important additional influencing factors in this study, we controlled for these variables in investigating the effects of self-compassion on suicide risk and the underlying mechanisms.

RESULTS

Descriptive Statistics and Correlations

The results of the description statistics and correlation analysis of main variables are shown in **Table 1**. According to Pearson's correlation analysis, gender was significantly associated with negative self-compassion, gratitude, and PTSD. However, the correlation with other variables was insignificant. Age was associated only with PTSD but not with other variables. No significant correlation was found between traumatic exposure and other variables and between positive self-compassion and PTSD. The correlation among other main variables was significant.

SEM Analyses

We used SEM to examine the mediating effects of gratitude and PTSD between self-compassion and suicide risk. First, we estimated the measurement model, which included three latent variable constructs: positive self-compassion, negative self-compassion, and PTSD. We found that the model fitting index was acceptable [$\chi^2/df = 3.82$, CFI = 0.97, TLI = 0.96, RMSEA (90% CI) = 0.075 (0.059–0.088)]. Further structural model analysis is also possible.

Second, after controlling for the effects of gender, age, and traumatic exposure, we established a direct effect model and added two direct effect paths from positive/negative self-compassion to suicide risk (**Figure 1**). We found that the data fitting of the direct effect model was good [$\chi^2/df = 3.65$, CFI = 0.96, TLI = 0.94, RMSEA (90% CI) = 0.073 (0.059–0.087)]. In the path analysis results, positive self-compassion had a negative effect on suicide risk ($\beta = -0.28$, $p < 0.001$), and negative self-compassion had a positive effect on suicide risk ($\beta = 0.35$, $p < 0.001$).

Third, based on the direct effect model, we added two mediating variables, namely, gratitude and PTSD between self-compassion and suicide risk. Moreover, based on previous

TABLE 1 | Means, standard deviations, and correlations among the main variables.

	Mean	SD	1	2	3	4	5	6	7	8
1 Gender[a]	–	–	–							
2 Age	14.94	1.58	−0.03	–						
3 Traumatic exposure	20.81	4.31	−0.03	−0.02	–					
4 PSC	39.23	8.52	0.08	0.00	0.01	–				
5 NSC	37.74	8.84	0.16***	0.07	−0.01	0.50***	–			
6 Gratitude	24.39	6.92	0.13**	0.04	0.06	0.33***	0.10*	–		
7 PTSD	13.51	9.96	0.12*	0.11*	−0.06	−0.03	0.35***	−0.17***	–	
8 Suicide risk	3.67	1.31	0.03	−0.01	−0.04	−0.10*	0.19***	−0.27***	0.46***	–

*Coded [a]: 1, male; 2, female; PSC, positive self-compassion; NSC, negative self-compassion; PTSD, posttraumatic stress disorder. *p < 0.05; **p < 0.01; ***p < 0.001.*

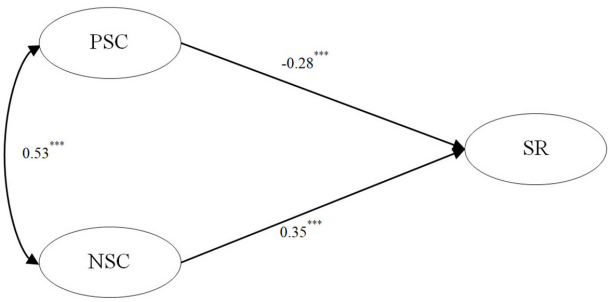

FIGURE 1 | The direct effects model after controlling gender, age, and traumatic exposure. PSC, positive self-compassion; NSC, negative self-compassion; SR, suicide risk. ***$p < 0.001$.

TABLE 2 | Bias-corrected bootstrap tests of mediating effects.

Path	Standardized β	Standardized 95% CI	
		Low	High
PSC-Gratitude-SR	−0.07*	−0.12	−0.03
NSC-Gratitude-SR	0.02*	0.01	0.04
PSC-PTSD-SR	−0.12**	−0.17	−0.06
NSC-PTSD-SR	0.25***	0.18	0.30
PSC-Gratitude-PTSD-SR	−0.03*	−0.03	−0.02
NSC-Gratitude-PTSD-SR	0.01*	0.00	0.01

*PSC, positive self-compassion; NSC, negative self-compassion; SR, suicide risk; PTSD, posttraumatic stress disorder. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.*

theories and studies (Fredrickson, 2001; Fredrickson et al., 2003; Kashdan et al., 2006), we added a path from gratitude to PTSD and structured a multiple indirect effect model (**Figure 2**). The results of the model revealed that the fitting index was acceptable [χ^2/df = 2.87, CFI = 0.96, TLI = 0.95, RMSEA (90% CI) = 0.061 (0.052–0.071)]. In the path analysis results, positive self-compassion had a significant positive effect on gratitude (β = 0.42, $p < 0.001$) and had a negative effect on PTSD (β = −0.28, $p < 0.001$), whereas negative self-compassion had a significant negative effect on gratitude (β = −0.15, $p < 0.01$) and had a positive effect on PTSD (β = 0.57, $p < 0.001$). Gratitude had a significant negative effect on suicide risk (β = −0.16, $p < 0.01$), while PTSD had a positive effect on suicide risk (β = 0.43, $p < 0.001$), and gratitude had a significant negative predictive effect on PTSD (β = −0.17, $p < 0.001$).

To further verify the significance of the mediating effects, the bias-corrected bootstrap method was used to calculate the mediating effect values and their 95% CI. **Table 2** illustrates these results, which showed an indirect and negative effect of positive self-compassion on suicide risk via gratitude and PTSD (β = −0.07, 95% CI = −0.12 to −0.03; β = −0.12, 95% CI = −0.17 to −0.06) and via an indirect path from gratitude to PTSD (β = −0.03, 95% CI = −0.03 to −0.02). Negative self-compassion had a positive effect on suicide risk via gratitude and PTSD (β = 0.02, 95% CI = 0.01 to 0.04; β = 0.25, 95% CI = 0.18 to 0.30) and via an indirect path from gratitude to PTSD (β = 0.01, 95% CI = 0.00 to 0.11). These results suggested that gratitude and PTSD play complete mediating roles between self-compassion and suicide risk.

DISCUSSION

After controlling for the effects of gender, age, and trauma exposure in the direct effect model, we found that the positive self-compassion of post-disaster adolescents has a direct negative effect on suicide risk, which supports previous theories and studies (Chang et al., 2017; Rabon et al., 2019). This result indicates that positive self-compassion can help individuals gain a clear and balanced mind and stay focused on the emotions of

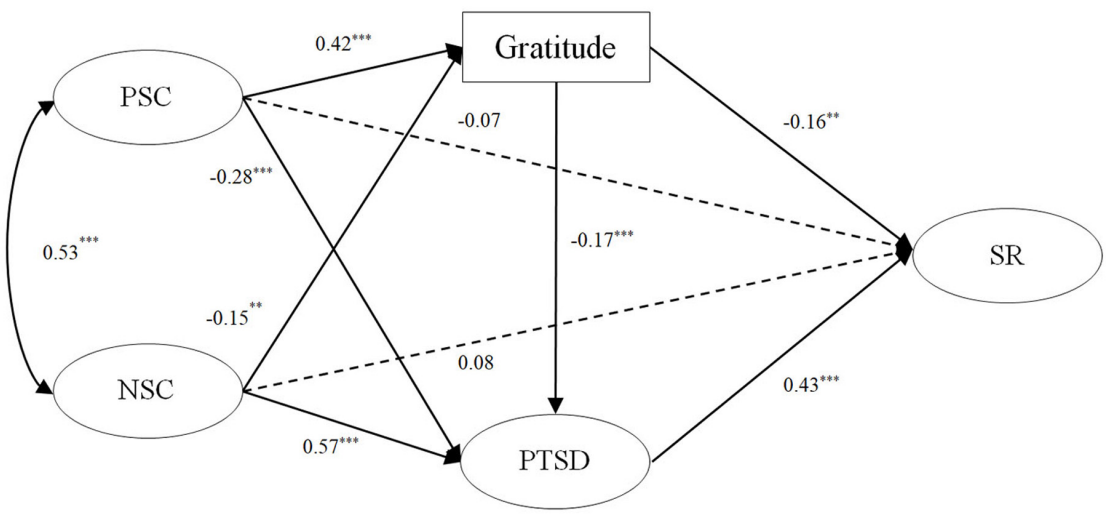

FIGURE 2 | The multiple indirect effects model after controlling gender, age, and traumatic exposure. PSC, positive self-compassion; NSC, negative self-compassion; PTSD, posttraumatic stress disorder; SR, suicide risk. **$p < 0.01$; ***$p < 0.001$.

the moment, rather than ruminate and immerse in overwhelming negative emotions (Selby et al., 2013; Heath et al., 2016), which can ultimately reduce adolescents' suicide risk.

In the indirect effect model, we observed that negative self-compassion has a direct and positive role in the suicide risk among adolescents. The results support the differential activation theory of suicidality (Lau et al., 2004), which is consistent with previous research (Joeng and Turner, 2015). Negative self-compassion activates self-related negative emotions, such as self-criticism, guilt, and shame (López et al., 2015), which make individuals feel hopeless and powerless. When adolescents are immersed in painful emotions for a long time and unable to deal with difficult situations, they likely resort to suicidal behaviors to escape from the current pain (Brown et al., 2002).

Importantly, we found that in the indirect effect model, positive self-compassion reduces the suicide risk among adolescents through the mediating effect of gratitude, which verifies emotional experience theory (Lazarus and Lazarus, 1996) and the broaden-build theory of positive emotions (Fredrickson, 2004). For adolescents who have experienced earthquakes, the high level of self-compassion allows them to deal with the suffering in a calm and balanced attitude, rather than being plagued by pain and despair (Thompson and Waltz, 2008). This state allows adolescents to clearly perceive gratitude. Furthermore, high levels of gratitude can expand adolescents' cognitive and behavioral pattern; reduce negative cognition, emotion, and behavior (Fredrickson, 2004); and increase adolescents' life satisfaction and happiness (McCullough et al., 2002). These factors can reduce the psychological impact of traumatic events on adolescents and ultimately reduce the risk of suicide.

The current study also suggests that negative self-compassion exerts an indirect and positive effect on suicide risk via gratitude, which is consistent with theories and studies (Fredrickson et al., 2003; Kashdan et al., 2006; Neff et al., 2007; Koster et al., 2011; Caputo, 2015). Adolescents with negative self-compassion tend to see themselves as the center of pain after a disaster and focus too much cognitive resources on the negative cues of the traumatic event (Neff, 2003a). Therefore, adolescents cannot fully feel gratitude after receiving favors from others. Adolescents with low levels of gratitude are also at increased risk of suicide because they have been troubled by negative emotions and cognition for a long time.

Consistent with previous studies (Leary et al., 2007; Neff et al., 2007; Vettese et al., 2011; Zeller et al., 2015), positive self-compassion has a negative effect on suicide risk through PTSD. Specifically, adolescents with positive self-compassion tend to view traumatic events as disasters that are possible for all. Thus, viewing the impact of a disaster on the self with an objective and peaceful mind and caring for and treating the self with kindness after the trauma is easy to avoid thinking over the negative aspect of the traumatic event and finally alleviate the symptoms of PTSD. As one of the most important predictors of suicide risk (Joiner et al., 2009) in adolescents who experience negative events, a decrease in PTSD levels can correspondingly reduce the risk of suicide.

In addition, we observed that negative self-compassion has an indirect and positive effect on suicide risk via PTSD. Negative self-compassion in post-traumatic adolescents can exacerbate PTSD symptoms, and these findings confirm previous studies (Dunmore et al., 2001; Mayou et al., 2002). According to cognitive model (Ehlers and Clark, 2000), adolescents with negative self-compassion can magnify the sense of helplessness and despair they experience in the face of traumatic events and regard themselves as the center of pain, thereby focusing cognitive resources on negative emotions and ultimately aggravating PTSD, which can increase adolescents' suicide risk. On the basis of the interpersonal theory of suicide (Joiner, 2005), adaptation to pain and lack of fear of death are important factors that increase the risk of suicide. Adolescents with PTSD continuously and repeatedly experience painful emotions and fear of death from major life-threatening traumatic events. This habituation process causes them to lose their fear of death and become prone to suicidal ideation and behavior in the face of overwhelming pain to get rid of the pain (Panagioti et al., 2009).

Moreover, we found that self-compassion has a two-mediator indirect effect on suicide risk through gratitude via PTSD. Individuals with positive self-compassion experience high levels of gratitude; according to the broaden-build theory of positive emotions (Fredrickson, 2004), gratitude can promote positive emotions, help individuals expand their cognitive schemas (Folkman and Moskowitz, 2000), enhance behavioral flexibility (Fredrickson, 2004), construct personal resources (Fredrickson et al., 2003), and eliminate the physiological effects of negative emotions (Tugade and Fredrickson, 2004). These positive effects can reduce PTSD symptoms and, in turn, reduce suicide risk in adolescents who experience traumatic events. By contrast, adolescents with negative self-compassion have low levels of gratitude, which keeps PTSD from improving. This finding increases suicide risk for adolescents who are chronically troubled by PTSD.

However, we observed that the direct effect path from positive and negative self-compassion to suicide risk is insignificant. One possible explanation is that the mediating roles of gratitude and PTSD may cover the direct path of self-compassion and suicide risk.

CONCLUSION

In summary, this study explored the effects of the two components of self-compassion on suicide risk in adolescents after an earthquake and the underlying mechanisms between them. The results showed that positive self-compassion reduces suicide risk, whereas negative self-compassion increases suicide risk. Gratitude and PTSD play significant mediating roles between self-compassion and suicide risk.

This result enriches the current research on post-traumatic adolescent mental health and provides advice and enlightenment to psychological intervention workers in clinical disaster areas. First, this study confirms the important effects of self-compassion on post-traumatic adolescents, and positive and negative self-compassion has different effects on suicide risk. The results suggest that clinical psychologists can introduce techniques related to self-compassion, such as Compassion-Focused

Therapy, Mindful Self-Compassion, and Loving-Kindness Meditation (Barnard and Curry, 2011), when treating adolescents that are at risk of suicide. By means of the above psychological interventions, people can develop positive self-compassion and transform negative self-compassion caused by traumatic events, thus allow adolescents to reduce their negative emotions in the face of disasters, thereby reducing their risk of suicide.

Second, this study has demonstrated that gratitude is an important mechanism between self-compassion and suicide risk. However, previous research has shown that individual gratitude levels are relatively low during adolescence, because they have a limited span in terms of number of life circumstances for which they can feel grateful (Froh et al., 2011; Langher et al., 2016). Therefore, clinical psychologists are focusing on how to improve the gratitude of post-traumatic adolescents in order to reduce their suicide risk. The gratitude journal is one of the most widely used tools for practicing gratitude (Emmons and McCullough, 2003). In the process of psychological intervention for adolescents who have experienced a traumatic event, psychologists in school could incorporate this technique appropriately to promote an individual's level of gratitude, thereby reducing their potential suicide risk.

Finally, psychological intervention workers in disaster areas should pay attention to the identification and diagnosis of survivors' PTSD symptoms and timely give psychological treatment to reduce the risk of suicide.

Certain limitations exist in the study design and measurement. First, the research only controlled for gender, age, and trauma exposure but did not control for additional factors that may affect suicide risk. Considering that the psychological responses of individuals who have experienced traumatic events may be affected by other covariates, including and controlling for more covariates in future studies will diminish interference in the results. Second, the study was cross-sectional, which makes inferring causal relationships among variables difficult; future research must focus on this issue by using a longitudinal design. Third, the self-report method was uniformly adopted in this study, inevitably leading to a certain degree of common method biases. Future research should incorporate multiple methods to improve depth and quality of data. At last, all the variables in this study are self-reported by the subjects and have strong subjectivity, especially the measurement of gratitude, which is easily affected by the social desirability bias (Caputo, 2017). In future studies, individual's gratitude should be measured by different test methods, so as to reduce the social desirability bias as much as possible.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation, to any qualified researcher.

ETHICS STATEMENT

This study was approved by the Research Ethics Committee of the Beijing Normal University and conducted with the permission of the relevant leaders of the participating schools. All the participants signed a written informed consent. Considering that all our participants were juveniles under the age of 18, a written informed consent was also obtained from their parents before conducting the survey.

AUTHOR CONTRIBUTIONS

AL developed the study design, participated in and supervised the data collection, performed the statistical analysis, and drafted the manuscript. WW participated in and supervised the data collection, assisted in data collection and analysis, and made important modifications to the manuscript. XW conceived the study and revised the manuscript critically for important intellectual content. All authors contributed to the article and approved the submitted version.

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REFERENCES

Amir, M., Kaplan, Z., Efroni, R., and Kotler, M. (1999). Suicide risk and coping styles in posttraumatic stress disorder patients. *Psychother. Psychosom.* 68, 76–81. doi: 10.1159/000012316

Arimitsu, K., and Hofmann, S. G. (2015). Cognitions as mediators in the relationship between self-compassion and affect. *Pers. Individ. Differ.* 74, 41–48. doi: 10.1016/j.paid.2014.10.008

Barnard, L. K., and Curry, J. F. (2011). Self-compassion: conceptualizations, correlates, and interventions. *Rev. Gen. Psychol.* 15, 289–303. doi: 10.1037/a0025754

Bonner, R. L., and Rich, A. R. (1987). Toward a predictive model of suicidal ideation and behavior: some preliminary data in college students. *Suicide Life Threat. Behav.* 17, 50–63. doi: 10.1111/j.1943-278X.1987.tb00061.x

Brener, N. D., Kann, L., Kinchen, S. A., Grunbaum, J. A., Whalen, L., Eaton, D., et al. (2004). Methodology of the youth risk behavior surveillance system. *MMWR Recomm. Rep.* 53, 1–13.

Brown, M. Z., Comtois, K. A., and Linehan, M. M. (2002). Reasons for suicide attempts and nonsuicidal self-injury in women with borderline personality disorder. *J. Abnorm. Psychol.* 111, 198–202. doi: 10.1037/0021-843X.111.1.198

Caldera, T., Palma, L., Penayo, U., and Kullgren, G. (2001). Psychological impact of the hurricane Mitch in Nicaragua in a one-year perspective. *Soc. Psychiatry Psychiatr. Epidemiol.* 36, 108–114. doi: 10.1007/s001270050298

Caputo, A. (2015). The relationship between gratitude and loneliness: the potential benefits of gratitude for promoting social bonds. *Eur. J. Psychol.* 11, 323–334. doi: 10.5964/ejop.v11i2.826

Caputo, A. (2017). Social desirability bias in self-reported well-being measures: evidence from an online survey. *Univ. Psychol.* 16, 245–255. doi: 10.11144/Javeriana.upsy16-2.sdsw

Chang, E. C., Yu, T., Najarian, A. S. M., Wright, K. M., Chen, W., Chang, O. D., et al. (2017). Understanding the association between negative life events and suicidal risk in college students: examining self-compassion as a potential mediator. *J. Clin. Psychol.* 73, 745–755. doi: 10.1002/jclp.22374

Cox, B. J., Fleet, C., and Stein, M. B. (2004). Self-criticism and social phobia in the US national comorbidity survey. *J. Affect. Disord.* 82, 227–234. doi: 10.1016/j.jad.2003.12.012

Dieserud, G., Røysamb, E., Ekeberg, Ø, and Kraft, P. (2001). Toward an integrative model of suicide attempt: a cognitive psychological approach. *Suicide Life Threat. Behav.* 31, 153–168. doi: 10.1521/suli.31.2.153.21511

Dunmore, E., Clark, D. M., and Ehlers, A. (2001). A prospective investigation of the role of cognitive factors in persistent posttraumatic stress disorder (PTSD) after physical or sexual assault. *Behav. Res. Ther.* 39, 1063–1084. doi: 10.1016/S0005-7967(00)00088-7

Ehlers, A., and Clark, D. M. (2000). A cognitive model of posttraumatic stress disorder. *Behav. Res. Ther.* 38, 319–345. doi: 10.1016/S0005-7967(99)00123-0

Emmons, R. A., and McCullough, M. E. (2003). Counting blessings versus burdens: an experimental investigation of gratitude and subjective well-being in daily life. *J. Pers. Soc. Psychol.* 84, 377–389. doi: 10.1037//0022-3514.84.2.377

Esposito, C., Spirito, A., Boergers, J., and Donaldson, D. (2003). Affective, behavioral, and cognitive functioning in adolescents with multiple suicide attempts. *Suicide Life Threat. Behav.* 33, 389–399. doi: 10.1521/suli.33.4.389.25231

Fan, F., Zhang, Y., Yang, Y., Mo, L., and Liu, X. (2011). Symptoms of posttraumatic stress disorder, depression, and anxiety among adolescents following the 2008 Wenchuan earthquake in China. *J. Trauma Stress.* 24, 44–53. doi: 10.1002/jts.20599

Folkman, S., and Moskowitz, J. T. (2000). Positive affect and the other side of coping. *Am. Psychol.* 55, 647–654. doi: 10.1037//0003-066X.55.6.647

Fredrickson, B. L. (2001). The role of positive emotions in positive psychology: the broaden-and-build theory of positive emotions. *Am. Psychol.* 56, 218–226. doi: 10.1037/0003-066X.56.3.218

Fredrickson, B. L. (2004). The broaden-and-build theory of positive emotions. *Trans. R. Soc. B Biol. Sci.* 359, 1367–1377. doi: 10.1098/rstb.2004.1512

Fredrickson, B. L., Tugade, M. M., Waugh, C. E., and Larkin, G. R. (2003). What good are positive emotions in crisis? A prospective study of resilience and emotions following the terrorist attacks on the United States on September 11th, 2001. *J. Pers. Soc. Psychol.* 84, 365–376. doi: 10.1037/0022-3514.84.2.365

Freedy, J. R., Shaw, D. L., Jarrell, M. P., and Masters, C. R. (1992). Towards an understanding of the psychological impact of natural disasters: an application of the conservation resources stress model. *J. Trauma Stress.* 5, 441–454. doi: 10.1002/jts.2490050308

Freeman, T. W., Roca, V., and Moore, W. M. (2000). A comparison of chronic combat-related posttraumatic stress disorder (PTSD) patients with and without a history of suicide attempt. *J. Nerv. Ment. Dis.* 188, 460–463. doi: 10.1097/00005053-200007000-00011

Froh, J., Fan, J., Emmons, R. A., Bono, G., Huebner, E. S., and Watkins, P. (2011). Measuring gratitude in youth: assessing the psychometric properties of adult Gratitude Scales in children and adolescents. *Psychol. Assess.* 23, 311–324. doi: 10.1037/a0021590

Gilbert, P., McEwan, K., Matos, M., and Rivis, A. (2011). Fears of compassion: development of three self-report measures. *Psychol. Psychother. Theor. Res. Pract.* 84, 239–255. doi: 10.1348/147608310X526511

Good, M., and Willoughby, T. (2008). Adolescence as a sensitive period for spiritual development. *Child Dev. Perspect.* 2, 32–37. doi: 10.1111/j.1750-8606.2008.00038.x

Heath, N. L., Joly, M., and Carsley, D. (2016). Coping self-efficacy and mindfulness in non-suicidal self-injury. *Mindfulness.* 7, 1132–1141. doi: 10.1007/s12671-016-0555-3

Hiraoka, R., Meyer, E. C., Kimbrel, N. A., DeBeer, B. B., Gulliver, S. B., and Morissette, S. B. (2015). Self-compassion as a prospective predictor of PTSD symptom severity among trauma-exposed US Iraq and Afghanistan war veterans. *J. Trauma Stress* 28, 127–133. doi: 10.1002/jts.21995

Israel-Cohen, Y., Uzefovsky, F., Kashy-Rosenbaum, G., and Kaplan, O. (2014). Gratitude and PTSD symptoms among Israeli youth exposed to missile attacks: examining the mediation of positive and negative affect and life satisfaction. *J. Posit. Psychol.* 10, 99–106. doi: 10.1080/17439760.2014.927910

Joeng, J. R., and Turner, S. L. (2015). Mediators between self-criticism and depression: fear of compassion, self-compassion, and importance to others. *J. Couns. Psychol.* 62, 453–463. doi: 10.1037/cou0000071

Joiner, Jr., T. E. (2005). *Why People Die by Suicide*. Cambridge, MA: Harvard University Press.

Joiner, T. E. Jr., Van Orden, K. A., Witte, T. K., Selby, E. A., Ribeiro, J. D., Lewis, R., et al. (2009). Main predictions of the interpersonal–psychological theory of suicidal behavior: empirical tests in two samples of young adults. *J. Abnorm. Psychol.* 118, 634–646. doi: 10.1037/a0016500

Kashdan, T. B., Uswatte, G., and Julian, T. (2006). Gratitude and hedonic and eudaimonic well-being in Vietnam war veterans. *Behav. Res. Ther.* 44, 177–199. doi: 10.1016/j.brat.2005.01.005

Koster, E. H. W., De Lissnyder, E., Derakshan, N., and De Raedt, R. (2011). Understanding depressive rumination from a cognitive science perspective: the impaired disengagement hypothesis. *Clin. Psychol. Rev.* 31, 138–145. doi: 10.1016/j.cpr.2010.08.005

Kotler, M., Iancu, I., Efroni, R., and Amir, M. (2001). Anger, impulsivity, social support, and suicide risk in patients with posttraumatic stress disorder. *J. Nerv. Ment. Dis.* 189, 162–167. doi: 10.1097/00005053-200103000-00004

Krieger, T., Altenstein, D., Baettig, I., Doerig, N., and Holtforth, M. G. (2013). Self-compassion in depression: associations with depressive symptoms, rumination, and avoidance in depressed outpatients. *Behav. Ther.* 44, 501–513. doi: 10.1016/j.beth.2013.04.004

Lambert, N. M., Fincham, F. D., Stillman, T. F., and Dean, L. R. (2009). More gratitude, less materialism: the mediating role of life satisfaction. *J. Posit. Psychol.* 4, 32–42. doi: 10.1080/17439760802216311

Langher, V., Caputo, A., Nannini, V., and Sturiale, M. (2016). "Gratitude and envy: implication for career development," in *Psychology of Gratitude: New Research*, ed. A. R. Howard (Hauppauge, NY: Nova Science Publishers), 75–96.

Lau, M. A., Segal, Z. V., and Williams, J. M. G. (2004). Teasdale's differential activation hypothesis: implications for mechanisms of depressive relapse and suicidal behaviour. *Behav. Res. Ther.* 42, 1001–1017. doi: 10.1016/j.brat.2004.03.003

Lazarus, R. S., and Lazarus, B. N. (1996). *Passion and Reason: Making Sense of Our Emotions*. Oxford, ENG: Oxford University Press.

Leary, M. R., Tate, E. B., Adams, C. E., Batts Allen, A., and Hancock, J. (2007). Self-compassion and reactions to unpleasant self-relevant events: the implications of treating oneself kindly. *J. Pers. Soc. Psychol.* 92, 887–904. doi: 10.1037/0022-3514.92.5.887

Li, D., Zhang, W., Li, X., Li, N., and Ye, B. (2012). Gratitude and suicidal ideation and suicide attempts among Chinese adolescents: direct, mediated, and moderated effects. *J. Adolesc.* 35, 55–66. doi: 10.1016/j.adolescence.2011.06.005

López, A., Sanderman, R., Smink, A., Zhang, Y., van Sonderen, E., Ranchor, A., et al. (2015). A reconsideration of the self-compassion scale's total score: self-compassion versus self-criticism. *PLoS One* 10:e0132940. doi: 10.1371/journal.pone.0132940

Mayou, R. A., Ehlers, A., and Bryant, B. (2002). Posttraumatic stress disorder after motor vehicle accidents: 3-year follow-up of a prospective longitudinal study. *Behav. Res. Ther.* 40, 665–675. doi: 10.1016/S0005-7967(01)00069-9

McCullough, M. E., Emmons, R. A., and Tsang, J. A. (2002). The grateful disposition: a conceptual and empirical topography. *J. Pers. Soc. Psychol.* 82, 112–127. doi: 10.1037/0022-3514.82.1.112

McCullough, M. E., Tsang, J. A., and Emmons, R. A. (2004). Gratitude in intermediate affective terrain: links of grateful moods to individual differences and daily emotional experience. *J. Pers. Soc. Psychol.* 86, 295–309. doi: 10.1037/0022-3514.86.2.295

Mezuk, B., Larkin, G. L., Prescott, M. R., Tracy, M., Vlahov, D., Tardiff, K., et al. (2009). The influence of a major disaster on suicide risk in the population. *J. Trauma Stress* 22, 481–488. doi: 10.1002/jts.20473

Montero-Marín, J., Gaete, J., Demarzo, M., Rodero, B., Lopez, L. C. S., and García-Campayo, J. (2016). Self-criticism: a measure of uncompassionate behaviors toward the self, based on the negative components of the self-compassion scale. *Front. Psychol.* 7:1281. doi: 10.3389/fpsyg.2016.01281

Muris, P., and Petrocchi, N. (2017). Protection or vulnerability? A meta-analysis of the relations between the positive and negative components of self-compassion and psychopathology. *Clin. Psychol. Psychother.* 24, 373–383. doi: 10.1002/cpp.2005

Neff, K. D. (2003a). Self-compassion: an alternative conceptualization of a healthy attitude towards oneself. *Self Identity* 2, 85–101. doi: 10.1080/15298860309032

Neff, K. D. (2003b). The development and validation of a scale to measure self-compassion. *Self Identity* 2, 223–250. doi: 10.1080/15298860309027

Neff, K. D., Rude, S. S., and Kirkpatrick, K. L. (2007). An examination of self-compassion in relation to positive psychological functioning

and personality traits. *J. Res. Pers.* 41, 908–916. doi: 10.1016/j.jrp.2006.08.002

O'Connor, R. C. (2007). The relations between perfectionism and suicidality: a systematic review. *Suicide Life Threat. Behav.* 37, 698–714. doi: 10.1521/suli.2007.37.6.698

O'Connor, R. C. (2011). The integrated motivational-volitional model of suicidal behavior. *Crisis* 32, 295–298. doi: 10.1002/9781118903223.ch13

Panagioti, M., Gooding, P., and Tarrier, N. (2009). Post-traumatic stress disorder and suicidal behavior: a narrative review. *Clin. Psychol. Rev.* 29, 471–482. doi: 10.1016/j.cpr.2009.05.001

Panagioti, M., Gooding, P. A., Dunn, G., and Tarrier, N. (2011). Pathways to suicidal behavior in posttraumatic stress disorder. *J. Trauma Stress* 24, 137–145. doi: 10.1002/jts.20627

Portes, P. R., Sandhu, D. S., and Longwell-Grice, R. (2002). Understanding adolescent suicide: a psychosocial interpretation of developmental and contextual factors. *J. Adolesc.* 37, 805–814. doi: 10.1080/00140130210000048060

Rabon, J. K., Hirsch, J. K., Kaniuka, A. R., Sirois, F., Brooks, B. D., and Neff, K. (2019). Self-compassion and suicide risk in veterans: when the going gets tough, do the tough benefit more from self-compassion? *Mindfulness* 10, 2544–2554. doi: 10.1007/s12671-019-01221-8

Raes, F. (2010). Rumination and worry as mediators of the relationship between self-compassion and depression and anxiety. *Pers. Individ. Differ.* 48, 757–761. doi: 10.1016/j.paid.2010.01.023

Rao, N., and Kemper, K. J. (2017). Online training in specific meditation practices improves gratitude, well-being, self-compassion, and confidence in providing compassionate care among health professionals. *J. Evid. Based Complementary Altern. Med.* 22, 237–241. doi: 10.1177/2156587216642102

Rey, L., Quintana-Orts, C., Mérida-López, S., and Extremera, N. (2019). Being bullied at school: gratitude as potential protective factor for suicide risk in adolescents. *Front. Psychol.* 10:662. doi: 10.3389/fpsyg.2019.00662

Rogers, M. L., Kelliher-Rabon, J., Hagan, C. R., Hirsch, J. K., and Joiner, T. E. (2017). Negative emotions in veterans relate to suicide risk through feelings of perceived burdensomeness and thwarted belongingness. *J. Affect. Disord.* 208, 15–21. doi: 10.1016/j.jad.2016.09.038

Selby, E. A., Franklin, J., Carson-Wong, A., and Rizvi, S. L. (2013). Emotional cascades and self-injury: investigating instability of rumination and negative emotion. *J. Clin. Psychol.* 69, 1213–1227. doi: 10.1002/jclp.21966

Tang, T. C., Yen, C. F., Cheng, C. P., Yang, P., Chen, C. S., Yang, R. C., et al. (2010). Suicide risk and its correlate in adolescents who experienced typhoon-induced mudslides: a structural equation model. *Depress. Anxiety* 27, 1143–1148. doi: 10.1002/da.20748

Tarrier, N., and Gregg, L. (2004). Suicide risk in civilian PTSD patients. *Soc. Psychiatry Psychiatr. Epidemiol.* 39, 655–661. doi: 10.1007/s00127-004-0799-4

Thompson, B. L., and Waltz, J. (2008). Self-compassion and PTSD symptom severity. *J. Trauma Stress* 21, 556–558. doi: 10.1002/jts.20374

Tugade, M. M., and Fredrickson, B. L. (2004). Resilient individuals use positive emotions to bounce back from negative emotional experiences. *J. Pers. Soc. Psychol.* 86, 320–333. doi: 10.1037/0022-3514.86.2.320

Vettese, L. C., Dyer, C. E., Li, W. L., and Wekerle, C. (2011). Does self-compassion mitigate the association between childhood maltreatment and later emotion regulation difficulties? A preliminary investigation. *Int. J. Mental Health Addict.* 9, 480–491. doi: 10.1007/s11469-011-9340-7

Wang, W., Wu, X., and Lan, X. (2020). Rumination mediates the relationships of fear and guilt to posttraumatic stress disorder and posttraumatic growth among adolescents after the Ya'an earthquake. *Eur. J. Psychotraumatol.* 11:1704993. doi: 10.1080/20008198.2019.1704993

Wang, W., Wu, X., and Tian, Y. (2018). Mediating roles of gratitude and social support in the relation between survivor guilt and posttraumatic stress disorder, posttraumatic growth among adolescents after the Ya'an Earthquake. *Front. Psychol.* 9:2131. doi: 10.3389/fpsyg.2018.02131

Weathers, F. W. (2013). The PTSD checklist for DSM-5 (PCL-5): Development and initial psychometric analysis. *Paper Presented at the 29th annual meeting of the International Society for Traumatic Stress Studies*, Philadelphia, PA.

Wu, X., Zhang, Y., Lin, C., and Zang, W. (2013). The effect of disaster exposure on PTSD of primary and secondary students: Mediating and moderating effects. *Psychol. Dev. Educ.* 29, 641–648.

Ying, L., Chen, C., Lin, C., Greenberger, E., Wu, X., and Jiang, L. (2015). The relationship between posttraumatic stress symptoms and suicide ideation among child survivors following the W enchuan earthquake. *Suicide Life Threat. Behav.* 45, 230–242. doi: 10.1111/sltb.12118

Zeller, M., Yuval, K., Nitzan-Assayag, Y., and Bernstein, A. (2015). Self-compassion in recovery following potentially traumatic stress: longitudinal study of at-risk youth. *J. Abnorm. Child Psychol.* 43, 645–653. doi: 10.1007/s10802-014-9937-y

Zheng, Y. H., Fan, F., Yu, C. F., and Luo, T. C. (2011). Relationship between gratitude and symptoms of post-traumatic stress disorder among adolescents: mediation of social support and resilience. *Psychol. Dvpt. Ed.* 27, 522–528.

Zhou, X., and Wu, X. (2017). Moderating role of negative venting in the relationship between PTSD and violent behaviors and suicidal ideation in Chinese children after an earthquake. *Child Indic. Res.* 10, 221–230. doi: 10.1007/s12187-016-9383-1

Zhou, X., Wu, X., and Zhen, R. (2017). Assessing the latent structure of DSM-5 PTSD among Chinese adolescents after the Ya'an earthquake. *Psychiatry Res.* 254, 33–39. doi: 10.1016/j.psychres.2017.04.029

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Nonsuicidal Self-Injury: Its Associations With Pathological Internet Use and Psychopathology Among Adolescents

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Background/Hypotheses: As risk factors for nonsuicidal self-injury (NSSI), most studies highlight the importance of internalising disorders, while only a few researches show the connection between externalising disorders and NSSI. Although some papers have introduced the idea that increasing prevalence rates of NSSI are connected to the broader use of the internet, associations between NSSI and pathological internet use (PIU) are understudied. According to our hypothesis, there is a connection between PIU and NSSI, but this is mediated by psychopathological factors from both internalising and externalising dimensions.

Methods: In line with the dimensional approach of psychiatric disorders, participants (N = 363) were recruited from both clinical (N = 202 psychiatric inpatient) and nonclinical (N = 161 adolescents from secondary schools) settings. Measurements: Demographic Questionnaire; Strengths and Difficulties Questionnaire (SDQ); Deliberate Self-Harm Inventory (DSHI); Young Diagnostic Questionnaire for Internet Addiction (YDQ), Mini International Neuropsychiatric Interview Kid (M.I.N.I. Kid).

Results: There was high NSSI frequency (39.9%–71% of them were girls) in our sample. NSSI was significantly more frequent among those who showed threshold symptoms on SDQ than in the subthreshold group [H(3) = 53.293, p <.001]. In the NSSI frequency, there was also a significant difference between 'normal' internet users and both 'maladaptive' and 'pathological' internet users [H(2) = 10.039, p <.05 p = .007]. According to the mediator models, the relationship between PIU and NSSI is not a direct association; it is mediated by all examined psychopathological factors (M.I.N.I. kid diagnoses) except for obsessive-compulsive disorder (OCD), alcohol abuse and dependence, and adjustment disorder.

Conclusions: We found a high frequency of NSSI. According to our results, PIU in itself is not a risk factor for NSSI but might become a risk factor in the presence of comorbid

psychiatric disorders. All of these findings draw the attention of clinicians to the importance of careful screening of comorbid disorders with PIU.

Keywords: NSSI: nonsuicidal self-injury, PIU: pathological internet use, internet addiction, internalization, externalization, psychopathology, adolescent

INTRODUCTION

Due to the high prevalence of nonsuicidal self-injury (NSSI) in the past two decades, there is growing scientific interest in this phenomenon (1). It has become a proposed diagnosis in the 5th edition of the Diagnostic and Statistical Manual of Mental Disorders (2). The symptoms of NSSI in DSM-5 follow the main instructions of the definition of the 'International Society for the Study of Self-injury' (ISSS) made in 2007: NSSI is a deliberate self-injurious act with a nonsuicidal purpose, which is not socially sanctioned. It is important to distinguish it from drug overdoses, culturally sanctioned behaviours (*e.g.* piercings), and repetitive, stereotypical forms among people with developmental disorders (3). As a criterion for the proposed disorder, DSM-5 suggests: there should be 5 or more days in the past year when this kind of self-injurious acts happened. The nonadaptive 'coping strategy' nature of NSSI is also important: the individual who engages in NSSI must have the aim of reaching a better emotional state after the action (2).

Different risk factors, such as prior history of NSSI, cluster B personality, hopelessness, female gender, depression, prior suicidal thoughts/behaviour, exposure to peer NSSI, eating disorder, abuse, *etc.* are described (4). The associations between internalising psychopathology—when the symptoms are mainly presented towards the patient's inner world, *e.g.* the symptoms of major depressive disorder (MDD) and anxiety disorders (5)—and NSSI are well studied (6, 7), and some studies in the past few years have examined the link between externalising psychopathology—when the symptoms are mainly presented towards the patient's environment (5), *e.g.* the symptoms of conduct disorder (CD), oppositional defiant disorder (ODD), attention deficit hyperactivity disorder (ADHD)—and NSSI (8–10). To the best of our knowledge, NSSI still seems to be a multifactorial phenomenon, and whether it should be described as an individual diagnosis or a common symptom is still under discussion (11).

After a significant increase in the prevalence of NSSI at the beginning of the 21th century, prevalence rates have stabilised at high levels (12). This is the same period when internet spread all over the world (13). Content analysis studies repeatedly strengthen the cultural role of internet content in social media in the growth of NSSI prevalence in the general population *via* the influence of these web 2.0 based self-injury subcultural groups, where NSSI has become a culturally accepted phenomenon (14, 15). However, it is still unclear whether there is a specific association between pathological internet use (PIU) and NSSI or whether the broader use of internet is a risk factor for NSSI in itself.

PIU and 'internet addiction' are often used as synonyms. PIU has also been the focus of scientific research in the past two decades (16). In recent times, internet has become part of everyday life, especially among young people, although its effects on emotional and behavioural development are ambiguous (17). One type of 'internet addiction' is also a proposed diagnostic category in DSM-5: 'Internet Gaming Disorder' (2). Both this narrow category and the wider PIU are usually conceptualised as behavioural addiction disorders, with similar features to 'Gambling Disorder' (18). Definitions underline a preoccupation with internet use, withdrawal symptoms, tolerance, loss of control, loss of interest in old hobbies, excessive use of internet despite the knowledge of psychosocial problems, telling lies about the time spent on the internet, use of internet to reach a better emotional state, and the loss of anything important (job, friendship, *etc.*) in real life because of internet (2, 17, 18).

Although PIU and NSSI have similar risk factors, such as depression, anxiety, ADHD, higher rates of suicidal behaviour, impulse control problems, *etc.* (4, 18, 19), to the best of our knowledge there are only a few cross-sectional studies which have examined the association between PIU and self-injurious behaviours. In their recent systematic review, Marchant et al. (20) found only seven papers on this topic, with only two of them (21, 22) having investigated the connection between internet addiction and nonsuicidal self-injurious behaviours; they found a positive correlation between the two phenomena, while, interestingly, Aktepe et al. (22) found that adolescents with an internet addiction were less lonely and more satisfied with their lives. The rest of the papers explored a possible connection with potentially suicidal self-injurious behaviours (19, 22–26). All of the articles found a positive correlation between suicidal ideations and actions and internet addiction, as well as finding some common mediating factors between them, such as depression, anxiety, conduct problems, or ADHD (20).

After Marchant et al.'s (20) review period, additional four relevant papers were identified. Of these four articles, only Liu et al. (27) examined the possible association between PIU and NSSI: they found that internet addiction was related to an increased risk of self-harm with a hierarchical logistic regression analysis, after controlling for gender, family factors, exposure to suicidal thoughts in the real life, depression, alcohol/tobacco use, concurrent suicidality, and perceived social support. The other three articles (28–30) investigated the relationship between PIU and suicidal thoughts and actions; all three papers found a positive correlation.

To summarize the above, both internalising and externalising disorders are risk factors for NSSI. According to our hypothesis-1, in our sample NSSI is more frequent in all subgroups presenting clinical psychiatric symptoms (whether these symptoms are externalising, internalising, or mixed), compared

to those who present only subthreshold symptoms or do not present symptoms. Earlier studies draw attention to the possible link between PIU and NSSI, but this association has been understudied. According to our hypothesis-2, there is a positive association between PIU and NSSI in our cross-sectional adolescent sample, but this connection is not a direct association; it is mediated by psychopathological factors from both internalising and externalising dimensions.

MATERIALS AND METHODS

The methodology of this study, including ethics, subjects, measures, has already been published by Balazs et al. (10) and Horvath et al. (31). We only describe below the core and some additional information on the methods. Our first previous study (10) contained a subsample of the current work; the previous analysis was performed only in the clinical part of the whole sample of this study. In the second study (31) a different statistical design was used, and the focus was on life events and its role in suicidal *versus* nonsuicidal self-injury.

Ethics

The study was approved by The Ethical Committee of the Medical Research Council, Hungary (ETT-TUKEB), under study registration number 5750/2015/EKU. Both caregivers and participants who were older than 14 years old provided active written informed consent. They were informed both in written and oral forms about the study and had the opportunity to ask questions about the nature of the study. There was no refund for participating in the investigation.

Sample

In line with the dimensional approach of psychiatric disorders, participants were recruited from both clinical and nonclinical settings. The clinical sample was enrolled in Vadaskert Child and Adolescent Psychiatric Hospital and Outpatient Clinic between 25.02.2015 and 09.05.2016. Inclusion criteria were age older than 13 years and being an inpatient in the acute adolescent patient ward of the hospital, where patients are hospitalized for an average of five days, then they are usually reintegrated in their everyday (*e.g.* school) environment. Exclusion criteria were serious psychiatric states (*e.g.* a severe psychotic episode) or mental retardation leading to a condition preventing the completion of self-administered questionnaires. Altogether, 33 patients were excluded. Of the remaining 224 patients, 22 refused to participate.

The nonclinical sample was collected from 22 classes of years 8–11 from high schools and vocational schools in Budapest, Hungary between 12.09.2015 and 28.04.2017. Of the 185 students whose parent/caregiver previously gave consent at the parent–teacher meetings, 10 students did not consent to participate; also, in three cases, the parent/child had their consent withdrawn, and participants were not available for data collection despite their consent in 11 cases (*e.g.* the student left the school before their data were collected, or was repeatedly absent on data collection appointments). Exclusion criteria in this group were the same as for inpatient participants; participants with prior or current psychiatric disorders and/or psychiatric treatment could be included in the nonclinical group.

Measurements

Psychiatric symptoms and disorders according to DSM fourth edition (DSM-IV) (32) were evaluated by the modified version of Hungarian version of the modified Mini International Neuropsychiatric Interview Kid (M.I.N.I. Kid) 2.0 (33–36). The M.I.N.I. Kid was administered by trained MA psychology and medical students under strong continuous supervision by senior members of the study staff.

NSSI was evaluated by the Deliberate Self-Harm Inventory (DSHI) (37, 38), which is a self-administered questionnaire, with 17 questions on the method of self-injury being answered by a 'yes' or 'no'. DSHI comprises facets on frequency, severity, and duration of self-injury as well.

PIU is evaluated by 'Young Diagnostic Questionnaire for Internet Addiction' (YDQ) (39), which is also a self-administered questionnaire. Eight items ask about problematic internet use behaviour in the past 6 months with a 'yes' or 'no' answer: common fantasies about internet, preoccupation with internet use, unsuccessful attempts to reduce internet use, emotional problems connected to reducing the use of internet, longer internet use than planned previously, loss of anything important (job, friendship, *etc.*) in real life because of internet, telling lies about time spent on internet, and use of internet to reach a better emotional state.

The 'Strength and Difficulties Questionnaire' (SDQ) (40) is used to evaluate psychopathology both in internalising and externalising dimensions. It is a widely used tool in the literature. The SDQ has an official Hungarian version, validated by Turi et al. (41). The SDQ is also a self-reported questionnaire with 25 items, which investigate five main domains. The two externalising scales are 'hyperactivity/inattention' and 'conduct problems', while the two internalising scales are 'emotional symptoms' and 'peer relationship problems'; the 5th scale is 'prosocial behaviour'. There are three versions of the SDQ, depending on who is completing the questionnaire: the child, the parents, or the teachers; in this study, we used the self-rated children version of SDQ, which was also validated without the parent version by Turi et al. (41).

Study Groups

In line with the dimensional approach of psychiatric disorders, we assume that the mechanism between the assessed phenomena are comparable in both clinical and nonclinical populations, thus study groups were created based on participants' internalising and externalising scores, regardless of the clinical/nonclinical setting of their recruitment. We have based our decision on the above described recruitment methods, prior evidence for the high prevalence of NSSI (42) and pathological internet use (16) in nonclinical populations, and prior evidence on full and subthreshold psychiatric disorders' effect on everyday

functioning and quality of life in both clinical and nonclinical settings (43).

According to appropriate statistical analysis, our subjects were divided into subgroups according to internalising and externalising disorders by their SDQ score. SDQ-internalising subgroup (1): sum of SDQ Emotional symptom subscale and Peer relationship problem subscale score equal to or greater than nine; SDQ-externalising subgroup (2): sum of SDQ Conduct problems subscale and Hyperactivity/inattention subscale score equal to or greater than nine; SDQ-internalising and externalising subgroup (3): both SDQ internalising and externalising subgroup scores equal to or greater than nine; SDQ subthreshold subgroup (4): both SDQ internalising and externalising subgroup scores less than nine. These cut-off points are based on the Hungarian standard of SDQ (Turi et al, 2013). Furthermore, we examined our subjects according to internet use: we divided our subjects into three subgroups: normal internet users (0–2 score on YDQ), maladaptive internet users (3–4 score on YDQ), and pathological internet users (more than five score on YDQ). These cut-off points are based on previous research (16, 39). Each YDQ question is very decisive between 'addictive' and 'nonaddictive' internet use behaviour, therefore only individuals with maximum one or two scores can fulfil normal internet user category. Consequently, maladaptive internet users and pathological internet users were considered as two pathological internet user groups.

Statistics

IBM SPSS Statistics 22.0 was used to data analysis. Descriptive statistics are reported in the text. Mann–Whitney U tests were applied for continuous variables and chi-square tests were applied for categorical variables. The Kruska–Wallis test and Mann–Whitney U test were calculated to explore group differences across study subgroups. Spearman's rank Correlation was applied to analyse the correlation between NSSI, internet use, and M.I.N.I diagnoses symptoms. Those M.I.N.I. Kid diagnoses that were comorbid with NSSI and had prevalence 7% or above 7% were included in mediator model analyses (**Table 1**). According to this, the following diagnoses were not included in the statistical analyses: Tourette's syndrome, tic disorder, anorexia nervosa, bulimia nervosa, and autism spectrum disorder. To test the possible mediational effects of mental disorders on the relationship between internet use and NSSI, total, direct, and indirect effects were calculated using the mediation approach and SPSS PROCESS-Macro provided by Preacher and Hayes (44, 45). We conducted our analyses using dimensional approaches, that is why in the mediator model for mediator variables, we added the number of symptoms of the M.I.N.I. Kid diagnoses, and these continuous variables were used in the model. In case of affective disorders and anxiety disorders we made two bigger groups, in which we gathered the number of appropriate M.I.N.I Kid symptoms. In the mediator model, the independent variable was the score of YDQ, and the outcome variable was the number of self-harm-forms according to the Deliberate Self-Harm Inventory (DSHI) (10, 37). Gender and age were included as covariates. Related to NSSI outcome variable we used the sum of all 17 Deliberate Self-Harm Inventory (DSHI) items (10). Many individuals who self-injure use more than one method (37), so the outcome variable is calculated as a sum of YES answers of the types of self-harming behaviour occurring. Bootstrapping procedure (5,000 bootstrap sample) was used in the mediator model to show the significance because this method does not impose the assumption of normality of the sampling distribution (44).

The following grouped diagnoses were involved as mediator variables: a) affective disorders: major depressive episode, dysthymic disorder, hypo/manic episode; b) anxiety disorders: panic disorder, agoraphobia, separation anxiety disorder, social anxiety disorder, specific phobia, PTSD, GAD; c) OCD; d) ADHD; e) CD and ODD; f) alcohol abuse and dependence; g) psychoactive substance abuse and dependence; h) psychotic disorder; i) suicidality; and j) adjustment disorder.

The study is asserting statistical mediation with cross-sectional data.

RESULTS

Subjects

The whole study population consisted of 363 adolescents, of whom 202 were included from clinical setting and 161 adolescents from nonclinical settings; mean age of participating adolescents (N = 363) was 15.12 years (SD = 1.31). About half of our population were girls (183 girls; 50.7%). In the total sample (N = 363), 145 (39.9%) adolescents had NSSI, with 42 (29%) boys and 103 (71%) girls. There were significantly more girls than boys among the adolescents with NSSI ($\chi 2(1) = 41.071$ $p < 0.001$ $\phi = 0.336$). Prevalences of M.I.N.I Kid diagnoses are high among adolescents who reported NSSI, both in the clinical and in nonclinical sample. (**Table 1**).

SDQ Symptoms and NSSI

Examining the differences across the four groups (SDQ-internalising, SDQ-externalising, SDQ-internalising and externalising, SDQ-subthreshold symptoms), we found a significant difference in the frequencies of NSSI (Kruskal–Wallis test: $H(3) = 53.293$, $p < 0.001$) (**Table 2**).

Bonferroni correction was applied to control for multiple comparison ($p = 0.05/6 = 0.0083$). Specifically, adolescents who were referred for SDQ internalising (1) reported significantly more NSSI compared with adolescents with SDQ subthreshold symptoms (4) ($U = 4{,}045.000$ $z = -5.567$ $p < 0.001$). No significant differences were found between adolescents with SDQ internalising (1) and SDQ externalising (2) ($U = 1{,}946.000$ $z = -0.212$ $p = 0.832$) and the SDQ internalising and externalising group (3) ($U = 1{,}637.500$ $z = -0.876$ $p = 0.381$). Adolescents who were referred for SDQ externalising group (2) reported significantly more NSSI compared with adolescents with SDQ subthreshold symptoms (4) ($U = 2{,}945.000$ $z = -4.784$ $p<0.001$).

TABLE 1 | Prevalence of M.I.N.I Kid diagnoses.

M.I.N.I. Kid diagnoses	M.I.N.I. Kid diagnoses in total sample (N = 363)	M.I.N.I. Kid diagnoses—in total NSSI group (n = 145)	M.I.N.I. Kid diagnoses—in clinical NSSI group (n = 107)	M.I.N.I. Kid diagnoses—in nonclinical NSSI group (n = 38)
Major depressive episode	14.0%	28.5%	37.4%	2.7%
Suicidality—lifetime	46.8%	80.0%	88.8%	55.3%
Suicidality—current	31.4%	55.2%	68.2%	18.4%
Dysthymic disorder	9.1%	15.9%	17.8%	10.5%
Manic episode—lifetime	18.2%	30.3%	36.4%	13.2%
Manic episode—current	10.5%	19.3%	21.5%	13.2%
Hypomanic episode—lifetime	23.1%	25.5%	27.1%	21.1%
Hypomanic episode—current	10.7%	14.5%	15.0%	13.2%
Panic disorder—lifetime	15.9%	29.9%	36.4%	10.8%
Panic disorder (limited symptoms)	18.4%	26.4%	27.1%	24.3%
Panic disorder—current	12.0%	21.5%	27.1%	5.4%
Agoraphobia—current	23.1%	35.9%	43.0%	15.8%
Agoraphobia with Panic disorder	13.2%	24.1%	30.8%	5.3%
Agoraphobia without Panic disorder	9.9%	11.7%	12.1%	10.5%
Separation anxiety disorder	9.2%	16.7%	21.5%	2.7%
Social anxiety disorder	18.7%	32.6%	37.4%	18.9%
Specific phobia	10.9%	14.6%	15.9%	10.8%
OCD	20.1%	29.7%	37.4%	7.9%
PTSD	3.6%	6.9%	9.3%	0.0%
Alcohol dependence	9.8%	15.4%	15.5%	15.2%
Alcohol abuse	10.5%	15.2%	13.1%	21.1%
Psychoactive substance dependence	5.6%	9.8%	12.3%	2.7%
Psychoactive substance abuse	5.5%	9.0%	11.2%	2.6%
Tourette	1.1%	1.4%	1.9%	0.0%
Vocal Tic	0.3%	0.0%	0.0%	0.0%
Tic transitions—current	0.3%	0.0%	0.0%	0.0%
ADHD combined type	7.5%	12.5%	13.1%	10.8%
ADHD inattention type	9.5%	15.3%	19.6%	2.7%
ADHD hyperactivity-impulsivity type	3.9%	4.9%	3.7%	8.1%
CD	8.1%	13.9%	15.0%	10.8%
ODD	16.5%	28.5%	30.8%	21.6%
Psychotic disorder—lifetime	22.3%	38.9%	46.7%	16.2%
Psychotic disorder—current	8.9%	16.0%	17.8%	10.8%
Affective disorder with psychotic symptoms	5.3%	11.8%	15.9%	0.0%
Anorexia nervosa	5.2%	4.8%	6.5%	0.0%
Bulimia nervosa	1.9%	4.1%	4.7%	2.6%
GAD	2.0%	3.5%	4.7%	0.0%
Adjustment disorder	7.6%	11.5%	10.3%	14.7%
Autism spectrum disorder	5.0%	6.2%	8.4%	0.0%

TABLE 2 | Occurrence of NSSI by SDQ groups (how many people have NSSI by SDQ groups).

NSSI occurrence by adolescents	SDQ-internalizing	SDQ-externalizing	SDQ-internalizing and externalizing	SDQ-subthreshold symptoms
NO	34 (45.3%)	25 (47.2%)	16 (33.3%)	133 (77.8%)
YES	41 (54.7%)	28 (52.8%)	32 (66.7%)	38 (22.2%)
Total	75 (100%)	53 (100%)	48 (100%)	171 (100%)

(Related to SDQ we have data from 347 adolescents).

No significant differences were found between adolescents in the SDQ externalising group (2) and the SDQ internalising and externalising group (3) ($U = 1{,}117.500$ $z = -1.093$ $p = 0.275$). We found significantly more NSSI in the SDQ internalising and externalising group (3) compared with the SDQ subthreshold symptoms group (4) ($U = 2{,}127.000$ $z = -6.170$ $p < 0.001$).

We divided the whole sample into two groups (SDQ-threshold, SDQ subthreshold). Comparing the SDQ-threshold

and SDQ-subthreshold group, adolescents who were referred for the SDQ threshold group reported significantly more NSSI than the SDQ subthreshold group (U = 9,117.000 z = −7.181 p < 0.001).

Internet Use and NSSI Frequency

Examining the differences across the three internet use groups (normal, maladaptive, pathological), we found a significant difference in the frequencies of NSSI (Kruskal–Wallis test: H(2) = 10.039, p < 0.05 p = 0.007) (**Table 3**).

Bonferroni correction was applied to the control for multiple comparison (p = 0.05/3 = 0.017). Specifically, adolescents who were referred for maladaptive internet use reported significantly more NSSI compared with adolescents with normal internet use (U = 5,800.500 z = −2.586 p < 0.017 p = 0.010). We found significantly more NSSI in the pathological internet use group than in the normal internet use group (U = 2,020.000 z = −2.501 p < 0.017 p = 0.012). No significant differences were found between adolescents with maladaptive and pathological internet use (U = 625.500 z = −0.017 p > 0.017 p = 0.986).

Tests of Mediation in the Association Between Internet Use and NSSI

According to our results, NSSI has significant correlation with internet use and all measured M.I.N.I Kid diagnoses symptoms.

TABLE 3 | Occurrence of NSSI by internet use groups (normal, maladaptive, pathological) (how many people have NSSI by internet use groups).

NSSI occurrence by adolescents	Normal Internet use	Maladaptive Internet use	Pathological Internet use
NO	160 (63.5%)	29 (50.9%)	8 (36.4%)
YES	92 (36.5%)	28 (49.1%)	14 (63.6%)
Total	252 (100%)	57 (100%)	22 (100%)

(Related to internet use we have data from 331 adolescents).

TABLE 4 | Correlation between NSSI, internet use, and M.I.N.I Kid symptoms.

	NSSI		Internet use	
	Rs	p	Rs	p
NSSI			.203**	<.001
Internet use	.203**	<.001		
Affective disorders	.488**	<.001	.300**	<.001
Anxiety disorders	.446**	<.001	.220**	<.001
OCD	.322**	<.001	.124*	.023
ADHD	.308**	<.001	.285**	<.001
Alcohol abuse and dependence	.188**	<.001	.081	.153
Psychoactive substance abuse and dependence	.260**	<.001	.149**	.007
CD and ODD	.412**	<.001	.294**	<.001
Psychotic disorder	.383**	<.001	.255**	<.001
Suicidality	.508**	<.001	.267**	<.001
Adjustment disorder	.141*	.010	.030	.605

**p < .01.
*p < .05.

Internet use also has significant correlation with most M.I.N.I Kid diagnoses except for alcohol abuse and dependence and adjustment disorder (**Table 4**).

To test the possible mediational effects of M.I.N.I Kid diagnoses symptoms on the relationship between NSSI and internet use we calculated with mediation approach. Because of the results of Spearman's rank correlation (**Table 4**), we decided that we use all M.I.N.I Kid diagnoses (affective disorders, anxiety disorders, OCD, ADHD, CD, and ODD, alcohol abuse and dependence, psychoactive substance abuse and dependence, psychotic disorder, suicidality, adjustment disorder) symptoms in mediator model as mediator variables. Before mediation analysis, we have checked the correlations between M.I.N.I Kid diagnoses (**Table 5**). According to the results there are correlations between them (**Table 5**) that is why we used M.I.N.I Kid diagnoses symptoms as mediator variables in ten different mediator models (**Figure 1**).

Detailed results of mediations are presented in **Table 6**. Moreover **Table 7** summarizes the direct and indirect effects of mediation. Mediation results explain the relationship between internet use and NSSI. The pathway (C′)/direct effect shows direct relationship between internet use and NSSI. Mediation model shows that the independent variable (internet use) influences mediator variables (comorbid mental disorders) (Path A), which in turn influence the dependent variable (NSSI) (Path B). We apply Bonferroni correction in the mediation analyses to control for multiple comparison. (p = 0.05/10 = 0.005, p = 0.01/10 = 0.001). In the case of indirect effects, it is not possible to directly use Bonferroni correction while these are Bootstrapping 95% confidence intervals. Thus, we used Bonferroni correction in case of every path A and path B and we assume that if path A and path B are significant then the indirect effect is also significant. Although a Wald t-test could be conducted by calculating the proportion of the estimated effect and the bootstrapped standard error, if the sampling distribution of the statistic is not symmetric (and it is usually not symmetric in testing indirect effects), using t-statistic in a t-test would be invalid.

According to the results (**Table 6**), except for OCD, alcohol abuse and dependence, adjustment disorder, all measured comorbid mental disorders were predicted by internet use. All measured comorbid mental disorders have significant effect on the appearance of NSSI (Path B). In the mediation model gender and age were used as covariates.

Table 6 shows detailed information related to the total effect, direct effect and indirect effect (path A * path B) between internet use and NSSI. The total effect of internet use on NSSI can be expressed as the sum of the direct and indirect effects: C = C′ + A * B. Except for OCD, alcohol abuse and dependence, adjustment disorder, all other M.I.N.I diagnoses symptoms are significant indirect effect on the relationship of internet use and NSSI. In case of most mediator variables (affective disorders, anxiety disorders, ADHD, CD and ODD, psychoactive substance abuse and dependence, psychotic disorder, suicidality), results show there are only indirect effects (*via* mediators, Path A * Path B) between internet use and NSSI, and in case of all mediator variables direct effects (path C' - direct effect - direct relationship between internet

TABLE 5 | Correlations of M.I.N.I Kid symptoms.

		Affective disorders	Anxiety disorders	OCD	ADHD	CD and ODD	Alcohol abuse and dependence	Psychoactive substance abuse and dependence	Suicidality	Psychotic disorder	Adjustment disorder
Affective disorders	Rs		.778**	.540**	.645**	.583**	.175**	.293**	.603**	.502**	.307**
	p		<.001	<.001	<.001	<.001	.001	<.001	<.001	<.001	<.001
Anxiety disorders	Rs	.778**		.608**	.579**	.582**	.126*	.263**	.519**	.498**	.425**
	p	<.001		<.001	<.001	<.001	.021	<.001	<.001	<.001	<.001
OCD	Rs	.540**	.608**		.411**	.344**	0.02	.136*	.420**	.323**	.288**
	p	<.001	<.001		<.001	<.001	.708	.010	<.001	<.001	<.001
ADHD	Rs	.645**	.579**	.411**		.710**	.157**	.201**	.365**	.401**	.255**
	p	<.001	<.001	<.001		<.001	.004	<.001	<.001	<.001	<.001
CD and ODD	Rs	.583**	.582**	.344**	.710**		.225**	.296**	.428**	.449**	.280**
	p	<.001	<.001	<.001	<.001		<.001	<.001	<.001	<.001	<.001
Alcohol abuse and	Rs	.175**	.126*	0.02	.157**	.225**		.395**	.157**	.111*	.176**
dependence	p	.001	.021	.707	.004	<.001		<.001	.004	.042	.002
Psychoactive substance	Rs	.293**	.263**	.136*	.201**	.296**	.395**		.303**	.260**	.161**
abuse and dependence	p	<.001	<.001	.010	<.001	<.001	<.001		<.001	<.001	.003
Suicidality	Rs	.603**	.519**	.420**	.365**	.428**	.157**	.303**		.392**	.252**
	p	<.001	<.001	<.001	<.001	<.001	.004	<.001		<.001	<.001
Psychotic disorder	Rs	.502**	.498**	.323**	.401**	.449**	.111*	.260**	.392**		.218**
	p	<.001	<.001	<.001	<.001	<.001	.042	<.001	<.001		<.001
Adjustment disorder	Rs	.307**	.425**	.288**	.255**	.280**	.176**	.161**	.252**	.218**	
	p	<.001	<.001	<.001	<.001	<.001	.002	.003	<.001	< 001	

*$p < .01$.
*$p < .05$.

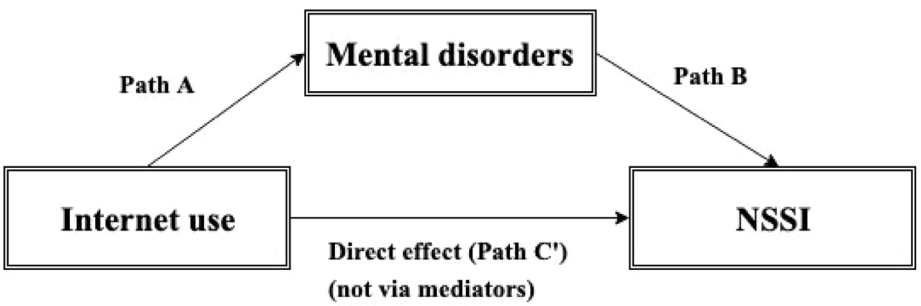

FIGURE 1 | Mediation model. Path A, path B, the direct pathway/effect between internet use and NSSI (C'), and indirect pathway/effect *via* mediating factors (Path A * Path B). Path A: The effect of the symptoms of internet use on comorbid mental disorders. Path B: The effect of the comorbid mental disorders on prevalence of NSSI.

use and NSSI) are not significant. It means that the relationship between internet use (independent variable) and NSSI (dependent variable) was fully influenced (mediated) by comorbid mental disorders. According to our results affective disorders, anxiety disorders, ADHD and CD and ODD have the strongest relationship with internet use, and suicidality, OCD, psychoactive substance abuse have the strongest relationship with NSSI.

DISCUSSION

To the best of our knowledge, this is the first study investigating the previously found connection between PIU and NSSI (21, 22, 27), and whether this is a direct connection or is mediated by other cofactors, such as comorbid psychopathology among clinical and nonclinical adolescent samples.

Although according to our study design, prevalence rates cannot be the main focus, firstly, we would like to highlight the high frequency of NSSI in our sample; it was 39.9% (71% girls). In line with previous studies (46–49), this result in this population, which is collected from clinical and nonclinical settings, underlines the impact of NSSI among all adolescents. In our sample, the frequency of NSSI significantly differed between girls and boys. There is an argument in the literature about this difference: some authors highlight its importance (42, 50), while others deny it (51, 52).

A relatively high frequency of NSSI was found in 'SDQ subthreshold group'. This finding supports the dimensional approach of our study because it shows that even in a group

TABLE 6 | Mediation of the effect of internet use on NSSI through mental disorders.

	Path A	Path B	Effect	SE	t	p	Bootstrapping 95% CI
Mediator variable: Affective disorder	1.335** p<.001	.140** p<.001	.183	.074	2.487	.013	
Total effect							
Direct effect			−.005	.068	−.067	.947	
Partial effect of control variables							
Gender			1.491**	.229	6.499	<.001	
Age			−.069	.086	−.802	.423	
Total indirect effect			.188*	.042			.119,.284
Model summary: R = .375, R2 = .140, F3, 326 = 17.759, p <.001							
Mediator variable: Anxiety disorder	1.905** p <.001	.064** p <.001	.183	.074	2.487	.013	
Total effect							
Direct effect			.061	.068	.889	.374	
Partial effect of control variables							
Gender			1.491**	.229	6.499	<.001	
Age			−.069	.086	−.802	.423	
Total indirect effect			.122*	.042			.050,.220
Model summary: R = .375, R2 = .140, F3, 326 = 17.759, p <.001							
Mediator variable: OCD	.155 p = .005	.432** p <.001	.183	.074	2.487	.013	
Total effect							
Direct effect			.116	.071	1.643	.101	
Partial effect of control variables							
Gender			1.491**	.229	6.499	<.001	
Age			−.069	.086	−.802	.423	
Total indirect effect			.067	.031			.018,.114
Model summary: R = .375, R2 = .140, F3, 326 = 17.759, p <.001							
Mediator variable: ADHD	.978** p <.001	.101** p <.001	.191	.074	2.597	.009	
Total effect							
Direct effect			.092	.075	1.229	.220	
Partial effect of control variables							
Gender			1.482**	.230	6.453	<.001	
Age			−.074	.086	−.858	.392	
Total indirect effect			.099*	.029			.053,.171
Model summary: R = .377, R2 = .142, F3, 324 = 17.867, p <.001							
Mediator variable: CD and ODD	.788** p <.001	.144** p <.001	.191	.074	2.597	.009	
Total effect							
Direct effect			.077	.074	1.048	.295	
Partial effect of control variables							
Gender			1.482**	.230	6.453	<.001	
Age			−.074	.086	−.858	.392	
Total indirect effect			.144*	.033			.059,.191
Model summary: R = .377, R2 = .142, F3, 324 = 17.867, p <.001							
Mediator variable: Alcohol abuse and dependence	.144 p = .036	.352** p <.001	.206	.078	2.640	.008	
Total effect							
Direct effect			.155	.075	2.074	.038	
Partial effect of control variables							
Gender			1.582**	.237	6.670	<.001	
Age			−.088	.088	−1.00	.318	
Total indirect effect			.051	.030			.007,.124
Model summary: R = .396, R2 = .157, F3, 306 = 18.968, p <.001							
Mediator variable: Psychoactive substance	.201** p <.001	.405** p <.001	.188	.073	2.565	.011	

(Continued)

TABLE 6 | Continued

	Path A	Path B	Effect	SE	t	p	Bootstrapping 95% CI
abuse and dependence							
Total effect							
Direct effect			.107	.071	1.515	.131	
Partial effect of control variables							
Gender			1.467**	.230	6.374	<.001	
Age			−.070	.086	−.816	.415	
Total indirect effect			.081*	.033			.029,.163
Model summary: R = .374, R2 = .140, F3, 321 = 17.419, p <.001							
Mediator variable: Psychotic disorder	.325** p <.001	.356** p <.001	.191	.074	2.597	.009	
Total effect							
Direct effect			.075	.068	1.105	.270	
Partial effect of control variables							
Gender			1.482**	.230	6.453	<.001	
Age			−.074	.086	−.858	.392	
Total indirect effect			.116*	.037			.056,.204
Model summary: R = .377, R2 = .142, F3, 324 = 17.867, p <.001							
Mediator variable Suicidality	.217** p <.001	.686** p <.001	.183	.074	2.487	.013	
Total effect							
Direct effect			.034	.065	.524	.601	
Partial effect of control variables							
Gender			1.491**	.229	6.499	<.001	
Age			−.069	.086	−.802	.423	
Total indirect effect			.149*	.046			.072,.255
Model summary: R = .375, R2 = .140, F3, 326 = 17.759, p <.001							
Mediator variable Adjustment disorder	.118 p = .039	.269** p <.001	.196	.076	2.569	.010	
Total effect							
Direct effect			.165	.076	2.179	.030	
Partial effect of control variables							
Gender			1.555**	.242	6.436	<.001	
Age			−.069	.089	−.777	.438	
Total indirect effect			.032	.023			.001,.096
Model summary: R = .391, R2 = .153, F3, 297 = 17.877, p <.001							

***p <. 001.*

**p <. 005.*

Path A: The effect of the symptoms of internet use on comorbid mental disorders. Path B: The effect of the comorbid mental disorders on prevalence of NSSI.

Effect—unstandardized regression coefficients, SE—standard error of the unstandardized regression coefficients, Bootstrapping 95% CI—95% confidence interval, Number of bootstrap resample: 5,000.

Bonferroni correction was applied to the control for multiple comparison. (p = 0.05/10 = 0.005, p = 0.01/10 = 0.001).

This table shows the detailed statistical results of the 10 mediator models; in ***Table 7*** *there is a short summary about the direct and indirect effect of each psychopathological group we examined.*

that can be considered 'nonclinical' based on the measurements, a serious mental health concern is very common. This is in line with those previous studies (43) underlining the role of subthreshold psychiatric symptoms in function-loss and in lower quality of life.

Our first hypothesis was supported. According to the comparison of psychopathology based on a screening instrument (SDQ-internalising, SDQ-externalising, SDQ-internalising and externalising, SDQ-subthreshold symptoms), there was no significant difference in NSSI frequency between the groups with pathology (SDQ-internalising, SDQ-externalising, and SDQ-internalising and externalising); however, all of them had a significantly higher NSSI frequency than the subthreshold group. These results support previous studies that underline the importance of externalising psychopathology in NSSI (8, 9) although earlier studies mainly focused on internalising disorders (4, 6, 53). According to our findings, NSSI seems to be a multifactorial phenomenon that is often comorbid with other psychiatric disorders, consistent with earlier studies (4, 6, 7, 9). This raises questions about the validity of an individual diagnosis as proposed by DSM-5 (2). So far, as NSSI is becoming a new diagnosis in next edition of DSM, comorbidity would become a rule rather than an exemption.

Our second hypothesis—that PIU and NSSI are connected to each other—was supported as well; we found this association when different internet user groups ('Normal', 'Maladaptive' and

TABLE 7 | Direct and indirect effects of internet use on NSSI through mental disorders.

PIU—Mental disorders—NSSI mediation	Effect	SE	t	p	Bootstrapping 95% CI
Mediator variable: Affective disorder					
Direct effect	−.005	.068	−.067	.947	
Indirect effect	.188*	.042			.119,.284
Mediator variable: Anxiety disorder					
Direct effect	.061	.068	.889	.374	
Indirect effect	.122*	.042			.050,.220
Mediator variable: OCD					
Direct effect	.116	.071	1.643	.101	
Indirect effect	.067	.031			.018,.114
Mediator variable: ADHD					
Direct effect	.092	.075	1.229	.220	
Indirect effect	.099*	.029			.053,.171
Mediator variable: CD and ODD					
Direct effect	.077	.074	1.048	.295	
Indirect effect	.144*	.033			.059,.191
Mediator variable: Alcohol abuse and dependence					
Direct effect	.155	.075	2.074	.038	
Indirect effect	.051	.030			.007,.124
Mediator variable: Psychoactive substance abuse and dependence					
Direct effect	.107	.071	1.515	.131	
Indirect effect	.081*	.033			.029,.163
Mediator variable: Psychotic disorder					
Direct effect	.075	.068	1.105	.270	
Indirect effect	.116*	.037			.056,.204
Mediator variable Suicidality					
Direct effect	.034	.065	.524	.601	
Indirect effect	.149*	.046			.072,.255
Mediator variable Adjustment disorder					
Direct effect	.165	.076	2.179	.030	
Indirect effect	.032	.023			.001,.096

***p <. 001.*

**p < .005.*

Effect—unstandardized regression coefficients, SE—standard error of the unstandardized regression coefficients, Bootstrapping 95% CI—95% confidence interval, Number of bootstrap resample: 5,000.

Bonferroni correction was applied to the control for multiple comparison. (p = 0.05/10 = 0.005, p = 0.01/10 = 0.001).

'Pathological') were analysed considering their frequency of NSSI. The 'Normal' group had a significantly lower NSSI frequency than the 'Maladaptive' and 'Pathological' groups; however, there were no differences between the two pathological groups. These findings are similar to previous researches (21, 22, 27). According to the mediator model, PIU has a significant effect on all examined comorbid psychiatric categories, and all comorbid mental disorders predict the appearance of NSSI significantly, except for OCD, alcohol abuse and dependence, adjustment disorder. PIU in itself is not a risk factor of NSSI; it is only a risk factor when there are comorbid psychiatric disorders, especially affective disorders, anxiety disorders, ADHD, CD and ODD, psychoactive substance abuse and dependence, psychotic disorder, and suicidality. This underlines the importance of assessing internet use habits in a structured way for all patients in clinical settings. From a suicide prevention aspect, it is very important to identify these adolescents because there is a lot of evidence that NSSI is strongly connected to suicide (54).

There are a lot of aspects of NSSI, and its risk factors were not assessed by our current study. *E.g*, influence of pubertal development is very important in NSSI because mature emotion regulation skills are strong protective factors of NSSI (55), and this psychological dimension is developing in the age of adolescence. This could be a possible explanation why NSSI is the most frequent in adolescents and why its prevalence decreases after the mid twenties (47). In our previous studies we have already investigated the role of ADHD (10) and life events (31) and in our further studies we are planning to investigate other dimensions such as Axis II diagnoses or further possible protective factor for NSSI, *e.g.* coping mechanisms.

Limitations

A limitation of our study was the cross-sectional design as casual relationships cannot be examined. Moreover, mediator variables may temporally occur between the predictors and criterion measures. In our mediation model we tested the mediation effect of mental disorders, but we did not assess all effects of other NSSI risk factors, such as hopelessness, abuse *etc.* It is a cross-sectional design, so causal relationship cannot be examined. Exactly the pathway is not known, so it might occur that dependent and independent variables are interchangeable because we do not exactly know which was first, pathological internet use and afterwards mental disorders, or the inverse. In

addition, it could be that pathological internet use first emerged which predicts anxiety disorder, which may have an effect on depression, which can influence NSSI occurrence.

Many individuals who engage in NSSI use multiple methods to harm themselves (37). Instead of NSSI frequency in our current study we analysed the number of methods because according to Saldias et al.'s (56) study, the authors also analysed the number of methods of NSSI because it was felt to be reasonably reliable self-report indicators of NSSI compared to the frequency. According to the authors' opinion, individuals with mental health problems are unable to accurately report the frequency due to the high number of NSSI episodes they had experienced. According to Black and Mildred's (57) study, 'retrospective information will make it more challenging to quantify exact frequencies, particularly when NSSI is a repetitive pattern (rather than an occasional act).' In addition, Black and Mildred (57) suggest that engaging in high number of NSSI methods has also been linked to suicide attempts, so the number of NSSI methods is an important part of suicide risk. Given these studies and because of the high prevalence of mental disorders in our sample, we decided that analysis of NSSI methods is more reliable than NSSI frequency.

Another limitation of our study was the use of self-reported questionnaires (PIU, SDQ, DSHI), which can be biased: some participants may show their problems more intensely than they really feel them, while other participants can hide their symptoms.

Furthermore, possible selection bias might have occurred during recruitment, possibly affecting the involvement of youth with highest risk in the nonclinical group: *e.g.* students whose parents were repeatedly unavailable for consent, students who were repeatedly absent from school at the times of data collection, or adolescents who have already dropped out from formal education could not be involved in the study sample.

There is another possible limitation: a subsample of our current work was analysed before, which can decrease the statistical power of the current analysis (10, 31).

Conclusions

n conclusion, we would like to highlight that the high frequency of NSSI, especially in the clinical group of adolescents with symptoms of PIU, calls the attention of the clinicians to the importance of routinely screening for NSSI in this population. Adolescents with symptoms of PIU and symptoms of comorbid psychiatric disorders need special focus. Early recognition and adequate treatment of the symptoms of PIU and comorbid conditions can be important in NSSI prevention among adolescents.

DATA AVAILABILITY STATEMENT

The datasets generated for this study are available on request to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by The Ethical Committee of the Medical Research Council, Hungary (ETT-TUKEB), under study registration number 5750/2015/EKU. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

GM participated in the design of the study, performed the literature search, participated in the data collection and analyses, and drafted the manuscript. DG participated in the data collection and analyses, performed the statistical analyses and drafted the manuscript. LH participated in the design of the study, participated in data collection and analysis, and drafted the manuscript. DS participated in the data collection and analysis, and drafted the manuscript. JB was the principal investigator of the study, participated in the design of the study, coordinated the steps of the data analyses and drafted the manuscript. All authors contributed to the article and approved the submitted version.

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REFERENCES

1. Taylor PJ, Jomar K, Dhingra K, Forrester R, Shahmalak U, Dickson JM. A meta-analysis of the prevalence of different functions of non-suicidal self-injury. *J Affect Disord* (2018) 227:759–69. doi: 10.1016/j.jad.2017.11.073
2. American Psychiatry Association. *Diagnostic And Statistical Manual Of Mental Disorders 5th edn. (DSM-5)*. American Psychiatry Association: Washington DC (2013).
3. Ross S, Heath NL, Toste JR. Non-suicidal self-injury and eating pathology in high school students. *Am J Orthopsychiatry* (2009) 79(1):83–92. doi: 10.1037/a0014826
4. Fox KR, Franklin JC, Ribeiro JD, Kleiman EM, Bentley KH, Nock MK. Meta-analysis of risk factors for nonsuicidal self-injury. *Clin Psychol Rev* (2015) 42:156–67. doi: 10.1016/j.cpr.2015.09.002
5. Achenbach TM, McConaughy SH, Howell CT. Child/adolescent behavioral and emotional problems: implications of cross-informant correlations for situational specificity. *psychol Bull* (1987) 101(2):213–32. doi: 10.1037/0033-2909.101.2.213
6. Bentley KH, Cassiello-Robbins CF, Vittorio L, Sauer-Zavala S, Barlow DH. The association between nonsuicidal self-injury and the emotional disorders: A meta-analytic review. *Clin Psychol Rev* (2015) 37:72–88. doi: 10.1016/j.cpr.2015.02.006
7. Zetterqvist M. The DSM-5 diagnosis of nonsuicidal self-injury disorder: a review of the empirical literature. *Child Adolesc Psychiatry Ment Health* (2015) 9:31. doi: 10.1186/s13034-015-0062-7
8. Allely CS. The association of ADHD symptoms to self-harm behaviours: a systematic PRISMA review. *BMC Psychiatry* (2014) 14:133. doi: 10.1186/1471-244X-14-133
9. Meszaros G, Horvath LO, Balazs J. Self-injury and externalizing pathology: a systematic literature review. *BMC Psychiatry* (2017) 17(1):160. doi: 10.1186/s12888-017-1326-y
10. Balazs J, Gyori D, Horvath LO, Meszaros G, Szentivanyi D. Attention-deficit hyperactivity disorder and nonsuicidal self-injury in a clinical sample of adolescents: the role of comorbidities and gender. *BMC Psychiatry* (2018) 18 (1):34. doi: 10.1186/s12888-018-1620-3
11. Lenkiewicz K, Racicka E, Brynska A. Self-injury - placement in mental disorders classifications, risk factors and primary mechanisms. Review of the literature. *Psychiatria Polska* (2017) 51(2):323–34. doi: 10.12740/PP/62655
12. Muehlenkamp JJ, Claes L, Havertape L, Plener PL. International prevalence of adolescent non-suicidal self-injury and deliberate self-harm. *Child Adolesc Psychiatry Ment Health* (2012) 6:10. doi: 10.1186/1753-2000-6-10
13. Leiner BM, Cerf VG, Clark DD, Kahn RE, Kleinrock L, Lynch DC, et al. A brief history of the internet. *SIGCOMM Comput Commun Rev* (2009) 39 (5):22–31. doi: 10.1145/1629607.1629613
14. Lewis SP, Rosenrot SA, Messner MA. Seeking validation in unlikely places: the nature of online questions about non-suicidal self-injury. *Arch Suicide Res* (2012) 16(3):263–72. doi: 10.1080/13811118.2012.695274
15. Moreno MA, Ton A, Selkie E, Evans Y. Secret Society 123: Understanding the Language of Self-Harm on Instagram. *J Adolesc Health* (2016) 58(1):78–84. doi: 10.1016/j.jadohealth.2015.09.015
16. Durkee T, Kaess M, Carli V, Parzer P, Wasserman C, Floderus B, et al. Prevalence of pathological internet use among adolescents in Europe: demographic and social factors. *Addict (Abingdon England)* (2012) 107 (12):2210–22. doi: 10.1111/j.1360-0443.2012.03946.x
17. Guan SS, Subrahmanyam K. Youth Internet use: risks and opportunities. *Curr Opin Psychiatry* (2009) 22(4):351–6. doi: 10.1097/YCO.0b013e32832bd7e0
18. Bisen SS, Deshpande YM. Understanding internet addiction: a comprehensive review. *Ment Health Rev J* (2018) 23(3):165–84. doi: 10.1108/MHRJ-07-2017-0023
19. Kaess M, Durkee T, Brunner R, Carli V, Parzer P, Wasserman C, et al. Pathological Internet use among European adolescents: psychopathology and self-destructive behaviours. *Eur Child Adolesc Psychiatry* (2014) 23(11):1093–102. doi: 10.1007/s00787-014-0562-7
20. Marchant A, Hawton K, Stewart A, Montgomery P, Singaravelu V, Lloyd K, et al. A systematic review of the relationship between internet use, self-harm and suicidal behaviour in young people: The good, the bad and the unknown. *PloS One* (2017) 12(8):e0181722. doi: 10.1371/journal.pone.0181722
21. Lam LT, Peng Z, Mai J, Jing J. The association between internet addiction and self-injurious behaviour among adolescents. *Injury Prev* (2009) 15(6):403–8. doi: 10.1136/ip.2009.021949
22. Aktepe E, Olgac-Dundar N, Soyoz O, Sonmez Y. Possible internet addiction in high school students in the city center of Isparta and associated factors: a cross-sectional study. *Turkish J Pediatr* (2013) 55(4):417–25.
23. Messias E, Castro J, Saini A, Usman M, Peeples D. Sadness, suicide, and their association with video game and internet overuse among teens: results from the youth risk behavior survey 2007 and 2009. *Suicide Life-Threatening Behav* (2011) 41(3):307–15. doi: 10.1111/j.1943-278X.2011.00030.x
24. Kim JY. The nonlinear association between Internet using time for non-educational purposes and adolescent health. *J Prev Med Public Health = Yebang Uihakhoe Chi* (2012) 45(1):37–46. doi: 10.3961/jpmph.2012.45.1.37
25. Park S, Hong KE, Park EJ, Ha KS, Yoo HJ. The association between problematic internet use and depression, suicidal ideation and bipolar disorder symptoms in Korean adolescents. *Aust New Z J Psychiatry* (2013) 47(2):153–9. doi: 10.1177/0004867412463613
26. Lin IH, Ko CH, Chang YP, Liu TL, Wang PW, Lin HC, et al. The association between suicidality and Internet addiction and activities in Taiwanese adolescents. *Compr Psychiatry* (2014) 55(3):504–10. doi: 10.1016/j.comppsych.2013.11.012
27. Liu HC, Liu SI, Tjung JJ, Sun FJ, Huang HC, Fang CK. Self-harm and its association with internet addiction and internet exposure to suicidal thought in adolescents. *J Formos Med Assoc = Taiwan yi zhi* (2017) 116(3):153–60. doi: 10.1016/j.jfma.2016.03.010
28. Kim BS, Chang SM, Park JE, Seong SJ, Won SH, Cho MJ. Prevalence, correlates, psychiatric comorbidities, and suicidality in a community population with problematic Internet use. *Psychiatry Res* (2016) 244:249–56. doi: 10.1016/j.psychres.2016.07.009
29. Kim K, Lee H, Hong JP, Cho MJ, Fava M, Mischoulon D, et al. Poor sleep quality and suicide attempt among adults with internet addiction: A nationwide community sample of Korea. *PloS One* (2017) 12(4):e0174619. doi: 10.1371/journal.pone.0174619
30. Bousono Serrano M, Al-Halabi S, Buron P, Garrido M, Diaz-Mesa EM, Galvan G, et al. Substance use or abuse, internet use, psychopathology and suicidal ideation in adolescents. *Adicciones* (2017) 29(2):97–104. doi: 10.20882/adicciones.811
31. Horváth LO, Győri D, Komáromy D, Mészáros G, Szentiványi D, Balázs J. Nonsuicidal Self-Injury and Suicide: The Role of Life Events in Clinical and Non-Clinical Populations of Adolescents. *Front Psychiatry* (2020) 11:370. doi: 10.3389/fpsyt.2020.00370
32. American Psychiatry Association. *Diagnostic And Statistical Manual Of Mental Disorders 4th edn. (DSM-IV)*. American Psychiatry Association: Washington DC (1994).
33. Lecrubier Y, Sheehan DV, Weiller E, Amorim P, Bonora I, Harnett Sheehan K, et al. The Mini International Neuropsychiatric Interview (MINI). A short diagnostic structured interview: reliability and validity according to the CIDI. *Eur Psychiatry* (1997) 12(5):224–31. doi: 10.1016/S0924-9338(97)83296-8
34. Sheehan DV, Lecrubier Y, Sheehan KH, Amorim P, Janavs J, Weiller E, et al. Mini-International Neuropsychiatric Interview (M.I.N.I.): the development and validation of a structured diagnostic psychiatric interview for DSM-IV and ICD-10. *J Clin Psychiatry* (1998) 59(Suppl 20):22–33;quiz 4-57.
35. Balázs JBA, Lefkovics E, Tamás Z, Nagy P, Gádoros J. A gyermek M.I.N.I. kérdőív magyar változatának ismertetése [The Hungarian Version of M.I.N.I. Kid]. *Psychiatria Hungarica* (2004) 19:358–64.
36. Sheehan DV, Sheehan KH, Shytle RD, Janavs J, Bannon Y, Rogers JE, et al. Reliability and validity of the Mini International Neuropsychiatric Interview for Children and Adolescents (MINI-KID). *J Clin Psychiatry* (2010) 71 (3):313–26. doi: 10.4088/JCP.09m05305whi
37. Gratz KL. Measurement of Deliberate Self-Harm: Preliminary Data on the Deliberate Self-Harm Inventory. *J Psychopathol Behav Assess* (2001) 23 (4):253–63. doi: 10.1037/t04163-000
38. Jenkins AL, McCloskey MS, Kulper D, Berman ME, Coccaro EF. Self-harm behavior among individuals with intermittent explosive disorder and personality disorders. *J Psychiatr Res* (2015) 60:125–31. doi: 10.1016/j.jpsychires.2014.08.013
39. Young KS. Internet addiction: The emergence of a new clinical disorder. *CyberPsychology Behav* (1998) 1(3):237–44. doi: 10.1089/cpb.1998.1.237

40. Goodman R. The Strengths and Difficulties Questionnaire: a research note. *J Child Psychol Psychiatry Allied Disciplines* (1997) 38(5):581–6. doi: 10.1111/j.1469-7610.1997.tb01545.x
41. Turi E, Gervai J, Aspan N, Halasz J, Nagy P, Gadoros J. [Validation of the Hungarian version of the Strengths and Difficulties Questionnaire in an adolescent clinical population]. *Psychiatria Hungarica A Magyar Pszichiatriai Tarsasag Tudomanyos Folyoirata* (2013) 28(2):165–79.
42. Brunner R, Kaess M, Parzer P, Fischer G, Carli V, Hoven CW, et al. Life-time prevalence and psychosocial correlates of adolescent direct self-injurious behavior: a comparative study of findings in 11 European countries. *J Child Psychol Psychiatry Allied Disciplines* (2014) 55(4):337–48. doi: 10.1111/jcpp.12166
43. Dallos G, Keresztény Á, Miklósi M, Gádoros J, Balázs J. Why are children and adolescents referred for psychiatric assessment without fulfiling diagnostic criteria for any psychiatric disorder? *Child Adolesc Ment Health* (2014) 19 (3):199–207. doi: 10.1111/camh.12046
44. Preacher KJ, Hayes AF. Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behav Res Methods* (2008) 40(3):879–91. doi: 10.3758/BRM.40.3.879
45. Hayes AF. *Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach*. The Guilford Press: New York, NY (2013).
46. Nock MK. Self-injury. *Annu Rev Clin Psychol* (2010) 6:339–63. doi: 10.1146/annurev.clinpsy.121208.131258
47. Swannell SV, Martin GE, Page A, Hasking P, St John NJ. Prevalence of nonsuicidal self-injury in nonclinical samples: systematic review, meta-analysis and meta-regression. *Suicide Life-Threatening Behav* (2014) 44 (3):273–303. doi: 10.1111/sltb.12070
48. Horvath OL, Meszaros G, Balazs J. [Non-suicidal self-injury in adolescents: current issues]. *Neuropsychopharmacologia Hungarica Magyar Pszichofarmakologiai Egyesulet lapja* (2015) 17(1):14–22.
49. Brown RC, Plener PL. Non-suicidal Self-Injury in Adolescence. *Curr Psychiatry Rep* (2017) 19(3):20. doi: 10.1007/s11920-017-0767-9
50. Madge N, Hewitt A, Hawton K, de Wilde EJ, Corcoran P, Fekete S, et al. Deliberate self-harm within an international community sample of young people: comparative findings from the Child & Adolescent Self-harm in Europe (CASE) Study. *J Child Psychol Psychiatry Allied Disciplines* (2008) 49(6):667–77. doi: 10.1111/j.1469-7610.2008.01879.x
51. Klonsky ED, Oltmanns TF, Turkheimer E. Deliberate self-harm in a nonclinical population: prevalence and psychological correlates. *Am J Psychiatry* (2003) 160(8):1501–8. doi: 10.1176/appi.ajp.160.8.1501
52. Whitlock J, Eckenrode J, Silverman D. Self-injurious behaviors in a college population. *Pediatrics* (2006) 117(6):1939–48. doi: 10.1542/peds.2005-2543
53. Jacobson CM, Gould M. The epidemiology and phenomenology of non-suicidal self-injurious behavior among adolescents: a critical review of the literature. *Arch Suicide Res* (2007) 11(2):129–47. doi: 10.1080/13811110701247602
54. Grandclerc S, De Labrouhe D, Spodenkiewicz M, Lachal J, Moro MR. Relations between Nonsuicidal Self-Injury and Suicidal Behavior in Adolescence: A Systematic Review. *PloS One* (2016) 11(4):e0153760. doi: 10.1371/journal.pone.0153760
55. McKenzie KC, Gross JJ. Nonsuicidal self-injury: an emotion regulation perspective. *Psychopathology* (2014) 47(4):207–19. doi: 10.1159/000358097
56. Saldias A, Power K, Gillanders DT, Campbell CW, Blake RA. The Mediatory Role of Maladaptive Schema Modes Between Parental Care and Non-Suicidal Self-Injury. *Cogn Behav Ther* (2013) 42(3):244–57. doi: 10.1080/16506073.2013.781671
57. Black EB, Mildred H. Characteristics of nonsuicidal self-injury in women accessing internet help sites. *Clin Psychol* (2018) 22:37 45. doi: 10.1111/cp.12094

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Differences in Behavioral Inhibitory Control in Response to Angry and Happy Emotions Among College Students With and Without Suicidal Ideation: An ERP Study

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Suicidal ideation is one of the strongest predictors of suicide. A large number of studies have illustrated the important effect of impulsivity on suicidal ideation, and behavioral inhibitory control (BIC) is a specific manifestation of impulsivity. The goal of the present study is to evaluate the difference in BIC in response to happy and angry emotions between individuals with or without suicidal ideation to reveal the underlying mechanism of the effect of impulsivity on suicidal ideation when accounting for the effect of emotion. Combining the ERP technique and the two-choice oddball paradigm, a total of 70 college students were recruited to participate in this study. The Beck Scale for Suicidal Ideation–Chinese Version was used to identify whether the participants had suicidal ideation. There were 30 participants in the risky-suicidal ideation (SI) group and 19 participants in the non-suicidal ideation (NSI) group. The results showed that the reaction time of the SI group was longer than that of the NSI group for happy emotions. At the electrophysiological level, the P3 amplitude of the NSI group was larger than that of the SI group regardless of the electrode sites and valence, and the P3 component elicited by angry faces was larger than those elicited by happy faces in the SI group. These findings suggest that individuals without suicidal ideation have better BIC, and the SI group has more difficulty controlling their responses to happy emotions than their responses to angry emotions.

Keywords: behavioral inhibitory control, ERPs, two-choice oddball paradigm, impulsivity, suicidal ideation

INTRODUCTION

Suicidality is becoming a serious threat to the health of college students and has become the second leading cause of death among college students in recent years (Heron, 2017). Suicidal ideation (SI) refers to individuals who currently have plans and wishes to die by suicide but have not initiated any overt suicide attempt (Beck et al., 1979), which is a main factor in the psychological process leading to suicidal behavior (Deykin and Buka, 1994). Impulsivity is a noteworthy personality trait that is associated with SI and has an important effect on SI (Klonsky and May, 2010). A number of studies have illustrated

that the risk of suicidal ideation increases with the level of impulsivity (Auerbach et al., 2016; Wang et al., 2019). Thus, to take effective measures to protect susceptible individuals from emerging SI, it is essential to clarify the underlying mechanism by which impulsivity influences SI.

As a personality trait, impulsivity is conceptualized as "a predisposition toward rapid, unplanned reactions to internal or external stimuli without regard to the negative consequences of these reactions" (Moeller et al., 2001). Barratt and Patton (1983) developed the Barratt Impulsiveness Scale to measure impulsivity. They theorized that impulsivity has three facets: attentional impulsivity (AI) is characterized by difficulty concentrating; non-planning impulsivity (NPI) is characterized by a lack of impulse control and a lack of planning for the future; motor impulsivity (MI) is characterized by acting without thinking. In addition to the self-report scale, a variety of tasks have been developed to assess impulsivity more objectively, such as the go/no-go task and the two-choice oddball paradigm. In particular, the go/no-go task consists of the presentation of a continuous series of "go" (i.e., the target) cues, to which participants are required to respond as accurately and quickly as possible, and "no-go" cues, which require participants to inhibit motor responses. However, motor responses are involved in the task, so the effects of inhibitory control observed in the task are likely to be contaminated by response-related processes. Therefore, the well-established two-choice oddball paradigm improves upon the aforementioned shortcomings of the go/no-go task and reflects one of the most important components of impulsivity, i.e., the ability to suppress inappropriate actions and thoughts, which can be measured by behavioral inhibitory control (BIC) (Logan et al., 1997; Yuan et al., 2017). Participants are required to respond to both standard (70%) and deviant (30%) stimuli by pressing different keys as quickly as possible (rather than one response to the "go" stimuli in a go/no-go task). The responses to standard stimuli would be a dominant response, which needs to be suppressed to ensure a correct response to the deviant stimuli. Thus, the two-choice oddball paradigm reflects the effect of BIC purely by subtraction between deviant and standard stimuli (Yuan et al., 2008a). In light of the aforementioned advantages, the two-choice oddball paradigm is adopted in this study.

Event-related potentials (ERPs) are often measured during the two-choice oddball paradigm to examine the cognitive processes underlying BIC. N2 and P3 components related to BIC have been consistently found across studies. N2 is a negative component that reflects conflict monitoring with the largest amplitude in frontal electrode sites (Yeung et al., 2004; Wang et al., 2011); P3 is a late positive component that reflects the inhibitory process itself with the largest amplitude in parietal electrode sites (Albert et al., 2010; Kamp and Donchin, 2015). Therefore, N2/P3 components of the difference wave (subtraction between deviant and standard stimuli) induced in the two-choice oddball paradigm are an effective index of BIC. BIC is an interrelated mechanism of impulsivity, and it has frequently proven that impulsivity levels increase as BIC decreases (Enticott et al., 2006). A decrease in BIC could predict suicidal risk (Venables et al., 2015). Thus, focusing on the relationship between BIC and SI could reveal the underlying mechanism of the effect of impulsivity on SI. The first goal of the present study is to compare the difference in BIC (indexed by N2 and P3 components) between SI and NSI groups to elucidate the neural correlates of impulsivity and SI.

Furthermore, the complex interactions between human emotional activity and inhibition control have been proven by a handful of studies (Gross, 2007; Rowe et al., 2007). For instance, as a product of out-of-control behavior, aggression is often closely related to negative emotions (Shafritz et al., 2006; Stewart et al., 2010), and the performance of cognition and behavioral control can lead to significantly different emotional experiences of the same event (Gross, 2007). Similarly, there is a significant negative correlation between impulsivity and the emotional stability of individuals (Carver and White, 1994), which suggests that low levels of BIC are pronounced under negative emotional states (Posner et al., 2002). Most of the aforementioned results were obtained from healthy participants. Emotion is closely related to the development of suicidal ideation (Heffer and Willoughby, 2017), and negative emotion is also considered an important risk factor for suicidal ideation (Brausch and Decker, 2014). Emotional vulnerability is a risk factor that has been repeatedly proven to contribute to suicidal ideation, suicidal behavior, and an increased likelihood of future suicide attempts (Arria et al., 2009; Palmierclaus et al., 2012). Therefore, what effect do emotions with different valences have on the BIC of individuals with suicidal ideation? Specifically, the study by Jollant et al. (2008) illustrates that individuals with a history of suicidal attempt have an increased sensitivity to disapproval from others, a higher propensity to act on negative emotions (especially to angry faces), and reduced attention to mildly positive stimuli. Along these lines, the second goal of the present study is to directly compare the BIC of individuals with or without SI under angry emotions and happy emotions to reveal how the two emotions impact the relationship between BIC and SI.

In summary, there are two highlights in the present study. The first is the difference in BIC of individuals with or without SI; the second is the effect of angry and happy emotions on BIC in the two groups. To this end, the study used a two-choice oddball paradigm combined with ERP technology to measure the BIC of individuals accurately. We predicted that there would be significant differences in BIC (indexed by N2 and P3 amplitudes) between participants with or without SI, and we also predicted that the N2 and P3 amplitudes would differ under angry and happy emotions in the two groups.

MATERIALS AND METHODS

Subjects

In total, 799 college students as paid volunteers from Tianjin Normal University participated in the present study. All participants were healthy, right-handed, with normal or corrected to normal vision, and signed an informed consent form before the experiment. To distinguish whether the participants had suicidal ideation, all of them completed twice measurements of the Beck Scale for Suicidal Ideation–Chinese

Version (BSI-CV) (Li et al., 2011), taking the 4–5 items as the standard of whether they had suicidal ideation (the total score of two items is greater than or equal to 1 suggest they had suicidal ideation). According to statistics, 139 of them had suicidal ideation in both two measurements, 479 of them had no suicidal ideation in both two measurements, and 181 of them had suicidal ideation in one of the measurements. A total of 70 participants (17 males, 53 females, age range from 18 to 23, mean age = 19.42) from 139 suicidal ideation and 479 non-suicidal ideation participated in the ERP experiments by telephone invitation.

Before the ERP experiment, the invited 70 participants completed the BSI-CV again and the Center for Epidemiological Studies Depression Scale (CES-D; 2010; Zhang et al., 2010). They were classified as suicidal ideation group and non-suicidal ideation group according to the criteria as follows: (1) the participants in risky-suicidal ideation group (SI) scored not equal to 0 in the 4–5 items of BSI-CV (suicidal ideation) and scored not equal to 0 in the 6–19 items of BSI-CV (suicidal risk). A total of 30 participants in the SI group, but 2 of them were excluded because of too many EEG artifacts (artifacts to reject were 86.8% and 92.1%), yielding 28 participants (6 males and 22 females, age range from 18 to 21, mean age = 19.20), entered the statistical analysis. 2) The participants in non-suicidal ideation group (NSI) scored equal to 0 in the 4–5 items of BSI-CV (non-suicidal ideation) and scored equal to 0 in the 6–19 items of BSI-CV (non-suicidal risk). A total of 19 participants in the NSI group, but 1 of them was excluded because of the extreme value of EEG data and 2 of them were excluded because of too many EEG artifacts (artifacts to reject were 92.1 and 87.1%), yielding 16 participants (2 males and 14 females, age range from 18 to 23, mean age = 19.36), entered the statistical analysis. The remaining 21 participants who did not meet the aforementioned grouping criteria were not included in the statistical analysis. The *t*-test for the scores of CES-D showed a significant difference in depression between the two groups ($t = 3.34$, $p = 0.002$). The level of depression in the SI group (42.64 ± 11.02) was significantly higher than that in the NSI group (31.94 ± 8.66), indicating the grouping criteria of this study had a good validity (Bronisch and Wittchen, 1994; Rockett et al., 2007).

Stimuli

The emotional faces employed in the present study were chosen from the Chinese Facial Affective Picture System (CFAPS; Wang and Luo, 2005). Before the experiment, 36 college students evaluated the identification of emotional type (happy, angry, and neutral), as well as the valence and arousal of the emotional faces. The identification of emotional types of faces (half of male and female) was rate greater than 70% by the students selected for the experiment (e.g., 70% of the students considered that a happy face did express a happy mood). The selected faces included 2 neutral faces as frequent standard stimuli, 12 faces as anger deviant stimuli, and 12 faces as happy deviant stimuli. There was a significant difference in valence between happy and angry faces ($t = 23.67$, $p < 0.001$), and there was no significant difference in arousal ($t = -1.10$, $p = 0.285$). Contrast and luminance levels of the pictures were also controlled. All the pictures were identical in size and resolution (4°8′ × 6°8′, 100 pixels per inch).

Procedure

Participants were seated in a quiet room at approximately 65 cm from a computer screen. Stimuli were presented using E-Prime version 2.0 (Psychological Software Tools, Pittsburgh, PA, United States). In each trial (see **Figure 1**), a 300-ms fixation cross was presented, which was followed by a blank screen whose duration varied randomly for 500–1500 ms. Then, a stimulus picture appeared on the screen. Participants were instructed to press the key on the keyboard with their corresponding finger as accurately and quickly as possible. If the standard picture (neutral faces) appeared (70%), press "F" and if the deviant picture (happy or angry faces) appeared (30%), press "J". The stimulus picture was terminated by a key pressing or was terminated when it elapsed for 1000 ms. Then 500 ms of blank screen ended the trial. The present study consisted of eight trials for practice and participants who achieved 100% accuracy could enter the formal experiment. The formal experiment comprised 12 blocks (half of male and female, and one block presents one single gender), which consisted of 60 trials (18 trials of deviation and 42 trials of standard) with a total of 720 trials. The 1-min break lasted between each block, yielding a total 40 min of the whole experiment.

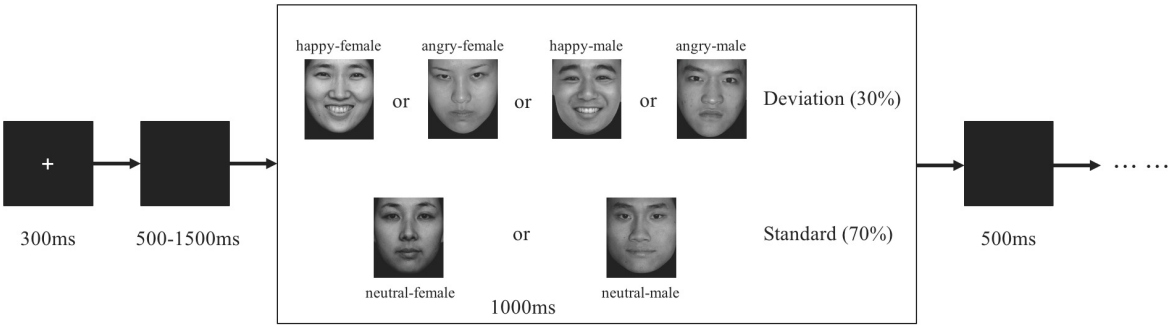

FIGURE 1 | Schematic illustration of the experimental procedure and the stimulus examples. Each trial presented a single deviant or standard stimulus. Participants press the "F" key and "J" key as the response for standard and deviant stimuli, respectively.

ERP Recording and Analysis

Electroencephalography (EEG) was recorded from 64 scalp sites using tin electrodes mounted in an elastic cap (Curry 7 system produced by Neuroscan company), with the references on the left and right mastoids for offline ERP computation (average mastoid reference; Luck, 2005) and a ground electrode on the medial frontal aspect. The vertical electrooculograms (EOGs) were recorded supra- and infra-orbitally at the left eye. The horizontal EOG was recorded from the left versus right orbital rim. The EEG and EOG were amplified using AC recording with the bandpass of 0.05–100 Hz (FIR filter) at a sampling rate of 1000 Hz. Data acquisition was not started until all impedance values were below 5 kΩ.

Signal processing and offline analysis were performed in MATLAB using the EEGLAB toolbox (Delorme and Makeig, 2004) and ERPLAB toolbox (Lopezcalderon and Luck, 2014). All data were re-referenced to the average of the left and right mastoid electrodes and bandpass filtered with low pass 30 Hz (24 dB/oct). Then, ERP waveforms were time-locked to the onset of stimuli and the average epoch was 1000 ms, including a 200-ms pre-stimulus baseline. Artifact detection and rejection were conducted on epoched uncorrected data files to identify and remove trials containing blinks and large eye movements at the time of stimulus presentation (mean EOG voltage exceeding ± 100 μV were excluded). Epochs with large artifacts (exceeding ± 100 μV) were excluded from analysis (Kudinova et al., 2015). Next, ERP data were baseline corrected to the mean amplitude of the pre-stimulus interval. Finally, ERP data for the correct response in each valence condition were overlapped and averaged separately. There were 99.92 trials for angry, 99.79 trials for happy, and 484.68 trials for neutral in SI group; 98.56 trials for angry, 98.50 trials for happy, and 483.69 trials for neutral in NSI group.

As shown by the topographical maps and ERP's grand averaged waveforms, ERP induced by deviant stimuli and standard stimuli were separated from about 150 ms, and the difference continued until about 700 ms. It was mainly composed of N2 (280–360 ms) and P3 (450–510 ms) on the waveform, and these components were largest at frontal and central-parietal sites (see **Figures 2**, **3**). Thus, we selected the following 15 electrode sites for statistical analysis: F1, Fz, F2 (three frontal sites); FC1, FCz, FC2 (three frontal-central sites); C1, Cz, C2 (three central sites); CP1, CPz, CP2 (three central-parietal sites); P1, Pz, P2 (three parietal sites). The mean amplitudes (from stimulus onset to the peak of each component) and the peak latencies were determined with an automated recognition by the ERPLAB toolbox. A three-way repeated measures ANOVA was conducted for the mean amplitude and latency of each component by SPSS 24.0. ANOVA factors were valence condition (two levels: happy and angry) and electrode site (15 sites: frontal sites F1, Fz, F2; frontal-central sites FC1, FCz, FC2; central sites C1, Cz, C2; central-parietal sites CP1, CPz, CP2; and parietal sites P1, Pz, P2) as within-subjects factor, and the group (two levels: risky-suicidal ideation and non-suicidal ideation) as between-subjects factor. The degrees of freedom of the *F*-ratio was corrected according to the Greenhouse–Geisser method. Bonferroni–Holm method was used for *post hoc* comparisons if significant main or interaction effects were found.

RESULTS

Behavioral Data

The mean RTs and standard errors of each condition in both groups are presented in **Table 1**. Errors were rare, all participants achieved ceiling accuracy for the standard and deviant stimuli (SI group = 95.05%, NSI group = 94.55%), and t-test showed that there was no difference in accuracy between the two groups ($t = 0.30$, $p = 0.762$). The ANOVA of the reaction times (RTs) with stimuli type (deviant, standard) and group (SI, NSI) showed an effect of stimuli type [$F(1, 42) = 328.35$, $p < 0.001$, $\eta^2 p = 0.887$], the RTs for deviant stimuli (569.44 ± 6.30) were significantly longer than that of standard stimuli (489.93 ± 5.78); and an effect of group [$F(1, 42) = 8.84$, $p = 0.005$, $\eta^2 p = 0.174$], the RTs for SI group (546.42 ± 6.79) were significantly longer than that of NSI group (512.95 ± 8.98). The ANOVA with valence (happy, angry) and group (SI, NSI) showed an effect of group [$F(1, 42) = 7.32$, $p = 0.010$, $\eta^2 p = 0.148$], the RTs for SI group (586.48 ± 7.59) was significantly longer than that of NSI group (552.40 ± 10.05); and an interaction effect between valence and group [$F(1, 42) = 7.01$, $p = 0.011$, $\eta^2 p = 0.143$]. The simple-effect analyses of two-way interaction showed a significant group effect in valences [$F(1, 42) = 10.06$, $p = 0.003$, $\eta^2 p = 0.193$], with longer RTs for SI group (588.41 ± 44.21) than for NSI group (545.05 ± 42.55) in happy valence; and the valence effect was significant in group [$F(1, 42) = 6.91$, $p = 0.012$, $\eta^2 p = 0.141$], with longer RTs for angry valence (559.75 ± 9.93) than for happy valence (545.05 ± 10.91) in NSI group. It can be seen that participants showed significant reaction time delay under the experimental conditions due to the need of reaction inhibition.

ERP Results

Test the Effect of BIC (Original Waveform)

The repeated ANOVA of the average amplitude of 280–360 ms interval with stimuli type (deviation, standard), electrode sites (frontal sites: F1, Fz, F2; frontal-central sites: FC1, FCz, FC2; central sites: C1, Cz, C2; central-parietal sites: CP1, CPz, CP2; parietal sites: P1, Pz, P2), and group (SI, NSI) was conducted. The results showed an effect of stimuli type [$F(1, 42) = 5.01$, $p = 0.031$, $\eta^2 p = 0.107$], the average amplitude for deviant stimuli (5.32 ± 0.84) was significantly larger than that of standard stimuli (4.43 ± 0.73); an effect of electrode sites [$F(2, 80) = 75.26$, $p < 0.001$, $\eta^2 p = 0.642$], largest N2 amplitudes were recorded at frontal electrode sites, and all anterior sites displayed larger N2 than posterior sites, in which Fz site recorded the largest N2 amplitude and P2 site recorded the smallest; an effect of group [$F(1, 42) = 11.53$, $p = 0.002$, $\eta^2 p = 0.215$], the average amplitude of SI group (2.30 ± 0.92) was significantly more negative than that of NSI group (7.46 ± 1.21); as well as an interaction effect between stimuli type and electrode sites [$F(2, 74) = 13.30$, $p < 0.001$, $\eta^2 p = 0.241$] showed the standard stimuli elicited a significantly

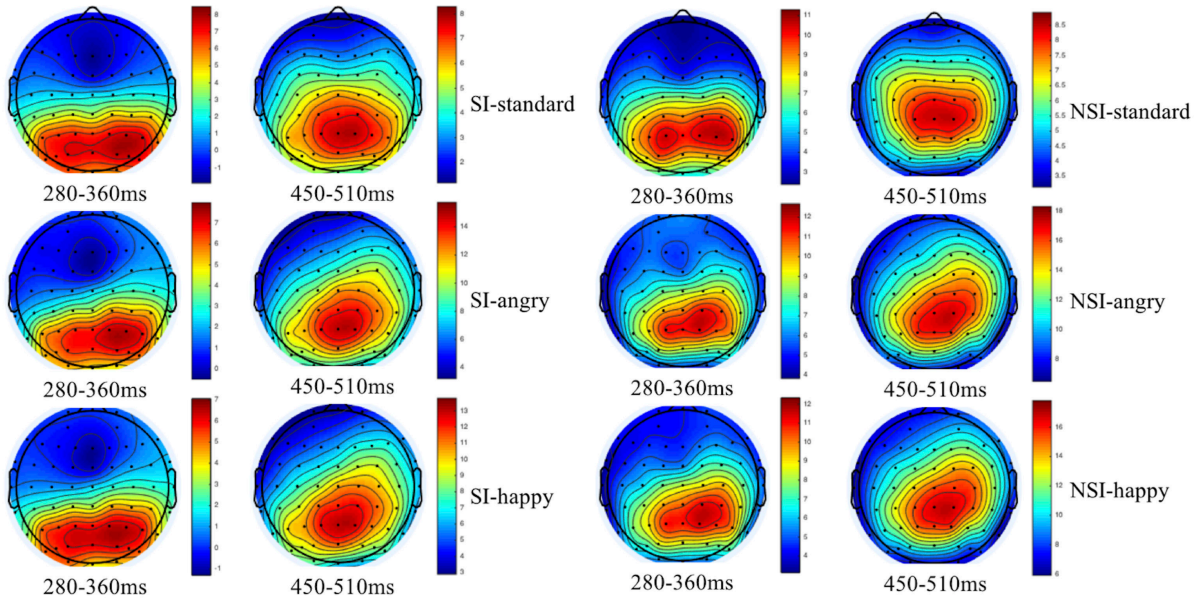

FIGURE 2 | Topographical maps of voltage amplitudes for original waveform at 280–360 ms and 450–510 ms in SI group (left panel) and NSI group (right panel). SI, risky-suicidal ideation; NSI, non-suicidal ideation.

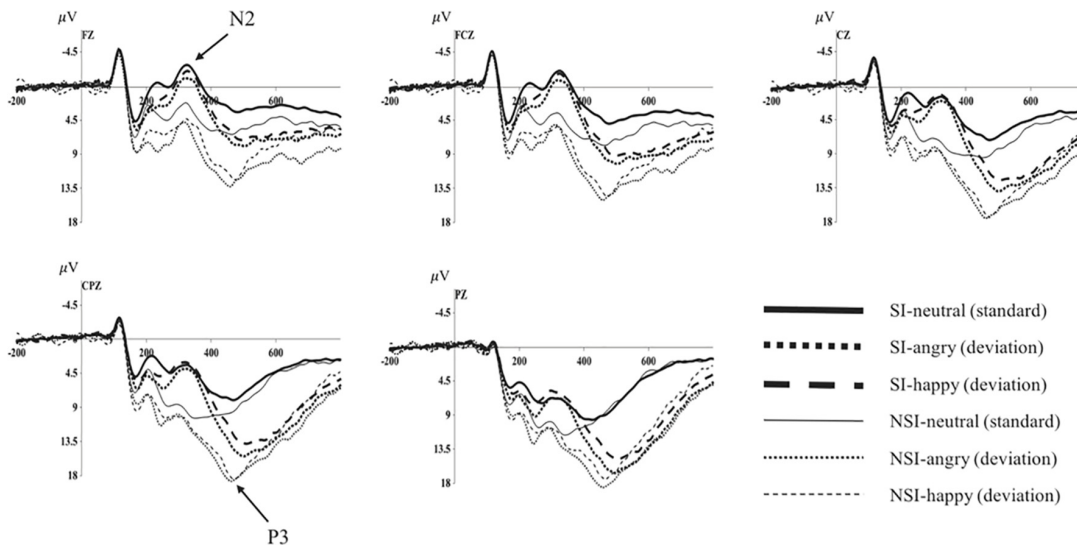

FIGURE 3 | Average of original ERPs at Fz, FCz, Cz, CPz, and Pz for neutral, angry, and happy conditions in SI group and NSI group. SI, risky-suicidal ideation; NSI, non-suicidal ideation.

larger negative component than deviant stimuli especially in frontal sites (as seen in **Figure 3**).

The repeated ANOVA of the average amplitude of 450–510 ms interval with stimuli type (deviation, standard), electrode sites (frontal sites: F1, Fz, F2; frontal-central sites: FC1, FCz, FC2; central sites: C1, Cz, C2; central-parietal sites: CP1, CPz, CP2; parietal sites: P1, Pz, P2), and group (SI, NSI) was conducted. The results showed an effect of stimuli type [$F(1, 42) = 114.24$, $p < 0.001$, $\eta^2 p = 0.731$], the average amplitude for deviant stimuli (12.23 ± 0.75) was significantly larger than that of standard stimuli (6.40 ± 0.55); an effect of electrode sites [$F(2, 75) = 43.54$, $p < 0.001$, $\eta^2 p = 0.509$], largest P3 amplitudes were recorded at parietal electrode sites, and all posterior sites displayed larger P3 than anterior sites, in which Pz site recorded the largest P3 amplitude and F1 site recorded the smallest; an effect of group [$F(1, 42) = 5.07$, $p = 0.03$, $\eta^2 p = 0.108$], the average amplitude of NSI group (10.68 ± 0.95) was significantly more positive than that of SI group (8.01 ± 0.72); as well as an interaction

TABLE 1 | Averaged reaction times (RTs) and standard errors (SE) for each of the conditions in both groups (ms).

	SI	NSI		
Stimuli type	**M ± SD**	**M ± SD**	***F***	***p***
Standard	506.36 ± 6.97	473.50 ± 9.21	8.84	0.005
Deviation	586.48 ± 7.59	552.40 ± 10.05		
Emotion				
Happy	588.41 ± 44.21	545.05 ± 42.55	7.32	0.010
Angry	584.54 ± 42.58	559.75 ± 33.94		

SI, risky-suicidal ideation; NSI, non-suicidal ideation.

effect between stimuli type and electrode sites [$F(2, 89) = 29.06$, $p < 0.001$, $\eta^2 p = 0.409$] showed the deviant stimuli elicited larger positive component than standard stimuli especially in the parietal sites, which exhibits significant P3 activity in the difference wave (as seen in **Figures 3**, **4**). In addition, there was a marginal significant interaction effect of stimuli type and group [$F(1, 42) = 3.80$, $p = 0.058$, $\eta^2 p = 0.083$]. The simple-effect analyses of two-way interaction showed a group effect in stimuli types [$F(1, 42) = 6.30$, $p = 0.02$, $\eta^2 p = 0.131$], with larger amplitude for NSI group (14.16 ± 1.19) than for SI group (10.41 ± 0.90) in deviant stimuli, and there was no difference between the two groups in standard stimuli. It can be seen that the deviant stimuli elicited a significant behavioral inhibition effect under the experimental conditions, which was concentrated in the parietal sites difference P3 activity.

Differences of BIC Processes in Group of SI and NSI (Deviation-Standard Difference Wave Analysis)

The repeated ANOVA of the difference wave of P3 with valence (angry, happy), electrode sites (frontal sites: F1, Fz, F2; frontal-central sites: FC1, FCz, FC2; central sites: C1, Cz, C2; central-parietal sites: CP1, CPz, CP2; parietal sites: P1, Pz, P2), and group (SI, NSI) was conducted. The results showed an effect of electrode sites [$F(2, 89) = 29.64$, $p < 0.001$, $\eta^2 p = 0.414$], largest P3 amplitudes were recorded at parietal electrode sites, and all posterior sites displayed larger P3 than anterior sites, in which Pz site recorded the largest P3 amplitude and F1 site recorded the smallest; and an effect of group [$F(1, 42) = 4.28$, $p = 0.045$, $\eta^2 p = 0.092$], the difference wave of NSI group (7.07 ± 0.87) was significantly larger that of SI group (4.80 ± 0.67) regardless of the electrode sites and valence. In addition, there was a marginal significant effect of valence [$F(1, 42) = 3.87$, $p = 0.056$, $\eta^2 p = 0.084$], the difference wave was larger in angry valence (6.40 ± 0.64) than that of happy valence (5.47 ± 0.55). The analysis of the peak latency showed an effect of electrode sites [$F(6, 232) = 4.42$, $p < 0.001$, $\eta^2 p = 0.095$], longest P3 latencies were recorded at parietal electrode sites, and all posterior sites displayed longer P3 latencies than anterior sites, in which P1 site recorded the longest P3 latency and Fz site recorded the shortest; and an effect of group [$F(1, 42) = 8.98$, $p = 0.005$, $\eta^2 p = 0.176$], the latency of SI group (489.98 ± 1.81) was significantly longer than that of NSI group (480.98 ± 2.40) (as seen in **Figure 4**).

The Explorations on the Effect of Emotions in the BIC of SI and NSI

Since the marginal significant effect of valence in the analysis of difference waveform, we analyzed the differences of BIC in happy and anger faces in SI and NSI group respectively to clarify exactly which group has significant emotional effects. The ANOVA of difference wave of SI group or NSI group with valence (angry, happy) and electrode sites (frontal sites: F1, Fz, F2; frontal-central sites: FC1, FCz, FC2; central sites: C1, Cz, C2; central-parietal sites: CP1, CPz, CP2; parietal sites: P1, Pz, P2) was conducted. In SI group, the analysis showed an effect of valence in P3 amplitude [$F(1, 27) = 8.36$, $p = 0.007$, $\eta^2 p = 0.237$], the amplitude was more positive in angry valence (5.46 ± 0.62) than that of happy valence (4.14 ± 0.60); and an effect of electrode sites in P3 amplitude [$F(2, 61) = 21.11$, $p < 0.001$, $\eta^2 p = 0.439$], largest

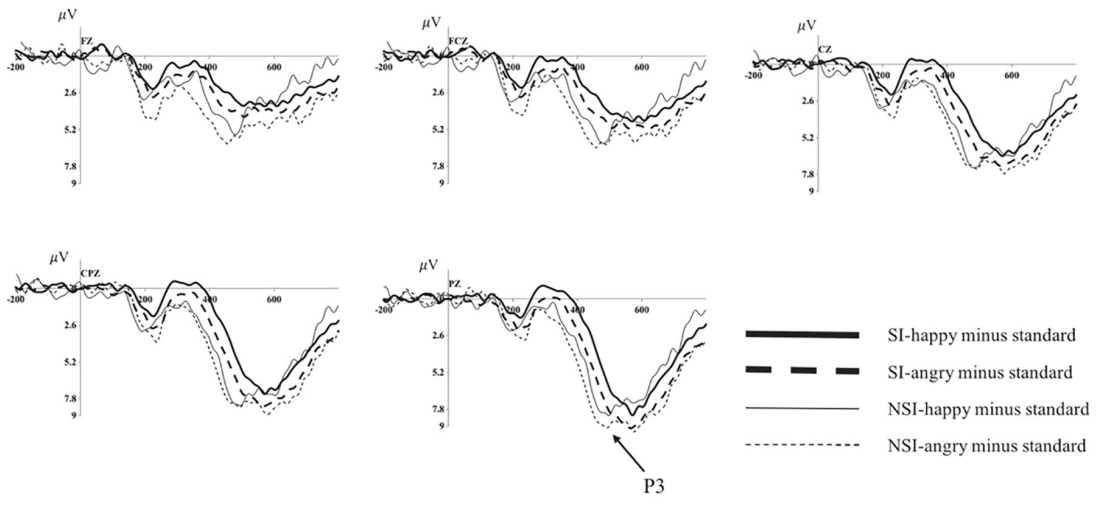

FIGURE 4 | Average of difference ERPs at Fz, FCz, Cz, CPz, and Pz for angry and happy in SI group and NSI group. SI, risky-suicidal ideation; NSI, non-suicidal ideation.

P3 amplitudes were recorded at parietal electrode sites, and all posterior sites displayed larger P3 than anterior sites, in which Pz site recorded the largest P3 amplitude and F1 site recorded the smallest; as well as an effect of electrode sites in P3 latency [$F(6, 152) = 2.65$, $p = 0.02$, $\eta^2 p = 0.089$], longest P3 latencies were recorded at parietal electrode sites, and all posterior sites displayed longer P3 latencies than anterior sites, in which P1 site recorded the longest P3 latency and F1 site recorded the shortest. In NSI group, the analysis showed an effect of electrode sites in P3 amplitude [$F(2, 26) = 10.20$, $p = 0.001$, $\eta^2 p = 0.405$], largest P3 amplitudes were recorded at parietal electrode sites, and all posterior sites displayed larger P3 than anterior sites, in which Pz site recorded the largest P3 amplitude and F1 site recorded the smallest.

DISCUSSION

Employing a two-choice oddball paradigm, the present study sheds light on two issues from a neural perspective: one is the difference in BIC between SI and NSI groups; the other is how angry and happy emotions impact BIC in the two groups. The results suggest that individuals without SI have better BIC, and individuals with SI need a more effortful BIC to complete the suppression of happy emotions. Different from most previous studies that used self-report scales to measure impulsivity, the present study used laboratory measurements to assess and compare BIC between SI and NSI groups, thereby providing intuitive evidence for the underlying mechanism of the effect of impulsivity on SI. Moreover, the present study highlights the effect of different emotions on the BIC of SI from an electrophysiological perspective, which provides an experimental basis for the study of the risk factors for SI.

The analysis of the original waveform reflects the validity of the two-choice oddball paradigm in measuring BIC. Given that response conflicts should be high when a low-frequency response must be made in the context of producing stereotyped or habitual responses (Braver et al., 2001; Nieuwenhuis et al., 2003), the dominant response of standard stimuli (high-frequency response) needs to be suppressed to ensure a correct response to deviant stimuli (low-frequency response), which requires more effort. Thus, a significant difference in P3 amplitudes was induced by the deviant and standard stimuli, thus indicating the effect of BIC, which was consistent with previous studies (Yuan et al., 2007, Yuan et al., 2008b). The N2 amplitude of standard stimuli in the present study was larger than that of deviant stimuli, which was contrary to previous studies (Yuan et al., 2008b; Xin et al., 2010). There may be two reasons for this result: one is that arousal in response to facial stimuli is weaker than arousal in response to evocative pictures, as the former may not be salient enough to induce an alert response of attention toward novel stimuli in the early stage of attention (Britton et al., 2006); the other is that the deviant stimuli in this experiment were repetitive and repeated many times (e.g., each emotional face of a model was repeated nine times), which reduced the unpredictability and made participants familiar with the stimuli, leading to the lack of an orientation response to novelty stimuli (Daffner et al., 2000).

The difference waveform is a sensitive index for measuring BIC in the two-choice oddball paradigm. The P3 component is considered an indicator of the processing of BIC (Donkers and Van Boxtel, 2004; Albert et al., 2010), and the amplitude induced by BIC is significantly larger than that induced by uncontrolled conditions (Yu et al., 2009). The P3 amplitude elicited in the NSI group was significantly larger than that of the SI group in the present study, indicating that the BIC of the NSI group was better than that of individuals with SI. According to the theory of Eysenck (1993), high impulsivity demonstrates reduced cognitive performance, which is reflected in a reduced P3 amplitude, and the P3 amplitude with cognitive control is smaller than that without cognitive control (Chen et al., 2008). The results suggest that individuals with SI need to consume more cognitive control to eliminate the interference of unrelated information to ensure the effective completion of the BIC process. Similarly, the P3 latency of individuals with SI was longer than that of the NSI group, which also indicates that the SI group takes longer to complete the BIC process. As a result of the deficit of cognitive control in suicidal ideation (Richard-Devantoy et al., 2013), this suggests that cognitive control may be a potential mechanism between suicidal ideation and impulsivity. Specifically, the ability of cognitive control is impaired when individuals develop SI, which further leads them to have difficulties orchestrating threatening thoughts and actions, thus increasing the risk of suicide. Based on the results of this study, identifying the internal mechanism of the high correlation between impulsivity and suicidal ideation is critical for the prevention of suicide.

Regarding the effect of emotion on BIC, the present study found that the P3 amplitude in response to happy faces was smaller than that in response to angry faces in the SI group, whereas the NSI group had no significant differences in BIC between the two emotions. In light of the P3 amplitude decreases in the condition of cognitive control (Chen et al., 2008), individuals with SI require more cognitive control to eliminate the interference of unrelated information to complete the process of inhibitory control under the condition of happy faces. In contrast to a previous study of healthy individuals showing that BIC was weaker in response to negative emotions (Yuan et al., 2007, 2012), the current study found that BIC decreased in response to positive emotions among the SI group. The Broaden-and-Build Model of Positive Emotions suggests that positive emotions significantly expand the scope and increase the flexibility of attention (Fredrickson, 1998; Schmitz et al., 2009), which makes individuals pay attention to the integrity of information and ignore the details of the information, thus making them unable to concentrate on the completion of the control task and hindering their BIC. Moreover, the reduced P3 amplitude that reflects impulsivity is usually interpreted as indicating a reduction in attentional resources that are available for information processing because these resources are not allocated effectively or because of decreased physiological arousal (Russo et al., 2008). In this way, the reason for this result may be that individuals with SI pay less attention to positive stimuli (Jollant et al., 2008), and they require more effort to exhibit BIC in response to happy (vs. angry) faces.

Individuals with SI have acceptable BIC in response to angry faces, which could be explained by the model of cognitive control of emotion (MCCE). MCCE suggests that there are four steps involved in generating emotional responses (Ochsner et al., 2012): perceiving stimuli in the environment, deploying attention to these stimuli, appraising the significance of stimuli, and responding to the stimuli, including automatic physiological responses. P3 component shows differences in the process of appraising stimuli, which represent the cognitive evaluation of the meaning of stimuli (Ito et al., 1998; Huang and Luo, 2006). Specifically, angry faces indicate more threatening information, and individuals tend to employ more attention to these faces and evaluate it as negative information, which would recruit more physiological and psychological resources and elicit a higher P3 amplitude. This result shows that different emotions have an effect on the BIC of the SI group but not the NSI group, which is helpful for understanding the relationship between impulsivity and SI from the role of emotion.

In addition, the present study points to two important contributions. First, we clarified the neural mechanism of BIC. Previous studies on BIC that employed fMRI technology found that the function of BIC associated with the fronto-basal ganglia networks, including the ventromedial prefrontal cortex, the prefrontal cortex of the central anterior, the orbitofrontal cortex, and the anterior cingulate cortices (ACC), plays an important role (Li et al., 2006; Aron, 2007; Dillon and Pizzagalli, 2008). Consistent with the results of brain imaging studies, the P3 component found in the present study was closely related to the inhibitory control of emotion and was mainly distributed in the central-parietal region, and the sources of P3 component were mainly in the ACC and lateral orbitofrontal cortex, which were revealed to be the major brain functional regions of emotional inhibitory control (Albert et al., 2010). Moreover, the present study provided more empirical evidence for the theory of suicidal ideation, leading the "emotion-impulsivity framework" of suicidal ideation to an ERP experiment. Based on previous studies only involving the impact of one of impulsivity or emotion on suicidal ideation (Albanese et al., 2019; Sarkisian et al., 2019; Wang et al., 2019), the ERP activities related to impulsivity–emotion interaction and suicidal ideation were explored in this study. The present findings could lay the foundation for further research on the etiological pathways of suicidal ideation employing fMRI.

Finally, some limitations of the present study should be outlined. First, the proportion of females was larger than that of males in the present study. Gender differences in BIC were found in a previous study (Fillmore and Weafer, 2004), and the advantage of females in BIC has been proven (Yuan et al., 2008a). Furthermore, gender differences in ERP components during response inhibition have been highlighted by other authors (Li et al., 2009; Huster et al., 2011). It is possible that the unbalanced proportion of gender might affect the results of this study. Second, the number of participants in the SI and NSI groups was unbalanced in the present study. Individuals with SI were more likely to refuse to participate in the experiment when they were recruited, which led us to find more SI participants and ultimately led to the imbalance of groups under strict grouping criteria. This might reduce the generalizability of the research results to some extent. Third, the different types of facial materials were not conspicuous enough and were repeated many times, which may not have attracted enough attention in the early stage of material presentation. This might account for the deficit of the N2 effect in the present study, which indicates conflict monitoring. Despite these limitations, we believe the present study encourages the use of psychophysiological indexes such as the P3 amplitude to measure and compare BIC between SI and NSI groups. The present study also provides a deeper understanding of the intriguing relationship among impulsivity, emotion, and SI.

DATA AVAILABILITY STATEMENT

The datasets generated for this study are available on request to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Ethics Committee of Tianjin Normal University. The participants provided written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

CW who has contributed to the study equally as LL is the co-first author of the manuscript. LL and CW designated the experiment. CW, JM, YL, and TL conducted the experiment. LL, CW, YJ, and XW analyzed the data and wrote the manuscript. LL and XW critically reviewed the manuscript. XB provided suggestions in reply to the review comments. All authors gave final approval of the version to be submitted.

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REFERENCES

Albanese, B. J., Macatee, R. J., Stanley, I. H., Bauer, B. W., and Schmidt, N. B. (2019). Differentiating suicide attempts and suicidal ideation using neural markers of emotion regulation. *J. Affect. Disord.* 257, 536–550. doi: 10.1016/j.jad.2019.07.014

Albert, J., López-Martín, S., and Carretié, L. (2010). Emotional context modulates response inhibition: neural and behavioral data. *Neuroimage* 49, 914–921. doi: 10.1016/j.neuroimage.2009.08.045

Aron, A. R. (2007). The neural basis of inhibition in cognitive control. *Neuroscientist* 13, 214–228. doi: 10.1177/1073858407299288

Arria, A. M., O'Grady, K. E., Caldeira, K. M., Vincent, K. B., Wilcox, H. C., and Wish, E. D. (2009). Suicide ideation among college students: a multivariate analysis. *Arch. Suicide Res.* 13, 230–246. doi: 10.1080/13811110903044351

Auerbach, R. P., Stewart, J. G., and Johnson, S. L. (2016). Impulsivity and suicidality in adolescent inpatients. *J. Abnorm. Child Psychol.* 45, 91–103.

Barratt, E. S., and Patton, J. H. (1983). "Impulsivity: cognitive, behavioral, and psychophysiological correlates," in *Biological Bases of Sensation-Seeking, Impulsivity, and Anxiety*, ed. M. Zuckerman (Hillsdale, NJ: Lawrence Erlbaum Associates), 77–121.

Beck, A. T., Kovacs, M., and Weissman, A. (1979). Assessment of suicidal ideation: the scale for suicide ideation. *J. Consult. Clin. Psychol.* 47, 343–352.

Brausch, A. M., and Decker, K. M. (2014). Self-esteem and social support as moderators of depression, body image, and disordered eating for suicidal ideation in adolescents. *J. Abnorm. Child Psychol.* 42, 779–789. doi: 10.1007/s10802-013-9822-0

Braver, T. S., Barch, D. M., Gray, J. R., Molfese, D. L., and Avraham, S. (2001). Anterior cingulate cortex and response conflict: effects of frequency, inhibition and errors. *Cereb. Cortex* 11, 825–836. doi: 10.1093/cercor/11.9.825

Britton, J. C., Taylor, S. F., Sudheimer, K. D., and Liberzon, I. (2006). Facial expressions and complex IAPS pictures: common and differential networks. *Neuroimage* 31, 906–919. doi: 10.1016/j.neuroimage.2005.12.050

Bronisch, T., and Wittchen, H. U. (1994). Suicidal ideation and suicide attempts: comorbidity with depression, anxiety disorders, and substance abuse disorder. *Eur. Arch. Psychiatry Clin. Neurosci.* 244, 93–98. doi: 10.1007/bf02193525

Carver, C. S., and White, T. L. (1994). Behavioral inhibition, behavioral activation, and affective responses to impending reward and punishment: the BIS/BAS scales. *J. Pers. Soc. Psychol.* 67, 319–333. doi: 10.1037/0022-3514.67.2.319

Chen, A. T., Xu, P., Wang, Q. H., Luo, Y. J., Yuan, J. J., Yao, D. Z., et al. (2008). The timing of cognitive control in partially incongruent categorization. *Hum. Brain Mapp.* 29, 1028–1039. doi: 10.1002/hbm.20449

Daffner, K. R., Mesulam, M. M., Scinto, L. F., Calvo, V., Faust, R., and Holcomb, P. J. (2000). An electrophysiological index of stimulus unfamiliarity. *Psychophysiology* 37, 737–747. doi: 10.1111/1469-8986.3760737

Delorme, A., and Makeig, S. (2004). EEGLAB: an open source toolbox for analysis of single-trial EEG dynamics including independent component analysis. *J. Neurosci. Methods* 134, 9–21. doi: 10.1016/j.jneumeth.2003.10.009

Deykin, E. Y., and Buka, S. L. (1994). Suicidal ideation and attempts among chemically dependent adolescents. *Am. J. Public Health* 84, 634–639. doi: 10.2105/ajph.84.4.634

Dillon, D. G., and Pizzagalli, D. A. (2008). Inhibition of action, thought, and emotion: a selective neurobiological review. *Appl. Prev. Psychol.* 12, 99–114. doi: 10.1016/j.appsy.2007.09.004

Donkers, F. C. L., and Van Boxtel, G. J. M. (2004). The N2 in go/no-go tasks reflects conflict monitoring not response inhibition. *Brain Cogn.* 56, 165–176. doi: 10.1016/j.bandc.2004.04.005

Enticott, P. G., Ogloff, J. R. P., and Bradshaw, J. L. (2006). Associations between laboratory measures of executive inhibitory control and self-reported impulsivity. *Pers. Individ. Dif.* 41, 285–294. doi: 10.1016/j.paid.2006.01.011

Eysenck, H. J. (1993). "The nature of impulsivity," in *The Impulsive Client: Theory, Research, and Treatment*, eds W. G. McCown, J. L. Johnson, and M. B. Shure (Washington, DC: American Psychological Association), 57–69. doi: 10.1037/10500-004

Fillmore, M. T., and Weafer, J. (2004). Alcohol impairment of behavior in men and women. *Addiction* 99, 1237–1246. doi: 10.1111/j.1360-0443.2004.00805.x

Fredrickson, B. L. (1998). What good are positive emotions? *Rev. Gen. Psychol.* 2, 300–319. doi: 10.1037/1089-2680.2.3.300

Gross, J. J. (2007). *The Handbook of Emotion Regulation*. New York, NY: Guilford Press.

Heffer, T., and Willoughby, T. (2017). The role of emotion dysregulation: a longitudinal investigation of the interpersonal theory of suicide. *Psychiatry Res.* 260, 379–383. doi: 10.1016/j.psychres.2017.11.075

Heron, M. (2017). Deaths: leading causes for 2015. *Natl. Vital Stat. Rep.* 66, 1–76.

Huang, Y. X., and Luo, Y. J. (2006). Temporal course of emotional negativity bias: an ERP study. *Neurosci. Lett.* 398, 91–96. doi: 10.1016/j.neulet.2005.12.074

Huster, R. J., Westerhausen, R., and Herrmann, C. S. (2011). Sex differences in cognitive control are associated with midcingulate and callosal morphology. *Brain Struct. Funct.* 215, 225–235. doi: 10.1007/s00429-010-0289-2

Ito, T. A., Larsen, J. T., Smith, N. K., and Cacioppo, J. T. (1998). Negative information weighs more heavily on the brain: the negativity bias in evaluative categorizations. *J. Pers. Soc. Psychol.* 75, 887–900. doi: 10.1037/0022-3514.75.4.887

Jollant, F., Lawrence, N. S., Giampietro, V., Brammer, M. J., Fullana, M. A., Drapier, D., et al. (2008). Orbitofrontal cortex response to angry faces in men with histories of suicide attempts. *Am. J. Psychiatry* 165, 740–748. doi: 10.1176/appi.ajp.2008.07081239

Kamp, S. M., and Donchin, E. (2015). ERP and pupil responses to deviance in an oddball paradigm. *Psychophysiology* 52, 460–471. doi: 10.1111/psyp.12378

Klonsky, E. D., and May, A. (2010). Rethinking impulsivity in suicide. *Suicide Life Threat. Behav.* 40, 612–619. doi: 10.1521/suli.2010.40.6.612

Kudinova, A. Y., Owens, M., Burkhouse, K. L., Barretto, K. M., Bonanno, G. A., and Gibb, B. E. (2015). Differences in emotion modulation using cognitive reappraisal in individuals with and without suicidal ideation: an ERP study. *Cogn. Emot.* 30, 999–1007. doi: 10.1080/02699931.2015.1036841

Li, C. S., Huang, C., Constable, R. T., and Sinha, R. (2006). Imaging response inhibition in a stop-signal task: neural correlates independent of signal monitoring and post-response processing. *J. Neurosci.* 26, 186–192. doi: 10.1523/jneurosci.3741-05.2006

Li, C. S. R., Zhang, S., Duann, J.-R., Yan, P., Sinha, R., and Mazure, C. M. (2009). Gender differences in cognitive control: an extended investigation of the stop signal task. *Brain Imaging Behav.* 3, 262–276. doi: 10.1007/s11682-009-9068-1

Li, X. Y., Phillips, M. R., Zhang, Y. L., Xu, D., Tong, Y. S., Yang, F. D., et al. (2011). Reliability and validity of the Chinese version of the Beck Suicide Ideation Scale (BSI-CV) among university students. *Chin. Ment. Health J.* 25, 862–866.

Logan, G. D., Schachar, R. J., and Tannock, R. (1997). Impulsivity and inhibitory control. *Psychol. Sci.* 8, 60–64. doi: 10.1111/j.1467-9280.1997.tb00545.x

Lopezcalderon, J., and Luck, S. J. (2014). ERPLAB: an open-source toolbox for the analysis of event-related potentials. *Front. Hum. Neurosci.* 8:213. doi: 10.3389/fnhum.2014.00213

Luck, S. J. (2005). *An Introduction to the Event-Related Potential Technique (Cognitive Neuroscience)*. Cambridge, MA: MIT Press.

Moeller, F. G., Barratt, E. S., Dougherty, D. M., Schmitz, J. M., and Swann, A. C. (2001). Psychiatric aspects of impulsivity. *Am. J. Psychiatry* 158, 1783–1793.

Nieuwenhuis, S., Yeung, N., Wildenberg, W. V. D., and Ridderinkhof, K. R. (2003). Electrophysiological correlates of anterior cingulate function in a go/no-go task: effects of response conflict and trial type frequency. *Cogn. Affect. Behav. Neurosci.* 3, 17–26. doi: 10.3758/cabn.3.1.17

Ochsner, K. N., Silvers, J. A., and Buhle, J. T. (2012). Functional imaging studies of emotion regulation: a synthetic review and evolving model of the cognitive control of emotion. *Ann. N. Y. Acad. Sci.* 1251, E1–E24.

Palmierclaus, J. E., Taylor, P. J., Gooding, P. A., Dunn, G., and Lewis, S. W. (2012). Affective variability predicts suicidal ideation in individuals at ultra-high risk of developing psychosis: an experience sampling study. *Br. J. Clin. Psychol.* 51, 72–83. doi: 10.1111/j.2044-8260.2011.02013.x

Posner, M. I., Rothbart, M. K., Vizueta, N., Levy, K. N., Evans, D. E., Thomas, K. M., et al. (2002). Attentional mechanisms of borderline personality disorder. *Proc. Natl. Acad. Sci. U.S.A.* 99, 16366–16370.

Richard-Devantoy, S., Olié, E., Guillaume, S., Bechara, A., Courtet, P., and Jollant, F. (2013). Distinct alterations in value-based decision-making and cognitive control in suicide attempters: toward a dual neurocognitive model. *J. Affect. Disord.* 151, 1120–1124. doi: 10.1016/j.jad.2013.06.052

Rockett, I. R. H., Wang, S., Lian, Y., and Stack, S. (2007). Suicide-associated comorbidity among us males and females: a multiple cause-of-death analysis. *Inj. Prev.* 13, 311–315. doi: 10.1136/ip.2007.015230

Rowe, G., Hirsh, J., and Anderson, A. (2007). Positive affect increases the breadth of attentional selection. *Proc. Natl. Acad. Sci. U.S.A.* 104, 383–388. doi: 10.1073/pnas.0605198104

Russo, P. M., Pascalis, V. D., Varriale, V., and Barratt, E. S. (2008). Impulsivity, intelligence and P300 wave: an empirical study. *Int. J. Psychophysiol.* 69, 112–118. doi: 10.1016/j.ijpsycho.2008.03.008

Sarkisian, K. L., Van, H. C. A., and Hill, G. H. (2019). Brooding, inattention, and impulsivity as predictors of adolescent suicidal ideation. *J. Abnorm. Child Psychol.* 47, 333–344. doi: 10.1007/s10802-018-0435-5

Schmitz, T. W., Eve, D. R., and Anderson, A. K. (2009). Opposing influences of affective state valence on visual cortical encoding. *J. Neurosci.* 29, 7199–7207. doi: 10.1523/jneurosci.5387-08.2009

Shafritz, K. M., Collins, S. H., and Blumberg, H. P. (2006). The interaction of emotional and cognitive neural systems in emotionally guided response inhibition. *Neuroimage* 31, 468–475. doi: 10.1016/j.neuroimage.2005.11.053

Stewart, J. L., Silton, R. L., Sass, S. M., Fisher, J. E., Edgar, J. C., Heller, W., et al. (2010). Attentional bias to negative emotion as a function of approach and withdrawal anger styles: an ERP investigation. *Int. J. Psychophysiol.* 76, 9–18. doi: 10.1016/j.ijpsycho.2010.01.008

Venables, N. C., Sellbom, M., Sourander, A., Kendler, K. S., Joiner, T. E., Drislane, L. E., et al. (2015). Separate and interactive contributions of weak inhibitory control and threat sensitivity to prediction of suicide risk. *Psychiatry Res.* 226, 461–466. doi: 10.1016/j.psychres.2015.01.018

Wang, C., Mo, J., Niu, X., Jia, X., and Lin, L. (2019). The role of interpersonal problems and family environment in the association between impulsivity and suicidal ideation: a moderate mediation model. *J. Nervous Ment. Dis.* 207, 22–28. doi: 10.1097/nmd.0000000000000916

Wang, Y., and Luo, Y. J. (2005). Standardization and assessment of college students' facial expression of emotion. *Chin. J. Clin. Psychol.* 13, 396–398.

Wang, Y., Yang, J., Yuan, J. J., Fu, A., Meng, X., and Li, H. (2011). The impact of emotion valence on brain processing of behavioral inhibitory control: spatiotemporal dynamics. *Neurosci. Lett.* 502, 112–116. doi: 10.1016/j.neulet.2011.07.039

Xin, Y., Li, H., and Yuan, J. J. (2010). Negative emotion interferes with behavioral inhibitory control: an ERP study. *Acta Psychol. Sin.* 42, 334–341. doi: 10.3724/sp.j.1041.2010.00334

Yeung, N., Botvinick, M., and Cohen, J. (2004). The neural basis of error detection: conflict monitoring and the error-related negativity. *Psychol. Rev.* 111, 931–959. doi: 10.1037/0033-295x.111.4.931

Yu, F. Q., Yuan, J. J., and Luo, Y. J. (2009). Auditory-induced emotion modulates processes of response inhibition: an event-related potential study. *Neuroreport* 20, 25–30. doi: 10.1097/wnr.0b013e32831ac9b1

Yuan, J. J., He, Y. Y., Zhang, Q. L., Chen, A. T., and Li, H. (2008a). Gender differences in behavioral inhibitory control: ERP evidence from a two-choice oddball task. *Psychophysiology* 45, 986–993. doi: 10.1111/j.1469-8986.2008.00693.x

Yuan, J. J., Meng, X., Yang, J., Yao, G., Hu, L., and Yuan, H. (2012). The valence strength of unpleasant emotion modulates brain processing of behavioral inhibitory control: neural correlates. *Biol. Psychol.* 89, 240–251. doi: 10.1016/j.biopsycho.2011.10.015

Yuan, J. J., Xu, M. M., Yang, J. M., and Li, H. (2017). The application of the two-choice oddball paradigm to the research of behavioral inhibitory control. *Scientia Sinica* 47, 1065–1073. doi: 10.1360/N052017-00125

Yuan, J. J., Zhang, Q., Chen, A., Li, H., Wang, Q., Zhuang, Z., et al. (2007). Are we sensitive to valence differences in emotionally negative stimuli? Electrophysiological evidence from an ERP study. *Neuropsychologia* 45, 2764–2771. doi: 10.1016/j.neuropsychologia.2007.04.018

Yuan, J. J., Yang, J. M., Meng, X. X., Yu, F. Q., and Li, H. (2008b). The valence strength of negative stimuli modulates visual novelty processing: electrophysiological evidence from an event-related potential study. *Neuroscience* 157, 524–531. doi: 10.1016/j.neuroscience.2008.09.023

Zhang, J., Wu, Z. Y., Fang, G., Li, J., Han, B. X., and Chen, Z. Y. (2010). Development of the Chinese age norms of CES-D in urban area. *Chin. Ment. Health J.* 24, 139–143.

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Social Support and Substance Use as Moderators of the Relationship Between Depressive Symptoms and Suicidal Ideation in Adolescents

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Literature reports that depressive symptoms may precede suicidal ideation. Several studies have identified social support and substance use as moderators of this relationship. However, no study has evaluated these variables together by testing how substance use can affect the moderating effect of social support in this relationship. The purpose of this article is to individually evaluate dimensions of social support (friends, family, significant others, and school) and substance use (alcohol, marijuana, and other illicit drugs), as moderators of the relationship between depressive symptoms and suicidal ideation, as well as analyze the moderating role of substance use in the moderation exerted by social support in this relationship. This study, quantitative and cross-sectional, considered 775 adolescents [Average age = 15.48 (*SD* = 0.96), 45.9% women], from 20 randomly selected schools in Santiago de Chile. Simple moderation models were used to analyze possible moderators separately, and double moderation models were used to analyze the moderating role of substance use in the moderating effect of social support. The results show that the four dimensions of social support moderate the relationship between depressive symptomatology and suicidal ideation, showing the strongest interaction in the case of family support, followed by support of a significant person, support at school, and support of friends, in that order. On the other hand, alcohol was the only drug that moderated the relationship in question. In addition, the results show that the use of alcohol limits the moderating effect of social support in the fields of family, significant person, and school support, but not in the case of support of friends. The use of marijuana and other illicit drugs did not affect the moderating effects of social support for any of the areas evaluated. The results are discussed according to the different roles that alcohol use can play in adolescence, and how these, together with perceived social support, are related to the emergence of suicidal ideation from depressive symptoms.

Keywords: depression, suicidal ideation, social support, alcohol use, moderation, substance use

INTRODUCTION

Globally, depressive disorders are the mental disorders that cause the most disability-adjusted life years (Rehm and Shield, 2019). These disorders, whose prevalence has its peak in adolescence (Patel, 2013; Whiteford et al., 2013), have serious consequences in various areas of people's lives. In the particular case of adolescents, evidence shows that depressive disorders are related to problems in areas as varied as general health, other mental health problems, interpersonal relationships, and their educational/work trajectories, among others, both in adolescence itself and in future adult life (Fergusson and Woodward, 2002; Keenan-Miller et al., 2007; McLeod et al., 2012, 2016; Johnson et al., 2018).

The most relevant of this disorder group is major depression. The diagnostic criteria from the Diagnostic and Statistical Manual of Mental Disorders (DSM-V) define the major depressive disorder based on the presence of a series of symptoms that "cause clinically significant distress or impairment in social, occupational, or other important areas of functioning" (American Psychiatric Association [APA], 2013, p. 161). The nine symptoms considered are: depressed mood, loss of interest or pleasure, appetite change, sleep disturbance, psychomotor changes, decreased energy, sense of worthlessness, impaired ability to think, concentrate, or make even minor decisions, and thoughts of death, suicidal ideation, or suicide attempts. Among these, at least five must occur during a period of 2 weeks, and at least one of them must be (a) depressed mood or (b) loss of interest.

The three elements considered in the suicidal symptoms usually appear gradually, starting from thoughts of death, to suicidal ideation, until ultimately reaching suicide attempt and committing suicide (Gómez et al., 2018). The mortality associated with this disorder, which is considered high, is explained almost entirely by consummated suicide (American Psychiatric Association [APA], 2013).

However, not all depressions have suicidal symptoms. In addition, when these symptoms show, they usually do so in the last instance and can be explained as the consequence of all the others (Gómez et al., 2018; Quintana-Orts and Rey, 2018). In this sense, only in some cases of depression, non-suicidal depressive symptoms precede suicidal depressive symptoms. Considering this, several authors have paid attention to variables that facilitate or prevent this step, in order to identify intervention points. Two examples of these variables are social support and substance use.

Several studies conducted in the adolescent population have reported a negative relationship between depression and perceived social support from the family (Rojas et al., 2012), peers/friends (Resset, 2016), school (Hernández, 2017), and other significant people (Lara et al., 2004; Erhardt and Lu, 2016). The same applies to the relationship between perceived social support and thoughts of death, suicidal ideation, or suicide attempts (Salvo Garrido and Melipillán, 2008; Sarmiento et al., 2010; Andrade, 2012; Morales et al., 2017). Other research has linked these three variables, concluding that perceived social support (from different actors) moderates the relationship between depression and suicidal symptoms (the more social support, the weaker the relationship), being the most important moderating effect in the case of family support (Brausch and Decker, 2014; Lamis et al., 2016; Fredrick et al., 2018).

Otherwise, there is also evidence on the relationship between substance use, depression, and suicidal symptoms in the adolescent population. Several studies have shown evidence of the positive relationship between alcohol consumption and depressive symptoms (Marmorstein, 2009; Anseán, 2014), as well as thoughts of death, suicidal ideation, or suicide attempts (Sanchis and Domènech, 2012; Bobes et al., 2017). There are also studies that show evidence of the relationship between depressive symptoms and use of marijuana and other illegal drugs (Pardo et al., 2004; Hallfors et al., 2005; Rojas et al., 2012), and there are other studies that show evidence that the use of illegal drugs is a risk factor for suicide in young people with depressive symptoms (Hallfors et al., 2004; Conner et al., 2017). In particular Dvorak et al. (2013), show specific evidence that alcohol consumption moderates the relationship between depression and suicidal ideation: the higher the consumption, the stronger the relationship between depression and suicidal ideation.

As shown above, evidence supports the moderating effect of perceived social support and substance use (at least in the case of alcohol) in the relationship between depression and suicidal symptoms. However, there are no studies that have evaluated the interaction of these moderating effects. It is necessary to investigate how these variables interact, considering that the capacity of social support to prevent suicide in adolescents with depressive symptoms could be impaired by substance use.

Taking this into account, it is necessary to ask, How does the use of substances moderate the moderating effect of social support in the relationship between depressive symptoms and suicidal ideation? In this sense, the present study had, as its first objective, to analyze how different types of social support (from family, friends, a significant person, and school) and substance use (alcohol, marijuana, and other illegal drugs) moderate the relationship between depressive symptoms and suicidal ideation in adolescent population. As a second objective, it is sought to analyze the moderating effect of substance use on the moderating effect of social support in the relationship between depressive symptoms and suicidal ideation.

TABLE 1 | Descriptive analysis of the study variables.

	Minimum	Maximum	*M*	*SD*
Thoughts of death or suicidal ideation	0.00	3.00	0.52	0.85
Depression	0.00	21.00	8.65	4.11
Family perceived support	1.00	5.00	3.71	0.98
Friends perceived support	1.00	5.00	3.71	1.03
Significant person perceived support	1.00	5.00	3.83	0.90
School perceived support	1.00	5.00	3.07	0.93
Alcohol use	0.00	3.00	0.51	0.70
Marijuana use	0.00	3.00	0.30	0.71
Other illegal drug use	0.00	3.00	0.06	0.35

TABLE 2 | Frequency of substance use and thoughts of death or suicidal ideation.

	Thoughts of death or suicidal ideation		Alcohol use		Marijuana use		Other illegal drug use	
	n	%	*n*	%	*n*	%	*n*	%
Never	510	65.81	460	59.35	635	81.94	750	96.77
Often	176	22.71	254	32.77	78	10.06	15	1.94
Very often	42	5.42	45	5.81	35	4.52	2	0.26
Always	47	6.06	16	2.06	27	3.48	8	1.03

TABLE 3 | Bivariate correlation matrix (Spearman's rho) for the study variables.

	1	2	3	4	5	6	7	8	9	10	11
1. Thoughts of death or suicidal ideation	1										
2. Depression	0.41**	1									
3. Family perceived support	−0.35**	−0.31**	1								
4. Friends perceived support	−0.16**	−0.11**	0.31**	1							
5. Significant person perceived support	−0.17**	−0.14**	0.47**	0.60**	1						
6. School perceived support	−0.17**	−0.20**	0.37**	0.43**	0.33**	1					
7. Alcohol use	0.15**	0.20**	−0.17**	0.06	0.03	−0.06	1				
8. Marijuana use	0.15**	0.11**	−0.19**	0.06	−0.05	−0.04	0.45**	1			
9. Other illegal drug use	0.13**	0.10**	−0.11**	0.01	0.03	−0.06	0.27**	0.35**	1		
10. Sex (0, male; 1, female)	0.13**	0.33**	−0.10**	0.01	0.03	−0.12**	0.10**	−0.01	−0.07	1	
11. Age (in years)	0.01	−0.01	−0.04	0.03	0.02	0.00	0.13**	0.15**	0.15**	0.02	1

***The correlation is significant at the 0.01 level (bilateral).*

MATERIALS AND METHODS

Participants

This study, quantitative and cross-sectional, considered 775 students in their first and second years of high school in the Chilean educational system, in the urban area of the Metropolitan Region of Chile. The average age was 15.48 (*SD* = 0.96), 45.90% female. The sampling method consisted of a probabilistic and two-stage design, where the first-level units were schools and the final-level units were the first and second years of secondary school. The sampling frame was composed of 2,484 schools belonging to Santiago (Center, South, North, East, and West), obtained from the official list of the Ministry of Education of Chile for 2017 (Ministerio de Educación, n.d.). The schools were selected using a random number generator that assigns a number for each school, while the classes within the schools were selected using a Kish selection grid (in cases where there was more than one class per level in the school).

Measures

Youth's Inventory-4

The Youth's Inventory-4 (YI-4) questionnaire (Gadow et al., 2002), was intended to evaluate mental health in adolescents whose age fluctuated from 12 to 18 years. This instrument aims at determining the risk of emotional and behavioral disorders via closed self-report questions. It considers a set of 120 items regarding symptoms, assessed on a Likert scale from 0 to 3 points. It examines 18 categories in consonance with the frequency they are reported (0, never; 1, sometimes; 2, often; 3, very often). The items of each dimension were designed by the diagnostic criteria of the DSM-IV. Regarding psychometric properties, the authors reported good reliability and discriminant validity (according with clinical diagnoses). For this article, only the items of depression subscale and the items referring to substance use were considered. The depression subscale is made up of eight items: "I don't feel happy, I feel sad," "I don't feel like doing anything," "I think about death or suicide," "I don't like how I am," "I feel tired, I have no energy to do things," "I eat a lot," "I sleep a lot," and "I have a hard time concentrating." Based on what was theoretically argued in the introduction of the article, the depression dimension for this study was constructed by adding a score obtained in each item of the subscale depression, excluding the item "I think about death or suicide," which was considered as a separate dependent variable of the study. In the original study (Gadow et al., 2002), a Cronbach's alpha of 0.82 was reported for the depression dimension (eight items). In this study, the depression dimension, made up of seven items, shows acceptable reliability (Cronbach's

TABLE 4 | Linear model of predictors of thoughts of death or suicidal ideation (TD or SI), considering perceived family support (R^2 = 28.62%, $p < 0.001$).

	b	95% CI	*SE B*	*t*	*P*
Constant	−0.17	[−1.16, 0.81]	0.50	−0.34	0.73
Perceived family support	0.08	[−0.05, 0.21]	0.06	1.25	0.21
Depression	0.19	[0.15, 0.24]	0.02	8.41	<0.001
Perceived family support × Depression	−0.03	[−0.05, −0.02]	0.01	−5.44	<0.001
Sex	−0.07	[−0.18, 0.04]	0.05	−1.30	0.20
Age	−0.02	[−0.07, 0.04]	0.03	−0.55	0.58

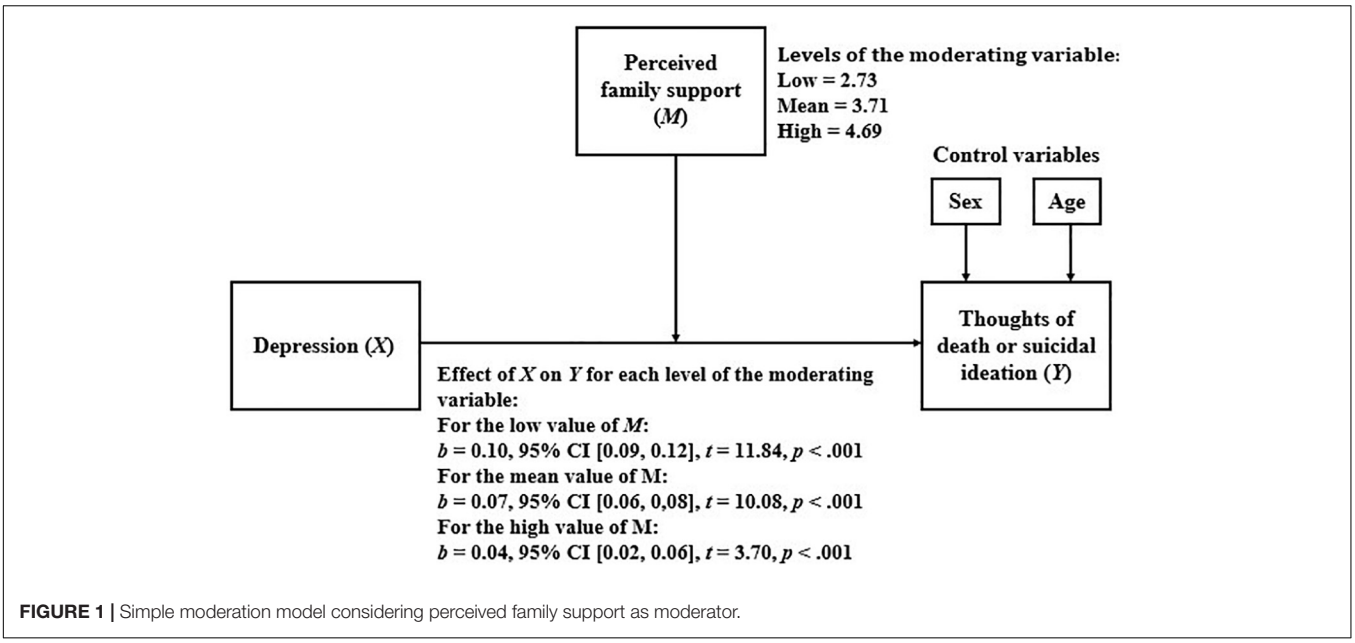

FIGURE 1 | Simple moderation model considering perceived family support as moderator.

alpha = 0.74). The items referring to substance use were "I drink alcoholic beverages (beer, wine, and other spirits)," "I smoke marijuana," and "I use other illegal drugs (cocaine, crack, LSD, and ecstasy, etc.)."

Scale of Perceived Social Support in Adolescent Population

The scale of perceived social support, originally developed by Zimet et al. (1988) and validated for the adolescent population in the Chilean context by Mosqueda Díaz et al. (2015), aims to measure perceived social support in three dimensions: family, friends, and another significant person. It has 12 items (four for each dimension), which consist of statements about perceived social support that must be evaluated on a Likert scale with values from one to five (1, strongly disagree; 5, strongly agree).

The dimension support from the family is made up of the following items "My family really tries to help me," "I get the emotional help and support I need from my family," "I can talk about my problems with my family," and "My family is willing to help me make decisions." Both in the Chilean validation of the instrument and in this study, this group of items showed good reliability (Cronbach's alpha = 0.85 and 0.87, respectively).

TABLE 5 | Linear model of predictors of TD or SI, considering perceived friends support (R^2 = 20.96%, $p < 0.001$).

	B	95% CI	*SE B*	*t*	*p*
Constant	−0.27	[−1.26, 0.71]	0.50	−0.55	0.58
Perceived friends support	0.02	[−0.10, 0.14]	0.06	0.38	0.70
Depression	0.13	[0.09, 0.17]	0.02	6.11	<0.001
Perceived friends support × Depression	−0.01	[−0.02, 0.00]	0.01	−2.03	<0.05
Sex	−0.07	[−0.18, 0.05]	0.06	−1.13	0.26
Age	0.00	[−0.06, 0.05]	0.03	−0.06	0.95

In the case of support from friends, the dimension considered the items "My friends really try to help me," "I can count on my Friends when things go wrong," "I have friends with whom I can share my joys and sorrows," and "I can talk about my problems with my friends." Excellent reliability was observed (Cronbach's alpha = 0.92) and is similar to that reported in the Chilean validation of the scale (Cronbach's alpha = 0.89). The dimension of social support from a significant person consisted of: "There is a special person who is around when I need them," "There is a special person with whom I can share my joys and sorrows," "I have a special person who is a real source of comfort for me," and "There is a special person in my life who cares about my feelings." It achieved the same reliability as the validation of the scale for the Chilean context, which is acceptable (Cronbach's alpha = 0.79).

In order to also consider a crucial dimension for adolescents, a fourth dimension of perceived social support was included in this study, referring to the perceived support at school, considering the following items: "I feel supported by my head teacher," "I feel supported by the principal of my school," and "I feel supported by my classmates." These four items together showed good reliability (Cronbach's alpha = 0.80).

The scores of each dimension were calculated as the average of the four items that make them up.

Data Analysis

First, descriptive analyses of the study variables were performed (calculation of minimum and maximum scores, means and standard deviations, and frequencies, in the case of items of substance use and thoughts of death/suicidal ideation). A bivariate correlation analysis (Spearman's rho) was then performed among all the variables, in order to observe how they were associated.

Subsequently, seven simple moderation analyses were performed, considering depression as an independent variable

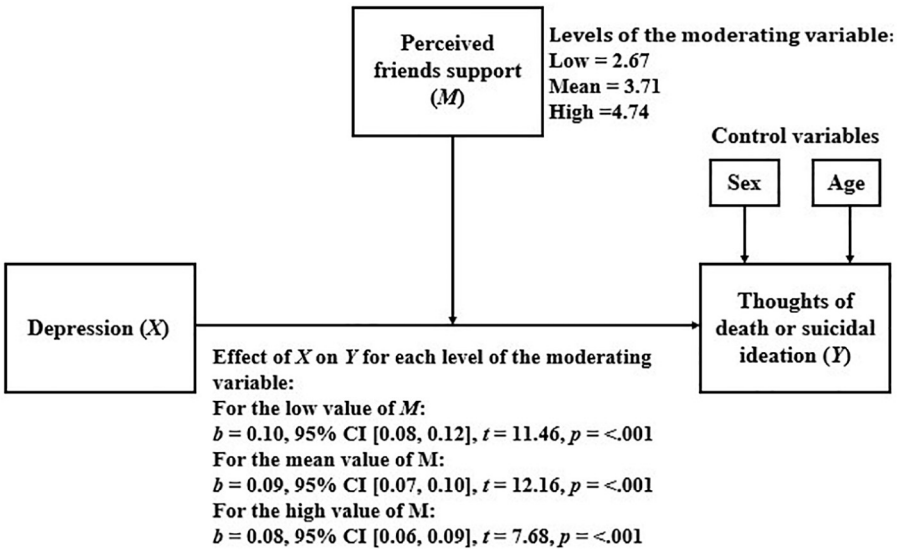

FIGURE 2 | Simple moderation model considering perceived friends support as moderator.

and suicidal ideation as a dependent variable, in all models, and using the four types of social support (family, friends, another significant person, and school) and the three types of substance uses (alcohol, marijuana, and other illicit drugs) as moderators. Moderation analyses allow us to analyze whether the relationship between two variables is affected by the values of a third variable (Hayes, 2018). In this case, they will allow us to analyze whether the relationship between depression and suicidal ideation varies according to the different levels of perceived social support or substance use by adolescents.

Finally, a double moderation analysis was carried out in order to test how the substance uses that were statistically significant in the simple models moderated the moderating effect of the different types of social support in the relationship between depression and suicidal ideation. Due to the significant differences by sex and age observed in adolescents in depression and substance use reported in the previous literature (Eisenberg et al., 2014; Salk et al., 2017), all moderation analyses included sex and age as control variables. The statistical analyses were carried out through the IBM-SPSS v.24 program and the modeling tool PROCESS for SPSS v2.10 (Hayes, 2018).

TABLE 6 | Linear model of predictors of TD or SI, considering significant person perceived support (R^2 = 22.33%, $p < 0.001$).

	b	95% CI	*SE B*	*t*	*p*
Constant	−0.36	[−1.38, 0.65]	0.52	−0.70	0.48
Significant person perceived support	0.06	[−0.08, 0.20]	0.07	0.84	0.40
Depression	0.17	[0.11, 0.22]	0.03	6.16	< 0.001
Significant person perceived support × Depression	−0.02	[−0.03, −0.01]	0.01	−3.02	< 0.001
Sex	−0.05	[−0.17, 0.06]	0.06	−0.94	0.35
Age	0.00	[−0.06, 0.05]	0.03	−0.17	0.86

Ethical Considerations

The present study has been approved by the ethics committee of the Faculty of Education, Andrés Bello University according to resolution 15/2017 of the year 2017.

RESULTS

Descriptive Results

Table 1 shows the minimum and maximum scores, mean, and the standard deviation of each of the variables considered in the study.

Table 2 shows the frequencies that participants declared about presenting thoughts of death or suicidal ideation and using alcohol, marijuana, and other illegal drugs. As shown, 65.81% of the participants stated that they had never had thoughts of death or suicidal ideation. Moreover, 40.65% of the participants declare to consume alcohol (with different frequency levels), while this percentage reaches 18.06% for the use of marijuana and 3.23% for the use of other illegal drugs.

Correlations

Table 3 presents the Spearman correlation coefficients (Spearman rho), among all the variables. It can be seen that both thoughts of death or suicidal ideation and depression were associated negatively with the four types of perceived social support and positively with the three types of substance use. All these associations were statistically significant ($p < 0.01$). In addition, the three types of substance use evaluated showed a negative and statistically significant relationship ($p < 0.01$) with perceived family support. This did not occur for the other types of

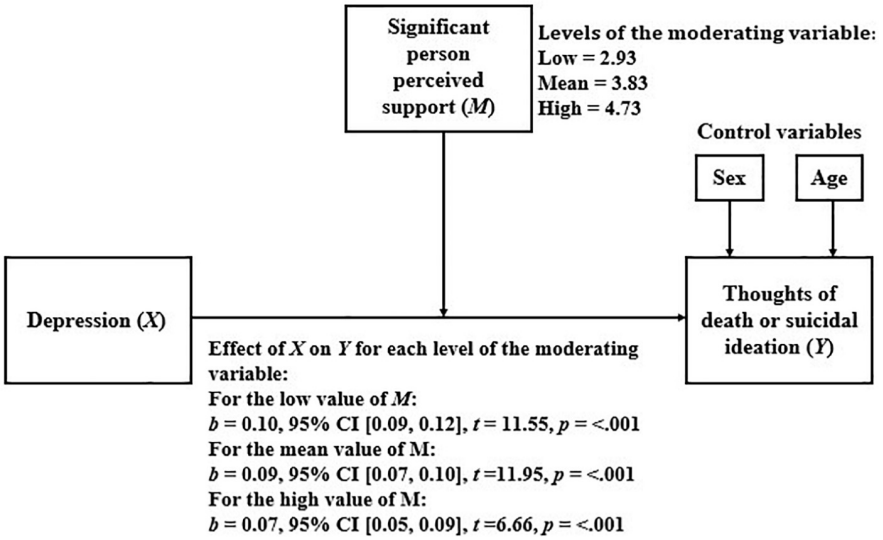

FIGURE 3 | Simple moderation model considering significant person perceived support as moderator.

perceived social support evaluated, which showed no association with substance use.

Simple Moderation Analysis

In this section, the results of the simple moderation analyses performed are presented. These models considered thoughts of death or suicidal ideation as the dependent variable, depression as an independent variable, and the different types of perceived social support and use of substances as moderating variables. A BCa bootstrapped CI based on 5,000 samples was used to calculate the confidence intervals of all the models used. The mean, low, and high values of the moderating variables considered their mean plus/minus a standard deviation.

To simplify the presentation of the results, the acronym TD or SI was used to replace the name of the variable *thoughts of death or suicidal ideation.*

Perceived Family Support as a Moderator of the Relationship Between Depression and Thoughts of Death or Suicidal Ideation

Table 4 shows the results of the linear regression model that considers TD or SI as a dependent variable and depression, perceived family support, and the interaction between them, as independent variables.

The fact that the interaction between independent variables was statistically significant for the model means that the moderation is also significant. Then, we proceeded to analyze how the relationship between depression and TD or SI varied for the different levels of perceived family support. The results of this analysis are presented in **Figure 1**. As shown, as perceived family support increases, the relationship between depression and TD or SI becomes weaker.

Perceived Friends Support as a Moderator of the Relationship Between Depression and Thoughts of Death or Suicidal Ideation

Table 5 shows the results of the linear regression model that considers TD or SI as a dependent variable and depression, perceived friends support, and the interaction between them, as independent variables.

Because the moderation was statistically significant, we proceeded to analyze how the relationship between depression and TD or SI varied for the different levels of perceived friends support. The results of this analysis are presented in **Figure 2**. As shown, as perceived friends support increases, the relationship between depression and TD or SI becomes weaker.

Significant Person Perceived Support as a Moderator of the Relationship Between Depression and Thoughts of Death or Suicidal Ideation

Table 6 shows the results of the linear regression model that considers TD or SI as a dependent variable and depression, significant person perceived support, and the interaction between them, as independent variables.

Because the moderation was statistically significant, we proceeded to analyze how the relationship between depression

TABLE 7 | Linear model of predictors of TD or SI, considering perceived school support (R^2 = 20.85%, $p < 0.001$).

	b	95% CI	*SE B*	*t*	*p*
Constant	−0.24	[−1.21, 0.73]	0.49	−0.49	0.62
Perceived school support	0.02	[−0.11, 0.15]	0.07	0.35	0.73
Depression	0.13	[0.09, 0.17]	0.02	6.34	<0.001
Perceived school support × Depression	−0.01	[−0.03, 0.00]	0.01	−2.04	<0.05
Sex	−0.08	[−0.20, 0.03]	0.06	−1.43	0.15
Age	0.00	[−0.06, 0.05]	0.03	−0.08	0.94

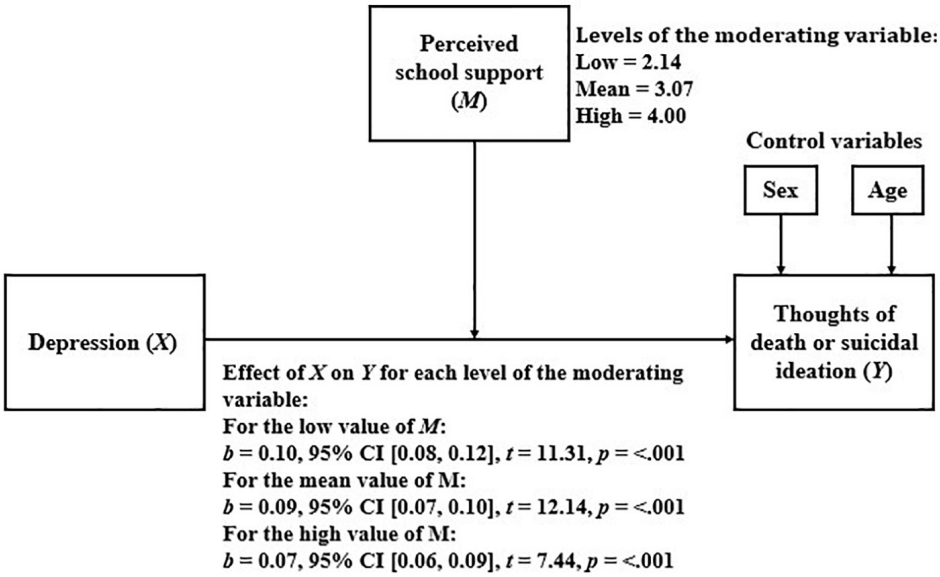

FIGURE 4 | Simple moderation model considering perceived school support as moderator.

and TD or SI varied for the different levels of significant person perceived support. The results of this analysis are presented in **Figure 3**. As shown, as significant person perceived support increases, the relationship between depression and TD or SI becomes weaker.

Perceived School Support as a Moderator of the Relationship Between Depression and Thoughts of Death or Suicidal Ideation

Table 7 shows the results of the linear regression model that considers TD or SI as a dependent variable and depression, perceived school support, and the interaction between them, as independent variables.

Because the moderation was statistically significant, we proceeded to analyze how the relationship between depression and TD or SI varied for the different levels of perceived school support. The results of this analysis are presented in **Figure 4**. As shown, as perceived school support increases, the relationship between depression and TD or SI becomes weaker.

TABLE 8 | Linear model of predictors of TD or SI, considering alcohol use (R^2 = 21.78%, p < 0.001).

	b	95% CI	*SE B*	*t*	*p*
Constant	0.07	[−0.82, 0.95]	0.45	0.15	0.88
Alcohol use	−0.09	[−0.28, 0.10]	0.10	−0.94	0.35
Depression	0.07	[0.06, 0.09]	0.01	8.52	<0.001
Alcohol use × Depression	0.02	[0.01, 0.04]	0.01	2.83	<0.001
Sex	−0.07	[−0.18, 0.05]	0.06	−1.14	0.25
Age	−0.02	[−0.07, 0.04]	0.03	−0.52	0.60

Alcohol Use as a Moderator of the Relationship Between Depression and Thoughts of Death or Suicidal Ideation

Table 8 shows the results of the linear regression model that considers TD or SI as a dependent variable and depression, alcohol use, and the interaction between them, as independent variables.

Because the moderation was statistically significant, we proceeded to analyze how the relationship between depression and TD or SI varied for the different levels of alcohol use. The results of this analysis are presented in **Figure 5**. As shown, as alcohol use increases, the relationship between depression and TD or SI becomes stronger.

Marijuana Use Support as a Moderator of the Relationship Between Depression and Thoughts of Death or Suicidal Ideation

Table 9 shows the results of the linear regression model that considers TD or SI as a dependent variable and depression, marijuana use, and the interaction between them, as independent variables.

In this case, the interaction was not statistically significant. That is, there is no evidence to argue that the use of marijuana moderates the relationship between depression and thoughts of death or suicidal ideation.

Other Illegal Drug Use as a Moderator of the Relationship Between Depression and Thoughts of Death or Suicidal Ideation

Table 10 shows the results of the linear regression model that considers TD or SI as a dependent variable and depression, other illegal drug use, and the interaction between them, as independent variables.

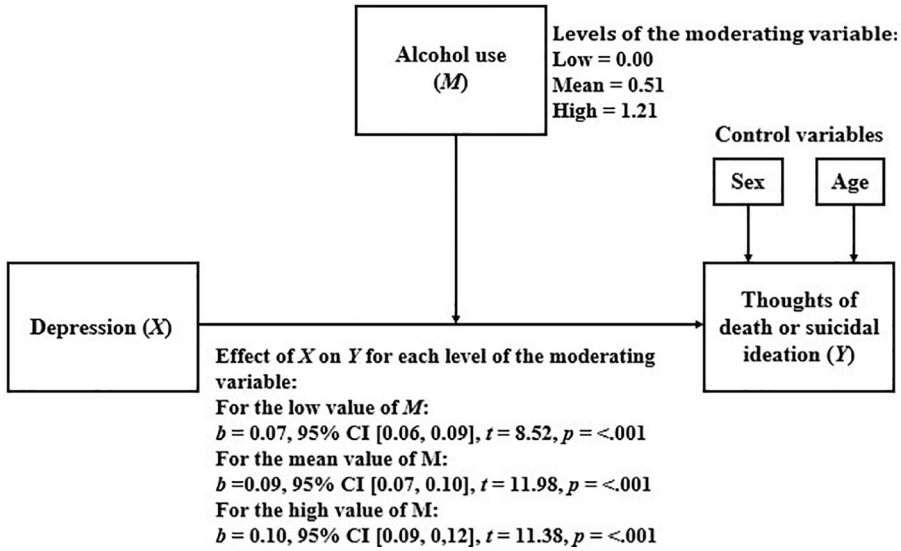

FIGURE 5 | Simple moderation model considering alcohol use as moderator.

In this case, the interaction was not statistically significant. That is, there is no evidence to argue that the use of marijuana moderates the relationship between depression and thoughts of death or suicidal ideation.

Double Moderation Analysis

The results of the double moderation analyses are presented below, which were performed to observe how substance use can moderate the moderation of perceived social support in the relationship between depression and thoughts of death or suicidal ideation (see **Figure 6**).

This procedure considers a multiple linear regression analysis, which includes, as a dependent variable, the thoughts of death or suicidal ideation, and as independent variables depression, perceived social support, substance use, and all possible combinations between these three variables (including the triple combination), as presented in **Figure 7**.

As in the previous analyses, a BCa bootstrapped CI based on 5,000 samples was used to calculate the confidence intervals of all the models used. Due to the quantity and complexity of the models, only the results of the triple interaction between depression, perceived social support, and substance use (for all combinations between the types of perceived social support and substance use) are presented, since this is the only thing that can show if the double moderation is statistically significant. These results are presented in **Table 11**.

Only four of the 12 double moderations analyzed were statistically significant. As shown, alcohol is present in three

TABLE 9 | Linear model of predictors of TD or SI, considering marijuana use (R^2 = 21.51%, $p < 0.001$).

	b	95% CI	*SE B*	*t*	*P*
Constant	0.13	[−0.76, 1.01]	0.45	0.28	0.78
Marijuana use	0.14	[−0.05, 0.32]	0.09	1.43	0.15
Depression	0.09	[0.07, 0.10]	0.01	11.59	<0.001
Marijuana use × Depression	0.00	[−0.01, 0.02]	0.01	0.47	0.64
Sex	−0.05	[−0.16, 0.06]	0.06	−0.86	0.39
Age	−0.03	[−0.08, 0.03]	0.03	−0.89	0.38

TABLE 10 | Linear model of predictors of TD or SI, considering other illegal drug use (R^2 = 20.51%, $p < 0.001$).

	b	95% CI	*SE B*	*t*	*p*
Constant	−0.03	[−0.92,0.86]	0.45	−0.07	0.94
Other illegal drug use	0.62	[0.14,1.09]	0.24	2.55	<0.05
Depression	0.09	[0.08,0.11]	0.01	12.95	<0.001
Other illegal drug use × Depression	−0.03	[−0.07,0.00]	0.02	−1.72	0.09
Sex	−0.05	[−0.17,0.06]	0.06	−0.94	0.35
Age	−0.02	[−0.07,0.04]	0.03	−0.53	0.60

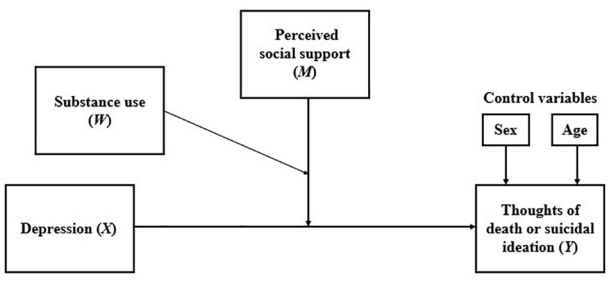

FIGURE 6 | Conceptual model of double moderation analysis.

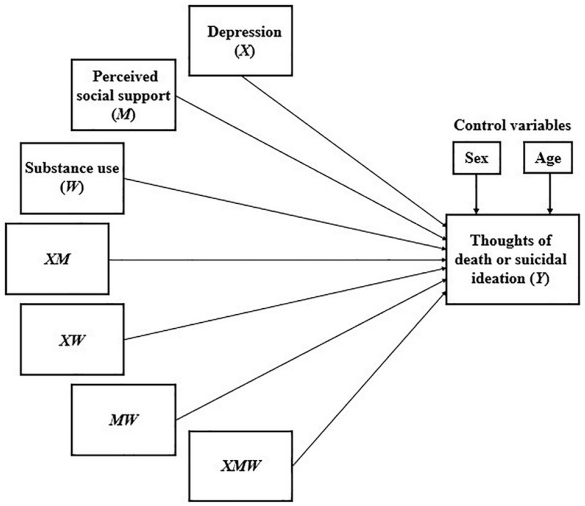

FIGURE 7 | Multiple linear regression analysis for the double moderation model.

of these four models. **Tables 12–15** show how the variables interacted in the models that were statistically significant.

As shown, as alcohol use increases, the ability of family support to weaken the relationship between depression and thoughts of death or suicidal ideation decreases. The same goes for alcohol in the case of significant person support and school support.

In the case of the use of other illegal drugs, the same happens: the greater the use of illegal drugs, the lower the capacity of a significant person to weaken the relationship between depression and suicidal ideation.

DISCUSSION

The results of this study showed that all types of social support evaluated are statistically significant moderators of the relationship between depression and thoughts of death or suicidal ideation (the higher the perceived social support, the weaker the relationship between depression and thoughts of dead or suicidal ideation, with family support having the most important moderating effect), following the line of evidence previously reported (Brausch and Decker, 2014; Lamis et al., 2016; Fredrick et al., 2018). The literature has indicated that social support helps people deal with difficulties in a better way, since a positive social environment provides confirmation of social identity (Korkiamaki and Ellonen, 2008). In this way, social support contributes by positively moderating negative events or stressors (Bliese and Britt, 2001). Especially in studies of children and adolescents, social support is seen as a sample of community social capital (Korkiamaki and Ellonen, 2008).

The same happened with the use of alcohol as a moderator of this relationship, where, as the study by Dvorak et al. (2013) showed, the higher the consumption of alcohol, the stronger the relationship between depression and thoughts of death and suicidal ideation. This could be because adolescents see in the use of alcohol an exit from their negative affective states in the short term, particularly in the case of affective states related to depression (Hussong et al., 2017), which has the consequence that they do not focus on asking for help or solving problems related to their state (Dvorak et al., 2013), which finally translates (in the long term) in the increase of negative emotional states and hopelessness. On the other hand, no evidence was found to support the idea that use of marijuana or other illegal drugs moderates this relationship.

When evaluating double moderations (moderation of substance use on the moderating effect of perceived social support in the relationship between depression and thoughts of dead or suicidal ideation), results showed that the use of alcohol affected the moderating role played by perceived social support from the family, school, and another significant person. The fact that the use of alcohol impacts social support as a protective factor could be due to the fact that people who suffer from a mental disorder tend to consume alcohol to avoid what they feel in social situations (Blumenthal et al., 2016; Collins et al., 2018). In this sense, one might think that this evasive use of alcohol would not allow for the strengthening of the social identity that social development contexts usually foster.

TABLE 11 | Statistical significance of the interaction between depression, perceived social support, and substance use, controlling by sex and age.

	b	95% CI	*SE B*	*T*	*p*
Depression × Family perceived support × Alcohol use	−0.02	[−0.03, 0.00]	0.01	−1.97	<0.05
Depression × Family perceived support × Marijuana use	−0.01	[−0.03, 0.01]	0.01	−1.27	0.21
Depression × Family perceived support × Other illegal drug use	−0.01	[−0.04, 0.02]	0.02	−0.49	0.62
Depression × Friends perceived support × Alcohol use	−0.01	[−0.02, 0.01]	0.01	−0.81	0.42
Depression × Friends perceived support × Marijuana use	0.00	[−0.01, 0.02]	0.01	0.43	0.66
Depression × Friends perceived support × Other illegal drug use	−0.03	[−0.06, 0.01]	0.02	−1.67	0.10
Depression × Significant person perceived support × Alcohol use	−0.02	[−0.04, 0.00]	0.01	−2.17	<0.05
Depression × Significant person perceived support × Marijuana use	−0.01	[−0.03, 0.01]	0.01	−0.98	0.33
Depression × Significant person perceived support × Other illegal drug use	−0.10	[−0.17, −0.03]	0.04	−2.76	<0.01
Depression × Perceived school support × Alcohol use	−0.02	[−0.03, 0.00]	0.01	−1.98	<0.05
Depression × Perceived school support × Marijuana use	−0.01	[0.00, 0.03]	0.01	1.59	0.11
Depression × Perceived school support × Other illegal drug use	−0.01	[−0.05, 0.02]	0.02	−0.81	0.42

TABLE 12 | Conditional effect of depression on TD or IS at different levels of alcohol use and perceived family support, controlling by sex and age.

Alcohol use	Family support	*b*	*SE B*	*t*	*p*	*LLCI*	*ULCI*
0.00	2.73	0.08	0.01	7.01	<0.001	0.06	0.10
0.00	3.71	0.06	0.01	7.13	<0.001	0.04	0.08
0.00	4.69	0.04	0.01	3.61	<0.001	0.02	0.06
0.51	2.73	0.09	0.01	10.06	<0.001	0.07	0.11
0.51	3.71	0.07	0.01	9.10	<0.001	0.05	0.08
0.51	4.69	0.04	0.01	3.85	<0.001	0.02	0.06
1.21	2.73	0.11	0.01	10.29	<0.001	0.09	0.13
1.21	3.71	0.07	0.01	7.59	<0.001	0.05	0.09
1.21	4.69	0.03	0.01	2.48	<0.05	0.01	0.06

TABLE 13 | Conditional effect of depression on TD or IS at different levels of alcohol use and significant person perceived support, controlling by sex and age.

Alcohol use	Significant person support	*b*	*SE B*	*t*	*p*	*LLCI*	*ULCI*
0.00	2.93	0.07	0.01	6.85	<0.001	0.05	0.10
0.00	3.83	0.06	0.01	7.44	<0.001	0.05	0.08
0.00	4.73	0.06	0.01	4.39	<0.001	0.03	0.08
0.51	2.93	0.10	0.01	10.74	<0.001	0.08	0.12
0.51	3.83	0.08	0.01	10.73	<0.001	0.06	0.09
0.51	4.73	0.06	0.01	5.70	<0.001	0.04	0.08
1.21	2.93	0.13	0.01	9.84	<0.001	0.10	0.16
1.21	3.83	0.10	0.01	10.59	<0.001	0.08	0.11
1.21	4.73	0.06	0.01	4.93	<0.001	0.04	0.09

TABLE 14 | Conditional effect of depression on TDorIS at different levels of other illegal drug use and significant person support, controlling by sex and age.

Other illegal drug use	Significant person support	*b*	*SE B*	*t*	*p*	*LLCI*	*ULCI*
0.00	2.93	0.10	0.01	11.09	<0.001	0.08	0.12
0.00	3.83	0.08	0.01	11.28	<0.001	0.07	0.10
0.00	4.73	0.06	0.01	6.27	<0.001	0.04	0.08
0.06	2.93	0.11	0.01	11.70	<0.001	0.09	0.13
0.06	3.83	0.08	0.01	11.76	<0.001	0.07	0.10
0.06	4.73	0.06	0.01	6.18	<0.001	0.04	0.08
0.40	2.93	0.16	0.03	6.15	<0.001	0.11	0.21
0.40	3.83	0.10	0.01	7.18	<0.001	0.08	0.13
0.40	4.73	0.05	0.01	4.29	<0.001	0.03	0.07

TABLE 15 | Conditional effect of depression on TD or IS at different levels of alcohol use and perceived school support, controlling by sex and age.

Alcohol use	School support	*b*	*SE B*	*t*	*p*	*LLCI*	*ULCI*
0.00	2.14	0.07	0.01	6.70	<0.001	0.05	0.09
0.00	3.07	0.07	0.01	7.48	<0.001	0.05	0.08
0.00	4.00	0.06	0.01	4.97	<0.001	0.04	0.08
0.51	2.14	0.09	0.01	10.32	<0.001	0.07	0.11
0.51	3.07	0.08	0.01	10.70	<0.001	0.06	0.09
0.51	4.00	0.07	0.01	6.33	<0.001	0.05	0.09
1.21	2.14	0.12	0.01	10.33	<0.001	0.10	0.14
1.21	3.07	0.10	0.01	10.51	<0.001	0.08	0.11
1.21	4.00	0.07	0.01	5.62	<0.001	0.05	0.10

Furthermore, the results did not show statistically significant evidence that alcohol use affected the moderating effect of perceived social support from friends. To interpret this, it is important to note that within the four areas of perceived social support evaluated (family, friends, significant person, and school), it is precisely the area of friends where the vast majority of situations in which adolescents consume alcohol occur. Considering this, it could be thought that the use of alcohol in adolescents, in addition to having negative consequences (Marshall, 2014), could also (in the particular sphere of friends) generate a space where they can share and validate themselves with peers, strengthening ties and reinforcing the sense of belonging between peers. In this way, the negative and positive aspects of alcohol use could tend to be nullified for the particular environment of friends. This would not happen in the case of the family, another significant person, and the school, where only the negative effects of alcohol use seem to be involved.

One of the limitations of this study is its methodological design (cross sectional). Longitudinal designs may allow for observing which variables that show associations appear first, which might hint at the most appropriate variables for intervention. Another limitation of this study was the way in which depressive symptoms were measured (self-report questionnaires). Although the instrument has good validity, it will never be as accurate as the clinical interviews conducted by health professionals, who may consider a greater number of variables when diagnosing. Future studies should consider these limitations in order to precisely clarify the conditions that prevent adolescents with depressive symptoms from developing suicidal behaviors, especially considering that there is not yet enough evidence that allows us to clearly understand the relationship between the variables that come into play in this phenomenon.

DATA AVAILABILITY STATEMENT

The datasets generated for this study are available on request to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Ethics Committee of the Faculty of Education, Andrés Bello University according to resolution 15/2017 of the year 2017. Written informed consent from the participants' legal guardian/next of kin was not required to participate in this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

AR, JO, FC, and LB were involved in the majority of the study, including planning and supervising the work, performing the measurements, processing the experimental data, performed the

analysis, drafting the manuscript, and designing the figures. CC and CZ aided in the sample design and interpreting the results, and worked on the manuscript. DP was involved in supervising the work and providing a methodological review. All authors discussed the results, commented critically on the manuscript, and read and approved the accepted version.

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REFERENCES

American Psychiatric Association [APA] (2013). *Diagnostic and Statistical Manual of Mental Disorders*, 5th Edn. Washington, DC: American Psychiatric Association [APA]. doi: 10.1176/appi.books.9780890425596

Andrade, J. (2012). Aspectos psicosociales del comportamiendo suicida en adolescentes. *Orbis* 15:22.

Anseán, A. (2014). *Suicidios: Manual de Prevención, Intervención y Postvención de la Conducta Suicida*. Suicidios: Manual de Prevención, Intervención y Postvención de La Conducta Suicida, 397–432.

Bliese, P. D., and Britt, T. W. (2001). Social support, group consensus and stressor-strain relationships: social context matters. *J. Organ. Behav.* 22, 425–436. doi: 10.1002/job.95

Blumenthal, H., Ham, L. S., Cloutier, R. M., Bacon, A. K., and Douglas, M. E. (2016). Social anxiety, disengagement coping, and alcohol-use behaviors among adolescents. *Anxiety Stress Coping* 29, 432–446. doi: 10.1080/10615806.2015.1058366

Bobes, J., Bousoño, M., Al-Halabí, S., Burón, P., Garrido, M., Díaz-Mesa, E. M., et al. (2017). Substance use or abuse, internet use, psychopathology and suicidal ideation in adolescents. *Adicciones* 29, 97–104. doi: 10.20882/adicciones.811

Brausch, A. M., and Decker, K. M. (2014). Self-esteem and social support as moderators of depression, body image, and disordered eating for suicidal ideation in adolescents. *J. Abnorm. Child Psychol.* 42, 779–789. doi: 10.1007/s10802-013-9822-0

Collins, J.-L., Thompson, K., Sherry, S. B., Glowacka, M., and Stewart, S. H. (2018). Drinking to cope with depression mediates the relationship between social avoidance and alcohol problems: a 3-wave, 18-month longitudinal study. *Addict. Behav.* 76, 182–187. doi: 10.1016/j.addbeh.2017.08.020

Conner, K. R., Bridge, J. A., Davidson, D. J., Pilcher, C., and Brent, D. A. (2017). Metaanalysis of mood and substance use disorders in proximal risk for suicide deaths. *Suicide Life Threat. Behav.* 49, 278–292. doi: 10.1111/sltb.12422

Dvorak, R. D., Lamis, D. A., and Malone, P. S. (2013). Alcohol use, depressive symptoms, and impulsivity as risk factors for suicide proneness among college students. *J. Affect. Disord.* 149, 326–334. doi: 10.1016/j.jad.2013.01.046

Eisenberg, M. E., Toumbourou, J. W., Catalano, R. F., and Hemphill, S. A. (2014). Social norms in the development of adolescent substance use: a longitudinal analysis of the international youth development study. *J. Youth Adolesc.* 43, 1486–1497. doi: 10.1007/s10964-014-0111-1

Erhardt, A., and Lu, E. (2016). *A 30 Años Originarios Del Interior Del País Que Asisten a la Resumen*. Available online at: https://repositorio.uade.edu.ar/xmlui/handle/123456789/4046%0Ahttps://repositorio.uade.edu.ar/xmlui/bitstream/handle/123456789/4046/Erhardt.pdf?sequence=1 (accessed January 15, 2020).

Fergusson, D., and Woodward, L. (2002). Mental health, educational, and social role outcomes of adolescents with depression. *Arch. Gen. Psychiatry* 59, 225–231. doi: 10.1001/archpsyc.59.3.225

Fredrick, S. S., Demaray, M. K., Malecki, C. K., and Dorio, N. B. (2018). Can social support buffer the association between depression and suicidal ideation in adolescent boys and girls? *Psychol. Sch.* 55, 490–505. doi: 10.1002/pits.22125

Gadow, K. D., Sprafkin, J., Carlson, G. A., Schneider, J., Nolan, E. E., Mattison, R. E., et al. (2002). A DSM-IV-referenced, adolescent self-report rating scale. *J. Am. Acad. Child Adolesc. Psychiatry* 41, 671–679. doi: 10.1097/00004583-200206000-00006

Gómez, A., Silva, H., and Amon, R. (2018). *El Suicidio. Teoría y Clínica*, 1st Edn. Santiago: Mediterraneo.

Hallfors, D. D., Waller, M. W., Bauer, D., Ford, C. A., and Halpern, C. T. (2005). Which comes first in adolescence - Sex and drugs or depression? *Am. J. Prevent. Med.* 29, 163–170. doi: 10.1016/j.amepre.2005.06.002

Hallfors, D. D., Waller, M. W., Ford, C. A., Halpern, C. T., Brodish, P. H., and Iritani, B. (2004). Adolescent depression and suicide risk. *Am. J. Prev. Med.* 27, 224–231. doi: 10.1016/j.amepre.2004.06.001

Hayes, A. F. (2018). *Introduction to Mediation, Moderation, and Conditional Process Analysis*, 2nd Edn. New York, NY: The Guilford Press.

Hernández, Q. (2017). Suicidologíaadolescente. *Rev. Rúbricas* 11, 55–63.

Hussong, A. M., Ennett, S. T., Cox, M. J., and Haroon, M. (2017). A systematic review of the unique prospective association of negative affect symptoms and adolescent substance use controlling for externalizing symptoms. *Psychol. Addict. Behav.* 31, 137–147. doi: 10.1037/adb0000247

Johnson, D., Dupuis, G., Piche, J., Clayborne, Z., and Colman, I. (2018). Adult mental health outcomes of adolescent depression: a systematic review. *Depress. Anxiety* 35, 700–716. doi: 10.1002/da.22777

Keenan-Miller, D., Hammen, C. L., and Brennan, P. A. (2007). Health outcomes related to early adolescent depression. *J. Adolesc. Health* 41, 256–262. doi: 10.1016/j.jadohealth.2007.03.015

Korkiamaki, R., and Ellonen, N. (2008). Social Capital, Social Work and Young Lives. *Nordisk Sosialt Arbeid* 28, 82–99.

Lamis, D. A., Ballard, E. D., May, A. M., and Dvorak, R. D. (2016). Depressive symptoms and suicidal ideation in college students: the mediating and moderating roles of hopelessness, alcohol problems, and social support. *J. Clin. Psychol.* 72, 919–932. doi: 10.1002/jclp.22295

Lara, M. A., Navarro, C., and Navarrete, L. (2004). Influencia de los sucesos vitales y el apoyo social en una intervención psicoeducativa para mujeres con depresión. *Salud Publica Mexico* 46, 378–387. doi: 10.1590/s0036-36342004000500004

Marmorstein, N. R. (2009). Longitudinal associations between alcohol problems and depressive symptoms: early adolescence through early adulthood. *Alcohol. Clin. Exp. Res.* 33, 49–59. doi: 10.1111/j.1530-0277.2008.00810.x

Marshall, E. J. (2014). Adolescent alcohol use: risks and consequences. *Alcoh. Alcohol.* 49, 160–164. doi: 10.1093/alcalc/agt180

McLeod, G. F. H., Horwood, L. J., and Fergusson, D. M. (2016). Adolescent depression, adult mental health and psychosocial outcomes at 30 and 35 years. *Psychol. Med.* 46, 1401–1412. doi: 10.1017/s0033291715002950

McLeod, J. D., Uemura, R., and Rohrman, S. (2012). Adolescent mental health, behavior problems, and academic achievement. *J. Health Soc. Behav.* 53, 482–497. doi: 10.1177/0022146512462888

Ministerio de Educación (n.d.). *Bases de Datos de Matrícula Por Estudiante*. Available online at: http://datos.mineduc.cl/dashboards/19776/descarga-bases-de-datos-de-matricula-por-estudiante/ (Accesed December 1, 2019).

Morales, S., Echávarri, O., Barros, J., de la Maino, M. P., Armijo, I., Fischman, R., et al. (2017). Intento e ideación suicida en consultantes a salud mental: estilos depresivos, malestar interpersonal y satisfacción familiar. *Psykhe* 26, 1–14. doi: 10.7764/psykhe.26.1.939

Mosqueda Díaz, A., Mendoza Parra, S., Jofré Aravena, V., and Barriga, O. A. (2015). Validez y confiabilidad de una escala de apoyo social percibido en población adolescente. *Enfermeria Glob.* 14, 125–136. doi: 10.6018/eglobal.14.3.200551

Pardo, A. G., Sandoval, D. A., and Umbarila, Z. D. (2004). Adolescencia y depresión. *Rev. Colomb. Psicol.* 13, 17–32.

Patel, V. (2013). Reducing the burden of depression in youth: what are the implications of neuroscience and genetics on policies and programs? *J. Adolesc. Health* 52, S36–S38. doi: 10.1016/j.jadohealth.2012.04.016

Quintana-Orts, C., and Rey, L. (2018). Forgiveness, depression, and suicidal behavior in adolescents: gender differences in this relationship. *J. Genet. Psychol.* 179, 85–89. doi: 10.1080/00221325.2018.1434478

Rehm, J., and Shield, K. D. (2019). Global burden of disease and the impact of mental and addictive disorders. *Curr. Psychiatry Rep.* 21:10. doi: 10.1007/s11920-019-0997-0

Resset, S. (2016). Relación percibida con pares y padres y su asociación con ansiedad y depresión en adolescentes Entre Rios. *Rev. Argent. Ciencias Comport.* 8, 18–26. doi: 10.1016/S1405-8871(16)30064-5

Rojas, G., Gaete, J., Guajardo, V., Martínez, V., Barroihlet, S., Meneses, J., et al. (2012). Consumo de sustancias y síntomas depresivos en escolares de liceos municipales de Santiago. *Rev. Méd. Chile* 140, 184–191. doi: 10.4067/s0034-98872012000200006

Salk, R. H., Hyde, J. S., and Abramson, L. Y. (2017). Gender differences in depression in representative national samples: meta-analyses of diagnoses and symptoms. *Psychol. Bull.* 143, 783–822. doi: 10.1037/bul0000102

Salvo Garrido, L., and Melipillán, A. R. (2008). Predictores de suicidalidad en adolescentes. *Rev. Chilena Neuro Psiquiatria* 46, 115–123. doi: 10.4067/s0717-92272008000200005

Sanchis, C. F., and Domènech, L. E. (2012). Ideación y conducta suicida en los jóvenes. *Rev. Psicoterapia* 21, 5–22.

Sarmiento, Z., Sanchez, S., Vargas, I., and Alvarez, M. (2010). Conducta suicida y su relación con los factores de riesgo psicosociales. *Medisan* 14, 1054–1060.

Whiteford, H. A., Degenhardt, L., Rehm, J., Baxter, A. J., Ferrari, A. J., Erskine, H. E., et al. (2013). Global burden of disease attributable to mental and substance use disorders: findings from the global burden of disease Study 2010. *Lancet* 382, 1575–1586. doi: 10.1016/S0140-6736(13)61611-6

Zimet, G. D., Dahlem, N. W., Zimet, S. G., and Farley, G. K. (1988). The multidimensional scale of perceived social support. *J. Pers. Assess.* 52, 30–41. doi: 10.1207/s15327752jpa5201_2

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The Mediating Role of Impulsivity in the Relationship Between Suicidal Behavior and Early Traumatic Experiences in Depressed Subjects

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Background: Depressed patients with early traumatic experiences may represent a clinically and biologically distinct subtype, with worse clinical outcomes and greater risk of suicide. Since early traumatic experiences alter development of systems that regulate the stress response, increasing sensitivity to stress and mood disorders later in life, certain personality features may influence coping strategies, putting individuals with depression and a history of early traumatic experiences at greater risk of suicidal behavior.

Objective: To determine whether impulsivity mediates the relationship between early traumatic experiences and suicidal behavior in patients with major depressive disorder (MDD).

Methods: The total sample consists of 190 patients [mean age (*SD*) = 53.71 (10.37); females: 66.3%], with current MDD (DSM-5 criteria). The Childhood Trauma Questionnaire-Short Form (CTQ-SF), the List of Threatening Experiences (LTE), and the Barratt Impulsiveness Scale-11 (BIS-11) were used to assess childhood and adulthood adverse life events and impulsivity, respectively. We developed mediation models by bootstrap sampling methods.

Results: Eighty-one (42.6%) patients had a history of previous suicide attempts (SA). CTQ-SF-Total and BIS-11-Total scores were significantly higher in MDD patients with previous SA. Correlation analyses revealed significant correlations between the CTQ-SF-Total and BIS-11-Total, CTQ-SF-Total and HDRS-Total, and BIS-11-Total and HDRS-Total scores. Regression models found that CTQ-SF-Total, BIS-11-Total, and HDRS-Total scores were associated with SA. Mediation analyses further revealed the

association between CTQ-SF-Total and SA was mediated by the indirect effect of the BIS-11-Total score ($b = 0.007$, 95% CI = 0.001, 0.015), after statistically controlling for sex, the HDRS-Total, and the LTE-Total.

Discussion: Data suggest that impulsivity could mediate the influence of childhood trauma on suicidal behavior. This will help understand the role of risk factors in suicidal behavior and aid in the development of prevention interventions focused on modifiable mediators when risk factors are non-modifiable.

Keywords: suicidal behavior, stressful life events, childhood trauma, impulsivity, depression

INTRODUCTION

According to recent reports, depressed patients with early traumatic experiences may represent a clinically and biologically distinct subtype (1). Converging data from animal and human studies have illustrated how early-life adversity induces epigenetic regulation of multiple genes in the brain involved in the regulation of diverse biological processes (2), which may help understand the clinical heterogeneity found in this population. These neurobiological processes are of clinical importance given the association of early-life adversity with earlier age at onset of depressive illness, greater symptom severity, more comorbidity, poorer treatment response, and greater risk of suicide (1, 3).

Suicide prevention is a major public health concern. In 2017, it was estimated that, by the year 2020, about 800,000 people would die by suicide each year and at least 10–20 times more people would attempt suicide annually (4). Identifying those at greatest risk for completing or attempting suicide is a key aspect of suicide prevention (5). Psychiatric disorders, especially mood disorders, are among the most important risk factors for suicide (6). Reported prevalence of positive lifetime history of suicide attempts (SA) among depressed patients is high, although it varies among studies and settings. Figures from research conducted in outpatient and inpatient samples range between 30 and 40% in major depressive disorder (MDD) (7–9). Notably, mood disorder patients exposed to physical and/or sexual abuse during childhood are at greater risk of suicide vs. subjects without such experiences (10).

However, the specific mechanisms whereby adverse childhood experiences affect suicidality in adults with MDD remain to be elucidated. As not all children exposed to stressful life experiences develop psychopathology or suicidal behaviors, it is plausible to assume that there are additional variables that may help explain such an association. Since early traumatic experiences alter development of systems that regulate the stress response, increasing sensitivity to stress and mood disorders later in life (11), it is conceivable that increased lifetime stressors coupled with certain personality features would put individuals with depression and a history of early traumatic experiences at greater risk of suicide. For instance, some authors argue that is an accumulation of stressful life events over time, and not merely the presence of an isolated stressful life event, that relates to the occurrence of depressive symptomatology or suicidal behavior (12, 13). Conversely, with regard to personality features, it has been shown that poor emotional regulation strategies, poor emotional cognition, behavioral impulsivity, and self-criticism the increase risk of suicidal behaviors (14–16). More specifically, it has been proposed that childhood trauma may constitute an environmental risk factor for the development of impulsivity and SA in patients with depression (17), with data suggesting that childhood trauma could be related with problems in emotion regulation, which may in turn enhance impulsivity (18). However, the evidence suggests that impulsivity traits are part of a developmental cascade that increases suicide risk in a subset of suicide (not all suicides are associated with impulsive-aggressive behaviors) (19, 20), impulsivity being one of the most accepted endophenotypes when studying suicidal behavior (21).

The present study is aimed at exploring whether impulsivity traits could mediate the established relationship between early traumatic experiences and suicidal behavior in patients with MDD. We hypothesized that impulsivity would be related to childhood trauma and suicidal behavior in patients with MDD. We further expected that impulsivity could mediate the relationship between childhood trauma and suicidality in these patients. However, an alternative hypothesis in which depression severity could mediate such relationship will also be explored.

MATERIALS AND METHODS

Participants

Cross-sectional study, including 190 Caucasian outpatients aged ≥18 years, recruited at the Mental Health Services in the area of Oviedo, Spain (population 331,936) from April 2016 to September 2018.

All participants had a diagnosis of current Major Depressive Disorder (MDD) according to the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) (22). The exclusion criteria were comorbid psychiatric diagnoses other than tobacco use, Hamilton Depression Rating Scale score <15, intellectual disability, or any serious physical illness. Diagnoses were made by a psychiatrist and confirmed with the Structured Clinical Interview for DSM-5 (SCID-5) (23).

Suicide attempt (SA) was defined as a "self-initiated sequence of behaviors by an individual who, at the time of initiation, expected that the set of actions would lead to his or her own death" (22).

All participants received information about the purposes and protocol of the study and signed the informed consent before any study procedures were performed. The study was conducted

in compliance with applicable laws and the provisions of the Declaration of Helsinki (24) and received institutional approval from the Clinical Research Ethics Committee of the Principality of Asturias.

Assessments

All participants were assessed by well-trained interviewers using an "*ad-hoc*" protocol for sociodemographic and clinical data (sex, age, marital status, level of education, work status, tobacco use, antidepressant drug treatment, number of SA, and age at first attempt) (25). We employed the Spanish version of the 17-item Hamilton Depression Rating Scale (HDRS) (26, 27) to determine the severity of the depression. The Spanish version of the Columbia-Suicide Severity Rating Scale (28, 29) was used to assess the presence and characteristics of suicidal behaviors. Impulsiveness was assessed with the Spanish version of the Barratt Impulsiveness Scale-11 (BIS-11) (30, 31). BIS-11 is a 30-item scale that evaluates motor, attention, and planning components, which are consecutively characterized by action inhibition, decision-making, and planning understanding. Each item is rated on a scale of up to four points: 1 = rarely/never; 2 = occasionally; 3 = often; and 4 = almost always/always. The Childhood Trauma Questionnaire-Short Form (CTQ-SF) (32) is a 28-item retrospective self-report questionnaire to detect early stressors (emotional, physical, and sexual abuse, and emotional and physical neglect). This scale has been adapted for use in Spanish (33). Finally, the Spanish version of the List of Threatening Experiences (LTE) has been used to detect stressful life events (12 different stressors) in the 6 months prior to the evaluation (34, 35).

Study Variables

We utilized four main variables during our analyses. These were: (1) History of previous SA (DSM-5 criteria); (2) Severity of childhood trauma measured with the CTQ-SF total score (CTQ-SF-Total); (3) Severity of impulsiveness assessed with the BIS-11 total score (BIS-11-Total), and (4) Severity of the depression assessed with the HDRS total score (HDRS-Total).

Statistical Analysis

Statistical analyses were carried out using IBM SPSS Statistics for Windows, Version 24.0. The statistical significance was set at 0.05. Descriptive statistical analyses were expressed as means and standard deviations (*SD*) for quantitative variables, with frequencies and percentages used for categorical variables. Partial correlations were applied to explore the association between CTQ-SF-Total, BIS-11-Total, HDRS-Total, and LTE-Total, controlling for the following sociodemographic and clinical covariates: age, sex, level of education, work status, and recurrence of depressive episodes. Logistic regression models were built to explore the association of CTQ-SF-Total, BIS-11-Total, and HDRS-Total, with previous SA. Finally, two mediation models were developed to test the role of impulsiveness and depression in explaining the effect of early traumatic experiences on suicidal behavior. To control for their possible confounding effect, we included sex, age, and those variables with statistically significant differences between groups with or without previous SA in the bivariate analysis as covariates in the mediation models.

We ran the mediation models using model 4 (simple mediation) of the PROCESS macro for SPSS (v3.4) (36). The main goal of a simple mediation model is to test if the total effect of the independent variable (X) on the dependent (Y) can be partially or entirely by an indirect pathway (paths a and b) through a third variable, called mediator (M), located between X and Y. We used history of SA as the independent variable, CTQ-SF-Total as the dependent variable, and, alternatively, BIS-11-Total or HDRS-Total as mediators, performing a bootstrapped analysis with 5,000 replications to determine the significance of the mediatory effect. Bootstrapping is a data resampling technique from a non-parametric approach that allows hypothesis testing, estimating of size-effects, and constructing of confidence intervals without making any assumptions about the shape of the variable distribution or the sampling distribution of the statistic (37). Given the binary outcome of the dependent variable, we could not calculate the total effect of our model. This was because, in the case of a dichotomous Y, the regression coefficient for X in a model of Y without the mediator included is not equal to the sum of the direct and indirect effects of X (38).

RESULTS

Sociodemographic and Clinical Characteristics

Table 1 shows the sociodemographic and clinical characteristics of the study sample. The final sample included 190 patients [mean age (*SD*) = 53.71 (10.37); females = 126 (66.3%)], of whom 81 (42.6%) had a history of previous SA. The mean number of SA was 2.78 (*SD* = 2.42). Ninety-seven patients (51.1%) had a single episode of MDD, while 93 patients (48.9%) had recurrent episodes, and the mean HDRS total score of the sample was 18.88 (*SD* = 5.77). Most participants had a primary education ($n = 89$, 46.8%), but only a minority ($n = 35$, 18.4%) were working at the time of the study. Compared with those without a previous SA, patients with a history of previous SA ($n = 81$, 42.6%) were significantly younger (51.11 vs. 55.69, $t = 3.071$, $p = 0.002$) and scored higher on the HDRS (20.02 vs. 18.03, $t = -2.387$, $p = 0.018$), CTQ-SF-Total (40.81 vs. 35.95, $t = -2.450$, $p = 0.015$), CTQ-Emotional Neglect (11.23 vs. 9.37, $t = -2.431$, $p = 0.016$), BIS-11-Total (67.21 vs. 62.22, $t = -2.997$, $p = 0.003$), BIS-11-Motor Impulsiveness (22.86 vs. 21.28, $t = -2.066$, $p = 0.040$), and BIS-11-Non-planning Impulsiveness (25.51 vs. 22.55, $t = -3.729$, $p < 0.001$). No differences were founds in the LTE score (2.98 vs. 2.69, $t = -1.922$, $p = 0.056$). All patients were on antidepressant drug treatment at the time of inclusion in the study.

Bivariate Correlations and Regression Analyses

Partial correlation analyses (**Table 2**) revealed a significant positive correlation between CTQ-SF-Total and BIS-11-Total ($r = 0.253$, $p = 0.001$), CTQ-SF-Total and HDRS-Total ($r = 0.152$,

TABLE 1 | Sociodemographic and clinical characteristics of the sample ($n = 190$): [mean (*SD*)] or (*n*, %).

	Total	No SA	Previous SA	Test (*p*)
Sociodemographic				
Age (years)	53.71 (10.37)	55.69 (9.97)	51.11 (10.40)	$t = 3.071$, $p = 0.002$
Sex				$\chi^2 = 2.690$, $p = 0.101$
Female	126 (66.3%)	67 (61.5%)	59 (72.8%)	
Male	64 (33.7%)	42 (38.5%)	22 (27.2%)	
Level of education				$\chi^2 = 4.565$, $p = 0.102$
Primary	89 (46.8%)	54 (49.5%)	35 (43.2%)	
High School	74 (38.9%)	36 (33.0%)	38 (46.9%)	
University	27 (14.2%)	19 (17.4%)	8 (9.9%)	
Work status				$\chi^2 = 1.538$, $p = 0.673$
Active	35 (18.4%)	23 (21.1%)	12 (14.8%)	
Unemployed	60 (31.6%)	32 (29.4%)	28 (34.6%)	
Work incapacity	26 (13.7%)	14 (12.8%)	12 (13.7%)	
Retired	69 (36.3%)	40 (36.7%)	29 (35.8%)	
Clinical				
Recurrent depressive episodes	93 (48.9%)	51 (46.8%)	42 (51.9%)	$\chi^2 = 0.477$, $p = 0.490$
HDRS Total	18.88 (5.77)	18.03 (6.17)	20.02 (5.00)	$t = -2.387$, $p = 0.018$
LTE Total	2.81 (1.00)	2.69 (0.87)	2.98 (1.14)	$t = -1.922$, $p = 0.056$
CTQ-SF-Total	38.02 (13.24)	35.95 (11.49)	40.82 (14.90)	$t = -2.450$, $p = 0.015$
CTQ-SF-EA	7.75 (3.98)	7.26 (3.63)	8.42 (4.34)	$t = -1.957$, $p = 0.052$
CTQ-SF-PA	6.38 (2.63)	6.07 (2.15)	6.80 (3.12)	$t = -1.805$, $p = 0.073$
CTQ-SF-SA	5.89 (2.93)	5.63 (2.33)	6.23 (3.57)	$t = -1.321$, $p = 0.189$
CTQ-SF-EN	10.17 (5.17)	9.38 (4.75)	11.23 (5.53)	$t = -2.431$, $p = 0.016$
CTQ-SF-PN	7.83 (2.96)	7.61 (3.01)	8.12 (2.88)	$t = -1.194$, $p = 0.234$
BIS-11-Total	64.35 (11.59)	62.22 (11.11)	67.21 (11.67)	$t = -2.997$, $p = 0.003$
BIS-11-A	18.58 (4.12)	18.39 (4.19)	18.84 (4.04)	$t = -0.735$, $p = 0.463$
BIS-11-M	21.95 (5.29)	21.28 (5.37)	22.86 (5.06)	$t = -2.066$, $p = 0.040$
BIS-11-NP	23.81 (5.58)	22.55 (5.11)	25.51 (5.78)	$t = -3.729$, $p < 0.001$

CTQ-SF, Childhood Trauma Questionnaire-Short Form; -EA, Emotional Abuse; -PA, Physical Abuse; -SA, Sexual Abuse; -EN, Emotional Neglect; -PN, Physical Neglect; BIS-11, Barratt Impulsiveness Scale; -A, Attentional Impulsiveness; -M, Motor Impulsiveness; -NP, Non-planning Impulsiveness; HDRS, Hamilton Depression Rating Scale; LTE, Brugha's List of Threatening Experiences; SA, Suicide Attempt.

$p = 0.040$), and BIS-11-Total and HDRS-Total ($r = 0.218$, $p = 0.003$). No correlation was found between CTQ-SF-Total and LTE score ($r = 0.035$, $p = 0.641$), BIS-11-Total and LTE score ($r = -0.033$, $p = 0.658$), nor HDRS-Total and LTE score ($r = 0.131$, $p = 0.075$). Three logistic regression models were performed, including history of previous SA as a binary dependent variable and, alternatively, CTQ-SF-Total, BIS-11-Total or HDRS-Total as an independent variable. In the first model, CTQ-SF-Total was significantly associated with history of previous SA [$\beta = 0.028$, $p = 0.014$, odds ratio (OR) = 1.029 (95% Confidence Interval (CI) = 1.006 – 1.052)]. The second model indicated that there was a significant association between BIS-11-Total and history of previous SA [$\beta = 0.039$, $p = 0.004$, OR = 1.039 (95% CI = 1.012 – 1.067)]. The third model revealed a significant association between HDRS-Total and history of previous SA [$\beta = 0.063$, $p = 0.020$, OR = 1.065 (95% CI = 1.010 – 1.123)].

TABLE 2 | Partial correlations between traumatic events, impulsiveness, and depressive symptoms [r (p)], after controlling for covariates (age, sex, level of education, work status, and recurrence of depressive episodes).

	CTQ-SF-Total	BIS-11-Total	HDRS-Total	LTE-Total
CTQ-SF-Total	-			
BIS-11-Total	0.253 (0.001)	-		
HDRS-Total	0.152 (0.040)	0.218 (0.003)	-	
LTE-Total	0.035 (0.641)	−0.033 (0.658)	0.131 (0.075)	-

CTQ-SF, Childhood Trauma Questionnaire-Short Form; BIS-11, Barratt Impulsiveness Scale; HDRS, Hamilton Depression Rating Scale; LTE, Brugha's List of Threatening Experiences.

Mediation Analysis

The first mediation model was performed to test the role of impulsiveness in explaining the effect of early traumatic experiences on suicidal behavior. Age, sex, and the HDRS-Total ($p = 0.018$) were included as covariates in the model, along with the LTE-Total ($p = 0.056$). Due to the significant difference between the groups with or without history of previous SA concerning age, we conducted the analysis in two steps: (1) excluding the age from the list of covariates and (2)

after its inclusion in the model. **Figure 1** shows the mediation models illustrating the relationship between the dependent variable (CTQ-SF-Total), the mediator (BIS-11-Total), and the independent variable (history of SA). In the first step, after adjusting for the indirect effects of the mediator (BIS-11-Total), the direct effect (path c′) of CTQ-Total on history of previous SA was not significant ($b = 0.020$, $p = 0.114$). The bootstrapped 95% CI for the indirect effect of CTQ-Total on history of previous SA through BIS-11-Total ($b = 0.007$) was entirely beyond zero (0.001, 0.015), revealing that a mediation occurred. When age was added as a covariate, the indirect effect of CTQ-Total on history of previous SA through BIS-11-Total was no longer significant, as the bootstrapped 95% CI included the zero (0.000, 0.014).

The second mediation model was performed to test the role of the severity of the depression in explaining the effect of early traumatic experiences on suicidal behavior. Age, sex, and the BIS-11-Total ($p = 0.003$) were included as covariates in the model, along with the LTE-Total ($p = 0.056$). As for the former model, the analysis was conducted in two steps: (1) excluding the age from the list of covariates and (2) after its inclusion in the model. In the first step, we did not observe a significant indirect effect of CTQ-Total on history of previous SA through HDRS-Total (95% CI for the indirect effect: −0.001, 0.007). The second step of the analysis showed a similar non-significant result (95% CI for the indirect effect: −0.002, 0.006).

DISCUSSION

We conducted a cross-sectional study in order to evaluate the potential role of impulsivity traits and severity of depression as mediators of the established relationship between early traumatic experiences and suicidal behavior in depressed subjects (39). The main finding of our work was that impulsivity could mediate the influence of childhood trauma on suicidal behavior, after statistically controlling for sex, the HDRS-Total, and the LTE-Total. This association was no longer significant when age was entered as a covariate in the model. However, it should be noted that, probably due to the recruitment process, the group with previous SA included significantly younger patients, which may have influenced this discrepancy.

Previous research has illustrated how mental health problems, including suicidal behavior, may be the consequence of early traumatic events. Epigenetic mechanisms of gene regulation could clarify how early life experiences can leave permanent biological marks on the brain and can increase the risk of psychiatric conditions and suicide later in life (40). Levels of environmental adversity early in the developmental period affect stress-regulating pathways leading to long-lasting effects on stress responsivity during adulthood (41).

However, since not all depressed subjects who have experienced traumatic events in childhood display suicidal behavior in adulthood, some authors have posited that additional variables should be considered when attempting to clarify how early life experiences exert their influence over the life span. The stress sensitization theory proposes that early adversity and stress later in life are linked (42). It suggests that repeated stress early in life dysregulates stress response systems and lowers the threshold for reactivity and adaptive responses to subsequent stress. Similarly, the theory of stress proliferation, which posits that "stress begets stress," helps explain how early traumatic experiences can result in secondary stressors (43). In the same vein, a chain reaction of adversity leading to accumulation of stressors throughout development has been reported (44, 45). Interestingly, in our sample, we do not find any correlation between stressors during childhood and adulthood, as assessed using CTQ and LTE scales, respectively. It is important to bear in mind that the LTE assesses stressful life events only in the 6 months prior to the sample evaluation. However, it may be that the direction of the association could vary if the presence of stressors during adulthood were explored over longer periods of adult life. On the other hand, the lack of association between stressors during adulthood and SA may be due to the fact that, in the present sample, the SA may be have occurred prior to the 6-months period assessed by the LTE.

Childhood adverse experiences challenge learning and academic achievement, compromising educational, workforce, and socioeconomic accomplishments in adulthood (46). Thus, the selection of negative social environments in adulthood may be not random, but rather the consequence of growing up in negative social environments (47). On the other hand, risky social environments mold coping styles, emotion regulation, and social cognition (39), and disturbances in these dimensions affect personality development. However, childhood adverse experiences have already been shown to increase impulsivity in suicidal patients (17, 48, 49). This is of clinical importance given that poor emotional regulation strategies, poor emotional cognition, behavioral impulsivity, and self-criticism are personality features that reportedly increase risk of suicidal behaviors (15, 16).

Our finding that impulsivity (as assessed by the BIS-11 scale) mediates the relationship between early traumatic experiences and suicidal behavior supports previous findings regarding the impact of recent stressors and certain personality features on suicidal behavior (6). However, at the same time, it adds to the previous literature a potential mechanism whereby adverse childhood experiences affect suicidality in adults with MDD.

However, a number of limitations of our work suggest that our results should be interpreted cautiously: the instruments used are based on patient reports, and no coefficient of agreement with interviewer diagnoses was computed. Furthermore, the information provided by subjects was not confirmed using other informants. The retrospective nature of the assessment was subject to recall bias and may have led to underreporting of early traumatic experiences; the clinical origin of the sample limits the generalizability of the findings, and, as analyses are cross-sectional, it is difficult to establish the real direction of the relationship found. However, childhood traumatic experiences and impulsivity are treated as single cumulative variables in this study, but they could alternatively be classified in different domains. Furthermore, the group with previous SA included significantly younger patients, which could be due

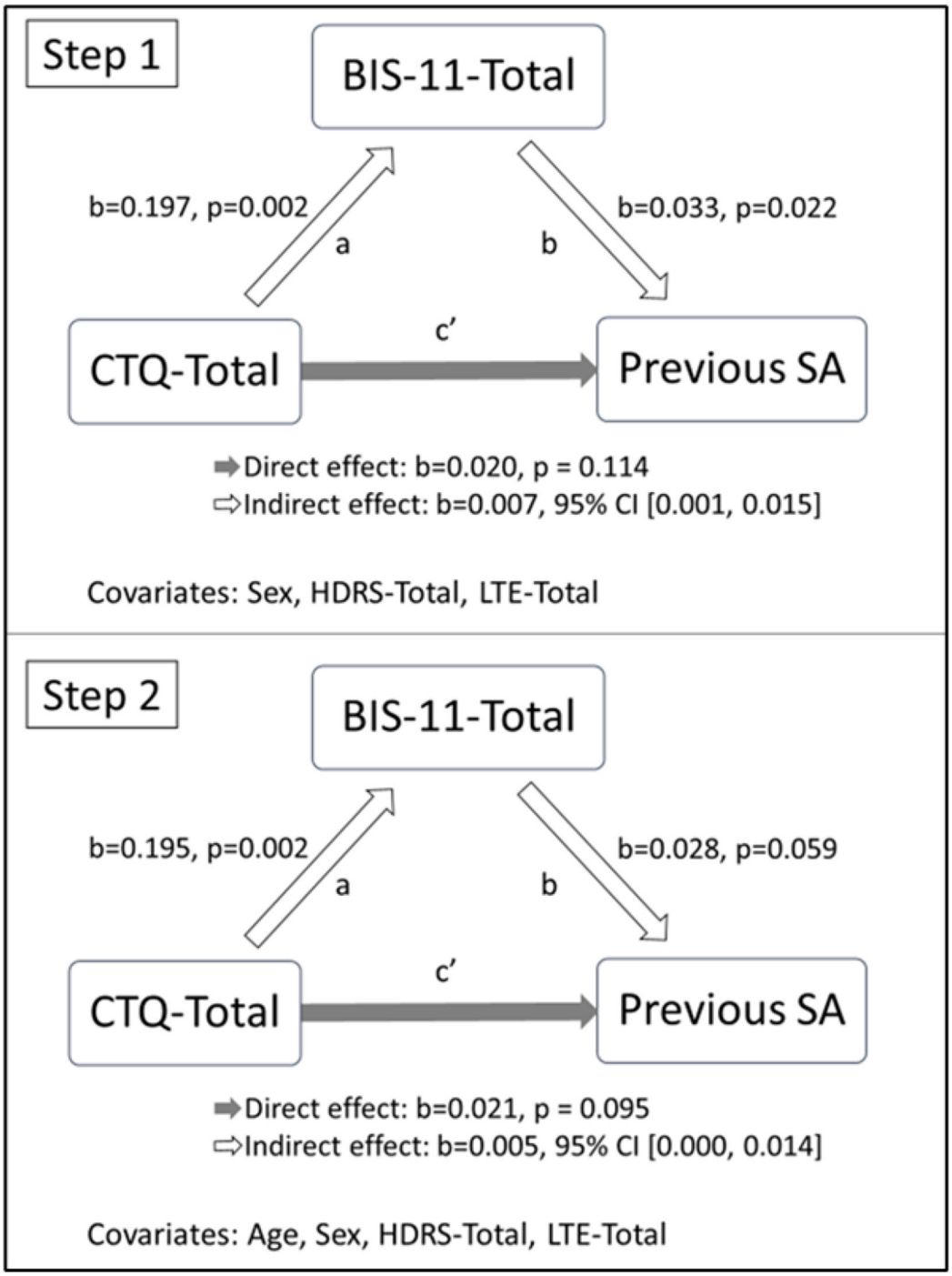

FIGURE 1 | Mediation models of the association between the CTQ-SF-Total score and history of previous SA through BIS-11-Total score. CTQ-SF, Childhood Trauma Questionnaire-Short Form; BIS-11, Barratt Impulsiveness Scale; SA, Suicide Attempt; HDRS, Hamilton Depression Rating Scale; LTE, Brugha's List of Threatening Experiences.

to the recruitment process in our sample rather than to a causal association between younger age and SA, limiting the interpretation of the effect of age on the mediation models. On the other hand, pharmacological treatment has not been included as a covariate in the mediation analyses. Finally, there is a theoretical limitation regarding mediation models. As some authors have pointed out (50), mediation models are based on confirmatory analysis, and if data support the hypothesis, it does not mean that the hypothesis is true or correct, although it is plausible and probably useful. We posited a mediation

relationship before we started the analyses, but we could not anticipate if it would be a partial or a total mediation relationship. However, based on the previous literature discussed above regarding childhood traumatic experiences, personality features, and suicidality, it is reasonable to think that the relationship between impulsivity and suicidal behavior is not spurious.

Despite these limitations, the results presented here have important implications. Our results suggest that the impact of childhood trauma on suicidal behavior in adulthood could be mediated by impulsiveness. This is important to better understand the role of risk factors in suicidal behavior, as well as for the development of prevention strategies that may focus on modifiable mediators when risk factors are non-modifiable. The presence of any of these mediators needs to be explored in depressed subjects, especially when there are known childhood adverse experiences. Alternatively, as "time does not heal all wounds" (51), it is of great importance from a public health standpoint not only to prevent childhood adversity but also to intervene once it occurs in order to avoid long-lasting negative mental health effects.

DATA AVAILABILITY STATEMENT

The datasets generated for this study are available on request to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Clinical Reseach Ethics Committee of the Principality of Asturias. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

FD, JC, LJ-T, IC-C, and PS analyzed and interpreted the data and wrote the manuscript. AV, JR-R, CM-C, LF-T, IM-M, LG-B, M^{a}G-P, JB, and PS followed up patients and performed/assisted in evaluations. FD, JC, M^{a}G-P, JB, and PS designed the study, analyzed data, contributed to data interpretation, and wrote the manuscript. All authors read and approved the final manuscript.

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REFERENCES

1. Teicher MH, Samson JA. Childhood maltreatment and psychopathology: a case for ecophenotypic variants as clinically and neurobiologically distinct subtypes. *Am J Psychiatry.* (2013) 170:1114–33. doi: 10.1176/appi.ajp.2013.12070957
2. Turecki G, Ota VK, Belangero SI, Jackowski A, Kaufman J. Early life adversity, genomic plasticity, and psychopathology. *Lancet Psychiatry.* (2014) 1:461–6. doi: 10.1016/S2215-0366(14)00022-4
3. Martins-Monteverde CMS, Baes CVW, Reisdorfer E, Padovan T, Tofoli SMC, Juruena MF. Relationship between depression and subtypes of early life stress in adult psychiatric patients. *Front Psychiatry.* (2019) 10:19. doi: 10.3389/fpsyt.2019.00019
4. World Health Organization. Department of Mental Health and Substance Abuse. World Health Organization (WHO). *Disease and Injury Country Mortality Estimates, 2000–2015*. (2017) Available online at: http://www.who.int/healthinfo/global_burden_disease/estimates/en/index1.html (accessed January 14, 2020).
5. Zalsman G, Hawton K, Wasserman D, van Heeringen K, Arensman E, Sarchiapone M, et al. Suicide prevention strategies revisited:10-year systematic review. *Lancet Psychiatry.* (2016) 3:646–59. doi: 10.1016/S2215-0366(16)30030-X
6. Mann JJ. Neurobiology of suicidal behavior. *Nat Rev Neurosci.* (2003) 4:819–28. doi: 10.1038/nrn1220
7. Isometsä E. Suicidal behaviour in mood disorders–who, when, and why? *Can J Psychiatry.* (2014) 59:120–30. doi: 10.1177/070674371405900303
8. Sokero TP, Melartin TK, Rytsälä HJ, Leskelä US, Lestelä-Mielonen PS, Isometsä ET. Suicidal ideation and attempts among psychiatric patients with major depressive disorder. *J Clin Psychiatry.* (2003) 64:1094–100. doi: 10.4088/jcp.v64n0916
9. Malone KM, Haas GL, Sweeney JA, Mann JJ. Major depression and the risk of attempted suicide. *J Affect Disord.* (1995) 34:173–85.
10. Carballo JJ, Akamnonu CP, Oquendo MA. Neurobiology of suicidal behavior. An integration of biological and clinical findings. *Arch Suicide Res.* (2008) 12:93–110. doi: 10.1080/13811110701857004
11. Sachs-Ericsson NJ, Rushing NC, Stanley IH, Sheffler J. In my end is my beginning: developmental trajectories of adverse childhood experiences to late-life suicide. *Aging Ment Health.* (2016) 20:139–65. doi: 10.1080/13607863.2015.1063107
12. de Tychey C, Garnier S, Lighezzolo-Alnot J, Claudon P, Rebourg-Roesler C. An accumulation of negative life events and the construction of alexithymia: a longitudinal and clinical approach. *J Pers Assess.* (2010) 92:189–206. doi: 10.1080/00223891003670125
13. Stein DJ, Chiu WT, Hwang I, Kessler RC, Sampson N, Alonso J, et al. Cross-national analysis of the associations between traumatic events and suicidal behaviour: findings from the World Mental Health Surveys. *PLoS ONE.* (2010) 5:e10574. doi: 10.1371/journal.pone.0010574
14. Bilsen J. Suicide and youth: risk factors. *Front Psychiatry.* (2018) 9:540. doi: 10.3389/fpsyt.2018.00540
15. Caro-Cañizares I, García-Nieto R, Díaz de Neira-Hernando M, Brandt SA, Baca-García E, Carballo JJ. The SDQ dysregulation profile is associated with self-injurious thoughts and behaviours in adolescents evaluated at a clinical setting. *Rev Psiquiatr Salud Ment.* (2019) 12:242–50. doi: 10.1016/j.rpsm.2018.07.001
16. McGirr A, Turecki G. The relationship of impulsive aggressiveness to suicidality and other depression-linked behaviours. *Curr Psychiatry Rep.* (2007) 9:460–6. doi: 10.1007/s11920-007-0062-2

17. Brodsky BS, Oquendo M, Ellis SP, Haas GL, Malone KM, Mann JJ. The relationship of childhood abuse to impulsivity and suicidal behaviour in adults with major depression. *Am J Psychiatry.* (2001) 158:1871–7. doi: 10.1176/appi.ajp.158.11.1871
18. Krause-Utz A, Erol E, Brousianou AV, Cackowski S, Paret C, Ende G, Elzinga B. Self-reported impulsivity in women with borderline personality disorder: the role of childhood maltreatment severity and emotion regulation difficulties. *Borderline Personal Disord Emot Dysregul.* (2019) 6:6. doi: 10.1186/s40479-019-0101-8
19. Leiva-Murillo JM, López-Castromán J, Baca-García E, EURECA Consortium. Characterization of suicidal behaviour with self-organizing maps. *Comput Math Methods Med.* (2013) 2013:136743. doi: 10.1155/2013/136743
20. Anestis MD, Soberay KA, Gutierrez PM, Hernández TD, Joiner TE. Reconsidering the link between impulsivity and suicidal behavior. *Pers Soc Psychol Rev.* (2014) 18:366–86. doi: 10.1177/1088868314535988
21. Mann JJ, Arango VA, Avenevoli S, Brent DA, Champagne FA, Clayton P, et al. Candidate endophenotypes for genetic studies of suicidal behavior. *Biol Psychiatry.* (2009) 65:556–63. doi: 10.1016/j.biopsych.2008.11.021
22. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders. 5th edn*. Arlington, VA: American Psychiatric Association. (2013).
23. First MB, Williams JBW, Karg RS, Spitzer RL. *Structured Clinical Interview for DSM-5 – Research Version (SCID-5 for DSM-5, Research Version, SCID-5RV)*. Arlington, VA: American Psychiatric Association. (2015).
24. World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. *JAMA.* (2013) 310:2191–4. doi: 10.1001/jama.2013.281053
25. García-Nieto R, Parra Uribe I, Palao D, López-Castroman J, Sáiz PA, García-Portilla MP, et al. Protocolo breve de evaluación del suicidio, fiabilidad interexaminadores. *Rev Psiquiatr Salud Mental.* (2012) 5:24–36. doi: 10.1016/j.rpsm.2011.10.001
26. Hamilton M. A rating scale for depression. *J Neurol Neurosurg Psychiatr.* (1960) 23:56–62.
27. Bobes J, Bulbena A, Luque A, Dal-Ré R, Ballesteros J, Ibarra N, et al. A comparative psychometric study of the Spanish versions with 6, 17, and 21 items of the hamilton depression rating scale. *Med Clin*. (2003) 120:693–700. doi: 10.1016/s0025-7753(03)73814-7
28. Posner K, Brown GK, Stanley B, Brent DA, Yershova KV, Oquendo MA, et al. The Columbia-Suicide Severity Rating Scale: initial validity and internal consistency findings from three multisite studies with adolescents and adults. *Am J Psychiatry*. (2011) 168:1266–77. doi: 10.1176/appi.ajp.2011.10111704
29. Al-Halabí S, Sáiz PA, Burón P, Garrido M, Benabarre A, Jiménez E, et al. Validation of a Spanish version of the Columbia-Suicide Severity Rating Scale (C-SSRS). *Rev Psiquiatr Salud Ment.* (2016) 9:134–42. doi: 10.1016/j.rpsm.2016.02.002
30. Patton JH, Stanford MS, Barratt ES. Factor structure of the Barratt impulsiveness scale. *J Clin Psychol.* (1995) 51:768–74.
31. Oquendo MA, Baca-Garcia E, Graver R, Morales M, Montalban V, Mann JJ. Spanish adaptation of the Barratt Impulsiveness Scale (BIS). *Eur J Psychiatry*. (2001) 15:147–55. doi: 10.1016/j.ijchp.2015.07.002
32. Bernstein DP, Stein JA, Newcomb MD, Walker E, Pogge D, Ahluvalia T, et al. Development and validation of a brief screening version of the Childhood Trauma Questionnaire. *Child Abuse Negl.* (2003) 27:169–90. doi: 10.1016/s0145-2134(02)00541-0
33. Hernandez A, Gallardo-Pujol D, Pereda N, Arntz A, Bernstein DP, Gaviria AM, et al. Initial validation of the Spanish childhood trauma questionnaire-short form: factor structure, reliability and association with parenting. *J Interpers Violence*. (2013) 28:1498–518. doi: 10.1177/0886260512468240
34. Brugha T, Bebbington P, Tennant C, Hurry J. The list of threatening experiences: a subset of 12 life event categories with considerable long-term contextual threat. *Psychol Med*. (1985) 15:189–94.
35. Motrico E, Moreno-Kustner B, de Dios Luna J, Torres-Gonzalez F, King M, Nazareth I, et al. Psychometric properties of the List of Threatening Experiences–LTE and its association with psychosocial factors and mental disorders according to different scoring methods. *J Affect Disord.* (2013) 150:931–40. doi: 10.1016/j.jad.2013.05.017
36. Hayes AF. *Introduction to Mediation, Moderation, and Conditional Process Analysis, 2nd edn*. New York, NY: The Guilford Press (2017).
37. Preacher KJ, Hayes AF. SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behav Res Method Instr Comput.* (2004) 36:717–31. doi: 10.3758/BF03206553
38. Hayes AF. *PROCESS Documentation Addendum*. (2019) Available online at: http://afhayes.com/public/v3docadd.pdf (accessed February 19, 2020).
39. Jones TM, Nurius P, Song C, Fleming CM. Modeling life course pathways from adverse childhood experiences to adult mental health. *Child Abuse Negl.* (2018) 80:32–40. doi: 10.1016/j.chiabu.2019.104237
40. Murgatroyd C, Spengler D. Epigenetics of early child development. *Front Psychiatry*. (2011) 2:16. doi: 10.3389/fpsyt.2011.00016
41. Alyamani RAS, Murgatroyd C. Epigenetic programming by early-life stress. *Prog Mol Biol Transl Sci.* (2018) 157:133–50. doi: 10.1016/bs.pmbts.2018.01.004
42. Manyema M, Norris SA, Richter LM. Stress begets stress: the association of adverse childhood experiences with psychological distress in the presence of adult life stress. *BMC Public Health.* (2018) 18:835. doi: 10.1186/s12889-018-5767-0
43. Pearlin LI, Schieman S, Fazio EM, Meersman SC. Stress, health, and the life course: some conceptual perspectives. *J Health Soc Behav*. (2005) 46:205–19. doi: 10.1177/002214650504600206
44. Shrira A. The effect of lifetime cumulative adversity on change and chronicity in depressive symptoms and quality of life in older adults. *Int Psychogeriatr.* (2012) 24:1988–97. doi: 10.1017/S1041610212001123
45. Turner HA, Butler MJ. Direct and indirect effects of childhood adversity on depressive symptoms in young adults. *J Youth Adolesc.* (2003) 32:89–103. doi: 10.1023/A:1021853600645
46. Nurius PS, Green S, Logan-Greene P, Borja S. Life course pathways of adverse childhood experiences toward adult psychological well-being: a stress process analysis. *Child Abuse Negl.* (2015) 45:143–53. doi: 10.1016/j.chiabu.2015.03.008
47. Raposa EB, Hammen CL, Brennan PA, O'Callaghan F, Najman JM. Early adversity and health outcomes in young adulthood: the role of ongoing stress. *Health Psychol.* (2014) 33:410–8. doi: 10.1037/a0032752
48. Jiménez-Treviño L, Saiz PA, García-Portilla MP, Blasco-Fontecilla H, Carli V, Iosue M, et al. 5-HTTLPR-brain-derived neurotrophic factor (BDNF) gene interactions and early adverse life events effect on impulsivity in suicide attempters. *World J Biol Psychiatry.* (2019) 20:137–49. doi: 10.1080/15622975.2017.1376112
49. Roy A. Childhood trauma and impulsivity. Possible relevance to suicidal behaviour. *Arch Suicide Res.* (2005) 9:147–51. doi: 10.1080/13811110590903990
50. Pardo A, Román M. Reflections on the Baron and Kenny model of statistical mediation. *Ann Psychol.* (2013) 29:614–23. doi: 10.6018/analesps.29.2.139241
51. Raposo SM, Mackenzie CS, Henriksen CA, Afifi TO. Time does not heal all wounds: older adults who experienced childhood adversities have higher odds of mood, anxiety, and personality disorders. *Am J Geriatr Psychiatry.* (2014) 22: 1241-50. doi: 10.1016/j.jagp.2016.07.019

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REVIEW
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Reviewing a Decade of Research Into Suicide and Related Behaviour Using the South London and Maudsley NHS Foundation Trust Clinical Record Interactive Search (CRIS) System

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Suicide is a serious public health issue worldwide, yet current clinical methods for assessing a person's risk of taking their own life remain unreliable and new methods for assessing suicide risk are being explored. The widespread adoption of electronic health records (EHRs) has opened up new possibilities for epidemiological studies of suicide and related behaviour amongst those receiving healthcare. These types of records capture valuable information entered by healthcare practitioners at the point of care. However, much recent work has relied heavily on the structured data of EHRs, whilst much of the important information about a patient's care pathway is recorded in the unstructured text of clinical notes. Accessing and structuring text data for use in clinical research, and particularly for suicide and self-harm research, is a significant challenge that is increasingly being addressed using methods from the fields of natural language processing (NLP) and machine learning (ML). In this review, we provide an overview of the range of suicide-related studies that have been carried out using the Clinical Records Interactive Search (CRIS): a database for epidemiological and clinical research that contains de-identified EHRs from the South London and Maudsley NHS Foundation Trust. We highlight the variety of clinical research questions, cohorts and techniques that have been explored for suicide and related behaviour research using CRIS, including the development of NLP and ML approaches. We demonstrate how EHR data provides comprehensive material to study prevalence of suicide and self-harm in clinical populations. Structured data alone is insufficient and NLP methods are needed to more accurately identify relevant information from EHR data. We also show how the text in clinical notes provide signals for ML approaches to suicide risk assessment. We envision increased progress in the decades to come, particularly in externally validating findings across multiple sites and countries, both in terms of clinical evidence and in terms of NLP and machine learning method transferability.

Keywords: electronic health records, natural language processing, machine learning, suicide attempted, suicide completed, self-injurious behaviour

INTRODUCTION

Suicidality Research Prior to CRIS

Prior to the introduction of electronic health records (EHRs), the study of suicidality in Camberwell, the southeast London catchment area served by King's College Hospital, was undertaken by paper case note review, for example of all referrals to a self-harm team over a 6 month period (1). Data was painstakingly extracted and checked from each consecutive referral to ensure they fitted written criteria and in the Neeleman et al. (1) study a single research question about ethnic differences was posed.

Later, when Dutta et al. (2–4) were trying to determine the epidemiology of completed suicides in a clinically representative cohort of patients experiencing their first episode of psychosis over a 40-year inception period, it was imperative that diagnostic consistency was stringent. They achieved this by amalgamating the Camberwell Cumulative Psychiatric Case Register for the period between January 1, 1965, and December 31, 1983 (5), and then for the period between January 1, 1984, and December 31, 2004, using the basic hospital computer records held at the time with structured fields, to generate a list of all patients admitted with any possible psychotic illness (according to ICD-9 and ICD-10 codes). They then used the information gleaned from reading through the paper case records of all these patients, including medical, nursing, social work, and occupational therapy notes, together with all correspondence relating to the year after each patient's first presentation to complete the Operational Checklist for Psychotic Disorders (OPCRIT) (6). This is a well-validated symptom checklist which enabled operational research diagnostic criteria (RDC) (7) computer diagnoses to be made using the OPRCIT program.

This methodology meant inclusion in the cohort was clearly and consistently defined, and the outcome of deaths by suicide and open verdicts up until March 31, 2007 according to the International Classification of Diseases (ICD) was identified by a direct case-tracing procedure with the Office for National Statistics (ONS) for England and Wales and the General Register Office (GRO) for Scotland. This enabled the study of early risk factors for suicide in the cohort (3) and also studies of both unnatural and natural causes of mortality in first episode psychosis patients (4).

OPCRIT+ (a redesigned version of OPCRIT for use in clinical settings with an expanded number of objectively rated items) facilitated access to structured symptom information entered by clinicians to generate diagnoses including "suicidal ideation" but not self-harm (8), limiting its application for the study of self-harm and suicidal behaviour. However, another more cogent reason for it not being as useful as hoped was "clinicians may feel that these documents are overly prescriptive and restrict their clinical freedom." There was "disgruntlement amongst the clinicians using the form; extra time on 'paperwork' is rarely popular" (9) and the OPCRIT+ remains a research tool to obtain "gold standard" research diagnoses, e.g., (10).

Why EHRs and CRIS?

The widespread adoption of EHRs has meant that large-scale clinical data are now available for clinical research, although researchers have to contend with the large volume, complexity and heterogeneity of these "big data" resources. Typical EHR systems store patient data in both structured fields and as unstructured text (as well as other media types, such as medical images). Structured data fields, such as drop-down menus, forms and checkboxes, tend to be made available to clinical practitioners as a means to directly encode patient diagnoses, assessment results, etc. in a predetermined format. However, rates of completion can vary. Unstructured text entry allows for more nuanced documentation, providing context to assessments, patient status, and other information pertinent to the clinical interaction. The availability of these electronic health data has greatly facilitated mental health research. Investigators can now use EHRs to gather data about clinical populations, identify participants for clinical trials, carry out retrospective case-control studies, develop and trial predictive models, and guide the implementation of evidence-based practices (11, 12).

In 2008, the South London and Maudsley National Health Service (NHS) Foundation Trust Biomedical Research Center (SLaM BRC) developed the Clinical Record Interactive Search (CRIS) application. Since 2008, CRIS became an extensive UK-based repository of anonymised, structured and free-text data derived from the EHR system used by SLaM [See (13) for further details]. Under a strict governance model, CRIS has provided secure access to the de-identified records of all those patients in contact with SLaM services. SLaM provides comprehensive mental health services to an ethnically and socioeconomically diverse population of over 1.2 million residents of all ages, covering four inner city and suburban London boroughs — Croydon, Lambeth, Lewisham and Southwark. SLaM also provides highly specialist services which treat patients from across the UK. SLaM CRIS has been the UK exemplar for all NHS Mental Health Trusts, providing an approach for transforming the electronic health record into a data asset and research tool. The SLaM based CRIS system has been replicated in 12 NHS Trusts across the UK[1] capturing over 2.6 million patients.

CRIS provides unprecedented information on mental disorders and outcomes in routine clinical care at scale, particularly through enhancements from the use of natural language processing (NLP) to extract previously inaccessible information, ranging from patients' cognitive function, smoking status and education, to antipsychotic medication profiles and substance misuse (14), as well as linkages to external data sources such as national mortality data from the ONS (15), education data (National Pupil Database) (16), and Hospital Episode Statistics (HES) (17). CRIS has also allowed smaller-scale linkages, such as SHIELD, a service improvement project investigating self-harm at the emergency departments of two major London hospitals (18).

The availability of this type of large-scale data heralds the prospect of using statistical and data science approaches to analyse larger cohorts and better understand how these behaviours manifest in healthcare settings (19). However, using these data also presents major challenges, as much of the key clinical information, including suicidal behaviour, is recorded as unstructured clinical case notes and correspondence (20–22).

[1] See https://crisnetwork.co/uk-cris-programme

Over the last 10 years, researchers have used CRIS to conduct a number of epidemiological studies to examine suicidal behaviours across a range of mental health conditions (e.g., autism, psychotic disorders), and demographic groups (e.g., adults, children and adolescents, pregnant women). Methodologies have evolved, improving the accuracy of identifying suicidality-related constructs and predictive models of suicide risk. In the following sections, we review the evidence generated from CRIS on suicidal behaviours, the NLP methods used, and the value of the resulting cohorts and datasets created.

IDENTIFICATION AND PREVALENCE ESTIMATES OF SUICIDALITY IN CRIS CLINICAL POPULATIONS

Suicide-related behaviour is the manifestation of a complex set of phenomena that depend on many contextual factors which can change quickly from 1 day to another. Completed suicide remains relatively rare, meaning that tools to assess suicide risk must have a high predictive validity to be of use in a clinical setting (23). Accurate identification of suicide-related behaviour is, therefore, both highly challenging and of prime importance in determining prevalence of suicidal behaviour in clinical populations, and for the development of risk models. While the earliest studies on suicide and related behaviour in CRIS relied on structured fields and mortality data linkages to identify cohorts, increasing efforts have focussed on using NLP to identify suicidality-related concepts in the high volume of unstructured clinical text held in the database. The task of automatically identifying mentions of suicidal behaviour in clinical notes is complicated by the necessity to distinguish actual events relating to the patient from negated mentions, behaviour reported as family history, or those that are recorded with a degree of uncertainty (24). Furthermore, given the inherent variation across clinical populations, which is reflected in the language used in clinical reporting, NLP tools developed for one clinical subpopulation, such as working age adults, may not be reliably transferable to another group, such as school age children, without adaptation. NLP systems used to identify suicide-related constructs in clinical notes must, therefore, be developed for and validated within each target population.

A wide range of known risk and contributory factors are associated with suicide, with symptoms of mental illness being recognisable in more than 85% of people who die by suicide, according to psychological autopsy interviews with family, friends and medical professionals (25, 26). Over the last 10 years, research using CRIS has been conducted to examine the associations of self-harm, suicidality and death by suicide with mental health conditions and a broad range of situational factors, from homelessness to drug misuse to limited service continuity (27–29). As we describe in our summary below, initial studies on suicide and related behaviour in CRIS used structured fields held within standard assessment forms or diagnostic codes. Progressively, researchers began to make use of CRIS's free-text fields and search functionalities, while more recently, NLP techniques have been employed to extract and structure suicide-related information from within the case notes. The principal characteristics of the clinical cohorts mentioned in this review are summarised in **Table 1**.

Using Structured Data

Suicidality Outcome Data

The Health of the Nation Outcome Scales (HoNOS) were introduced in 1996, to measure the health and social functioning of people with mental illness. Within SLaM, as with most UK mental health trusts, clinicians are expected to complete HoNOS for all patients receiving care. The non-accidental self-injury item on the HoNOS score has been shown to be the only individual item associated with higher mental health service costs (37). It has been used in a number of studies in CRIS to assess both the direct and indirect impact of self-harm. The individual non-accidental self-injury HoNOS item has been included as a covariate in a number of analyses of adverse outcomes within CRIS. These include homelessness and length of hospital stay for psychiatric inpatients (27), functional status and mortality in serious mental illness (38), facilitated discharge and bed days (39), and the effects of clozapine on premature mortality (15). When assessing self-harm as a potential risk factor for mortality among patients with personality disorder, the HoNOS item was again used in isolation as a marker of self-harm risk (40). Despite the provision of optional structured questionnaires on CRIS, such as the Patient Health Questionnaire-9 (PHQ-9) (whose final item enquires about thoughts of self-harm and suicide) and the Beck Scale for Suicide Ideation (BSS), very few are completed in general clinical work where free-text input is favoured by clinicians, making them of limited value for studies of real-world clinical cohorts. Conversely local NHS Trust requirements to complete structured suicide risk assessments for all patients means this data is better recorded and has been studied.

Suicide Risk Assessment Data

Structured suicide and violence risk assessments in mental health services has been shown to have low predictive accuracy for all-cause mortality (30), however these assessments have continued to be used in clinical practice. Lopez-Morinigo et al. examined the use of risk assessment proforma for their investigation into suicide completion in secondary mental health care. The risk proforma, which clinicians were expected to use at that time according to local clinical policy, consisted of present/absent tick boxes for factors including suicidal history, suicidal ideation and alcohol misuse. They found that patients with a diagnosis other than schizophrenia spectrum disorder who had died by suicide, were much less likely than patients with schizophrenia to either have had a full risk assessment or a complete HoNOS even though they showed increased frequency and greater predictability in key suicide risk assessment factors: suicidal ideation, hopelessness, impulsivity and significant loss (29). In their later study, they found structured risk assessment relating to suicide in schizophrenia spectrum disorders to be of little use in predicting completed suicide, with risk assessments fully completed in only 43.6% of patients who had died by suicide

TABLE 1 | Summarised characteristics of clinical cohorts created using CRIS for the study of suicide and related behaviour.

Study	Clinical group	Population size	Number of events	Age	Date range	Method to identify suicide and related behaviour
Polling et al. (18)	Adults attending ED	7,444	10,688 ED attendances	N/A	01/04/2009–31/12/2011	ICD-10 codes X60-X84, presence of keywords related to self-harm, suicide attempts and suicidality
Bogdanowicz et al. (28)	Patients with opioid use disorder	5,335	N/A	15–73 years Mean (SD) = 37.6 (9.07) years	01/04/2008–31/03/2014	ICD-10 codes X409-X450, Y120, Y125, F119[†]
Lopez-Morinigo et al. (30)	Patients with schizophrenia spectrum disorder	426 (71 cases, 355 controls)	N/A	Mean (SD) = 44.9 (18.0) years	01/01/2007–31/12/2013	ICD-10 codes X64, X70, X71, X78, X80, X81, X84, Y10-34
Lopez-Morinigo et al. (31)	Patients accessing secondary mental healthcare	13,758	N/A	Mean (SD) = 41.3 (12.2) for suicide, 40.6 (11.5) for no suicide	01/01/2007–01/04/2015	ICD-10 codes X64, X70, X71, X78, X80, X81, X84, Y10-34
Roberts et al. (32)	Individuals with chronic fatigue syndrome	2,147	N/A	Mean = 39.1 years	01/01/2007–31/12/2013	ICD-10 codes X60-X84
Taylor et al. (33)	Perinatal women with SMI	420	N/A	Mean (SD) = 31.9 (6.2) years	01/01/2007–31/12/2011	Presence of keywords [from (18)] related to self-harm, suicide attempts and suicidality
Downs et al. (34)	Children and adolescents with ASD	1,906	N/A	14–18 years	01/01/2008–31/12/2013	NLP, manual classification of suicidality-related expressions
Velupillai et al. (35)	Adolescents attending CAMHS	23,455	N/A	11–17 years	01/04/2009–31/03/2016	Manual annotation of suicidality-related expressions, NLP
Bittar et al. (36)	Patients accessing secondary mental healthcare	17,640 (2,913 cases, 14,727 controls)	21,175 admissions (4,235, cases, 16,940 controls)	Mean (SD) = 33.7 (15.6) years	02/04/2006–31/03/2017	X6*, X7*, X80-4*, Y1*, Y2*, Y30-4*, Y87*

[†] *Due to indeterminacy of intent, suicide by overdose and fatal drug poisonings are grouped together. *indicates all codes that begin with the given sequence.*

(30). Subsequent work revealed a limited role for structured risk assessment, especially in its usefulness in revealing more nuanced factors relevant to suicide risk such as "mental pain" (31). They suggest that research should "switch the focus from long-term risk factors to short-term risk algorithms, which are more relevant to the clinician."

Suicide Mortality Data

Research into mortality, including death by suicide, has typically utilised ICD-10 diagnostic codes (which must be completed as part of clinical assessment), linked with outcome data from the Office for National Statistics, ONS (15, 41). In a retrospective cohort study, Roberts et al. (32) used CRIS to investigate the mortality of individuals in secondary and tertiary care who had been diagnosed with chronic fatigue syndrome (CFS). Although all-cause mortality for people with CFS was not significantly different to that of the general population, there was a significantly elevated risk of completed suicide. CRIS has also been used to conduct a number of pharmaco-epidemiological studies, for example [Hayes et al. (15)] examined the risk or potential risk mitigation of psychopharmacological interventions on death by suicide in patients with serious mental illness (including schizophrenia, schizoaffective and bipolar disorders). Findings of this study demonstrated treatment with the medication clozapine was associated with a reduction in risk of death by unnatural causes, including suicide, as well as natural causes.

Using Unstructured Data

Free-Text Keywords to Study Self-Harm Presentations to Emergency Departments

Polling et al. (18) used external data linkages in combination with CRIS data (including keywords recorded in free-text fields) to create a novel dataset for the study of self-harm, which is strongly associated with mental health disorders, and is the strongest single risk factor for future suicide. In England, population-level assessment of self-harm is recorded in the Hospital Episode Statistics (HES) database. However, many emergency department attendances, namely those that do not lead to a hospital admission, still go unrecorded in HES, and completion of the reason for presentation is low, thus limiting the value of this data source for studies of self-harm presentations. Polling et al. addressed these shortcomings by combining routinely collected data from electronic health records in CRIS and HES. They validated their data against another dataset curated through manual review of emergency department notes and audit forms, also compiling a list of self-harm search terms.

Free-Text Keywords to Study Perinatal Self-Harm in Women With Psychiatric Disorders

Using the self-harm-related terms identified by Polling et al. (18) and Taylor et al. (33) investigated the prevalence and risk factors of self-harm and suicide ideation in women with psychotic disorders and bipolar disorder during pregnancy. They identified a cohort of 420 patients by performing a free-text search of CRIS records for both suicidal ideation and self-harm. The perinatal period is generally associated with lower risk of both suicide and self-harm in the general population, however, women diagnosed with severe postpartum psychiatric disorders are up to 70 times more at risk of suicide. In Taylor et al.'s cohort, 24.3% of women had a report of suicidal ideation and 7.9% had a recorded self-harm event during their index pregnancy.

Free-Text Keywords to Study Self-Harm and Human Trafficking

In a further study using the free-text search capabilities of CRIS, Borschmann et al. (42) carried out an analysis of self-harm among victims of human trafficking. They identified patients for their cohort by searching the CRIS free-text notes for terms indicating possible trafficking (e.g., "victim of trafficking," "sex trafficking," "trafficked"). In the same way, documents were screened for mentions of self-harm behaviour using a list of terms including "self-harm," "DSH," "burn*" and "electrocut*." They found that 33% of all trafficked patients had engaged in self-harm prior to care, while 25% did so during care. After self-harming, trafficked patients were subsequently more likely to be admitted to a ward than those who had not been victims of human trafficking. After self-harming, trafficked patients were more likely than non-trafficked patients to be admitted as a psychiatric inpatient, but less likely to attend an emergency department.

Using Natural Language Processing (NLP)

The first approaches that were developed to process CRIS data were pattern matching approaches to identify certain pieces of information (e.g., medication, smoking status, substance misuse) using the GATE framework (43). In many cases, the information of interest is a particular clinical construct (e.g., hallucinations, echolalia) or a specific diagnosis. A bespoke application, called TextHunter (14), was developed for these types of constructs. TextHunter is a software application that requires a set of manually pre-annotated examples to train a supervised machine learning classifier (Support Vector Machine). These NLP applications identify and classify the relevant constructs and produce structured variables indicating their presence or absence within the texts. These structured variables are stored in table columns in the CRIS database. Researchers may access these variables (along with the "standard" structured fields – e.g., diagnosis codes, demographic information, dates – from the EHR) through the SQL interface of the CRIS database to identify cohorts of patients for epidemiological studies and clinical research. Several studies cited herein have made use of these structured variables (28, 32, 36).

In addition to these "integrated" NLP applications, clinicians have worked alongside NLP researchers to develop custom NLP tools to identify suicide-related constructs in specific population samples within CRIS. As we have seen, the focus of most work has been the epidemiology and prevalence of suicidal behaviour, with NLP tools that use both rule-based (35, 44) and machine learning paradigms (45), including neural network architectures (46). Most recently, efforts have also been made to model dynamic suicide risk using supervised machine learning (36).

Study of Mortality in Opioid Use Disorder Patients Using NLP to Identify Cohorts

Using data from CRIS with an external linkage to ONS mortality data, Bogdanowicz et al. (28) investigated the effectiveness of addiction-specific clinical risk assessments for identifying groups with high mortality in opioid use disorder (OUD). Patients with a diagnosis of OUD were identified by ICD-10 code F11. ICD-10 diagnosis was supplemented with structured output of one of the CRIS NLP tools that identifies diagnoses in unstructured clinical notes. Overdose (both accidental and intentional) was the most common cause of death and clinically assessed suicidality was found to be significantly associated with increased overdose mortality.

NLP to Identify Suicide-Related Behaviour

Today, with the increasing body of research on suicide and related behaviour in CRIS, and a diversity of clinical population groups under study, has come a need to develop more targeted methods of accessing the suicide-related data within the unstructured clinical narratives. NLP systems designed for this task need to identify the different types of suicide-related behaviour (suicide attempt, suicidal ideation, self-harm, etc.) and account for the linguistic variation that indicates whether a mention is attested, negated or uncertain, is relevant to the patient, or a family member, and so on. These considerations have spurred on the recent development of bespoke NLP tools. For example, Gkotsis et al. (44) developed an NLP system specifically designed to detect whether a suicide-related concept is negated or not. This system was developed and evaluated on a random sample of clinical notes from CRIS. In a more recent study, Fernandes et al. (45) developed two NLP approaches to detect relevant mentions of suicidal ideation and another to identify recorded suicide attempts.

NLP Features to Identify Key Suicide Risk Periods

Identifying periods during which a patient is at elevated risk of making a suicide attempt is key to enabling timely intervention. However, information available to clinicians concerning the rapidly changing dynamic factors leading up to a suicide attempt has been limited. Bittar et al. (36) explored whether it is possible to use EHRs to automatically predict suicide attempts in a broad clinical population (across all age groups) using only data from a relatively short period of 30 days leading up to an event. This work was based on the hypothesis that periods prior to a suicide attempt are a time of acute crisis that is reflected, explicitly or implicitly, in clinician records,

making these periods distinguishable from periods not preceding an attempted suicide. Combining all three features of (1) structured data from EHRs, (2) structured values extracted by NLP software, and (3) vectorised bag-of-words of all documents provided the best model to classify or distinguish between "document windows" prior to a suicide attempt or not. Thus, the features were found to be complementary in this study.

NLP to Study Suicidal Behaviour in Children and Adolescents

The risk and conceptualisation of suicidal behaviour for children and adolescents can be different to adults (47). Downs et al. (34) conclude that the clinician notes on suicidal risk in children and adolescents are different to an adult review. For example, clinicians may have a greater reliance on third person report, where caregivers voice concerns regarding the young person's suicidality. It is also possible that suicidality is "discovered" rather than being the presenting complaint, hence changing the emphasis and position of suicide-related text/progress notes within the young person's clinical record.

Adolescence is associated with a high risk of suicide and self-harm compared to most other age groups, but few studies have examined the prevalence of suicidal behaviour in large adolescent patient cohorts. Downs et al. (34) first used CRIS to explore suicidality in young people but focussed on a population with autism spectrum disorders (ASD), who have shown much greater risk of suicidal behaviours than neurotypically developing children. A cohort of young people diagnosed with ASD were identified and NLP techniques were used to identify suicidal behaviour from the clinical notes in CRIS. Their corresponding free-text notes (progress reports, medical correspondence, risk assessments, etc.) were manually annotated for mentions of suicidality by clinical researchers. A prevalence analysis of suicidality in a sample of the data showed that only 3% of all documents mentioned suicide-related information.

Using a subset of this cohort, Holden et al. (48) used a historical cohort design and applied NLP approaches to extract information on victimisation by bullying and suicidal behaviour. They found those young people with ASD who were bullied were nearly twice as likely to report later suicidal ideation. The dataset created by Downs et al. has also recently proven useful to train machine learning models for use in suicide research. Song et al. (46) used a revised version of the data to develop a deep neural network classifier that identifies sentences containing positive mentions of suicidality while taking into account the contextual information in surrounding sentences. This type of approach provides an alternative to modelling suicide-related information from text that better takes into account the narrative discourse in the clinical documentation.

Velupillai et al. (19) developed and validated a method for identifying suicidality across a more heterogenous clinical adolescent population in EHRs using NLP, expanding the population beyond ASD. They examined 1,601,422 documents from 23,455 young people and developed a method to accurately identify suicidal behaviour information in a very broad clinical population. The resulting dataset and NLP approaches used, provide a powerful example of how NLP approaches can be used to rapidly examine the prevalence of suicidal behaviour in very large adolescent clinical populations.

NLP to Study Depression and Suicidality in Older Adults

Free-text mentions of depressive symptoms were used as outcome measures in the assessment of later-life depression in people from ethnic minorities by Mansour et al. (49). This study used NLP tools designed to detect depressive symptoms recorded in unstructured texts in CRIS, including the identification of mentions of suicidal ideation. These depressive symptom NLP tools, developed to account for the presence of contextual markers such as negation and irrelevant concepts, were also used by Cai et al. (50) in their investigation into predictors of mortality in people with late life depression.

THE NEXT TEN YEARS?

Although EHR data are not created for research purposes, they provide a rich resource for large-scale retrospective research, allowing identification of diverse and comprehensive clinical study samples. One of the main challenges in suicide research is obtaining sufficiently large study samples to study an outcome with a high enough base rate for predictive modelling to have a meaningful positive predictive value. The low base rate of completed suicide limits the predictive value of any model, whether established statistical techniques or machine learning (51), but related behaviours, such as suicidal ideation, intention, planning and self-harm can be studied. Over the past 10 years, CRIS has provided an unprecedented resource for studying suicide and related behaviour in a UK clinical population to an extent that would not have been possible before the introduction of EHRs. The development and implementation of this type of resource is an incredibly valuable investment, which should be encouraged.

One avenue of research being pursued in CRIS is comparison of suicide-related phenomenon over a span of time, within the same hospital trust culture, but where mandatory changes have occurred with regards to how assessments are made and recorded. The focus on a single mental health trust for a review opens the opportunity for a different set of more detailed analyses than a review that covers multiple sites (52).

Furthermore, EHRs reflect real-world clinical practice. This means that the context of how, for example, structured risk assessment tools and other schedules, like HoNOS, are used in daily clinical work needs to be well understood when including them as variables in clinical research studies. Most of the relevant information is found in the free text, and appropriate NLP solutions are key components for enabling risk modelling.

Looking to the future, replication studies of work based on SLaM CRIS, including the developed NLP applications, across other EHR systems and in other clinical catchment areas would provide insights into the generalisability of these particular models to new clinical settings. However, the portability of these NLP applications needs further scrutiny. The studies in this review all have developed their methodologies from the same CRIS system; clinical text may have higher internal homogeneity (e.g., in terminology) with respect to other CRIS systems based in other health districts. Testing the generalisability of the NLP tools described in this review across other health organisations is essential and has only just begun. As described earlier, CRIS has also been implemented in other sites across the UK. On example is the Camden & Islington Research Database (53), which has proved a useful starting point for comparison with SLaM CRIS as the data reflects a similar healthcare organisation with socio-demographic and geographic similarities, i.e., represents a comparable, but not identical, urban population.

Other studies using EHR data for suicide-related research range from those that use rule-based approaches to e.g., estimate the use of diagnostic codes vs. information recorded in free text broadly in EHR data (21) or to monitor suicidal patients in primary care (20), to studies using more advanced ML and NLP approaches for e.g., psychiatric readmission risk prediction using inpatient psychiatric discharge summaries where suicidality could be an important risk factor (54), for automated epidemiological surveillance of suicide attempts in emergency departments in France (22), or for estimating risk of death by suicide after discharge (55). Findings from these studies are, however, currently difficult to compare, as the underlying populations, healthcare settings, EHR systems, and data-driven approaches differ.

Furthermore, given the inherent variation across clinical populations, which is reflected in the language used in clinical reporting, NLP tools developed for one clinical subpopulation, such as working age adults, may not be reliably transferable to another group, such as school age children, without adaptation. NLP systems used to identify suicide-related constructs in clinical notes must, therefore, be developed for and validated within each target population. The same principle applies for the application of NLP tools across institutions and EHR systems. The studies in this review all use data from the same system, CRIS, for which language is likely to show a certain level of internal homogeneity (e.g., in terminology) with respect to other systems. Testing the generalisability of the NLP tools described below in this review has only just started.

When also including free text and NLP models, as mentioned above, the extent to which internal homogeneity (e.g., in terminology) impacts results across different institutions and clinical settings, is an area well worth further studies to further advance this field and provide evidence about the broader generalisability of findings. The culture, incentives, and structure of clinical systems outside of the UK may induce further differences between the signals of NLP systems for detecting discussion of suicide. Collaborative efforts are currently being made to compare methodologies and NLP tools across healthcare institutions not just within the UK, but also with collaborators in the USA. We envision advances in ML and NLP methods, standards for interoperability, and infrastructures to enable such comparisons in the future.

Furthermore, advances in computational analysis of EHR data, e.g., machine learning in combination with NLP, will continue to develop, and provide novel solutions to suicide research (56). With the existing CRIS subsets, clinical cohorts, and NLP approaches developed for the studies described in this review, benchmarks have been created that allow for appropriate comparisons between different methodologies.

Going beyond identification or prediction of those at risk, analysis of continuously collected data, and integration of EHR data with smartphone, wearable device and even social media data could allow collection of data across different time periods, not just at the time of clinical interactions, thus helping to understand suicidal crises and enabling delivery of targeted suicide prevention interventions (57).

SUMMARY AND CONCLUSION

In this review of a decade of research into suicide and related behaviour using CRIS we have summarised the evolution of different methods employed to identify suicide and related behaviour, including linkages to mortality data, structured ICD-10 codes, manual review of clinical notes, keyword searching in free text and relevant mentions identified using NLP techniques. Cohorts under study have varied in size from several hundred to tens of thousands of patients and have covered adult, elderly as well as child and adolescent patients. A range of clinical disorders have been described from the perspective of suicide and related behaviours, including pregnancy, severe mental illness and self-harm, opioid use disorder patients, chronic fatigue syndrome and autism spectrum disorders. Finally, some studies have identified and investigated specific clinical events, such as emergency department attendances or hospital admissions.

In conclusion, the breadth and depth of the research and findings of understanding suicide and related behaviour from this past decade using CRIS have accelerated the field in ways unthinkable prior to the availability of EHR data. These studies not only add to the clinical evidence base, but also reflect an important evolution of data-driven method applicability and development that is central to advancing this field further. We envision increased progress in the decades to come, particularly in externally validating findings across multiple sites and countries, both in terms of clinical evidence and in terms of NLP and machine learning method transferability.

GAINING ACCESS TO CRIS

The de-identified CRIS database has received ethical approval for secondary analysis: Oxford REC C, reference 18/SC/0372. The data is used in an anonymised and data-secure format under strict governance procedures. CRIS data is made available to researchers with appropriate credentials (provided by the

South London and Maudsley NHS Trust) working on approved projects. Projects are approved by a CRIS Oversight Committee, a body set up by and reporting to the South London and Maudsley Caldicott Guardian. On request, and after appropriate credentials have been obtained as well as arrangements with the lead of the respective CRIS project, data presented in this study can be viewed within the secure system firewall.

AUTHOR CONTRIBUTIONS

RD and SV proposed the manuscript and its contents. AB wrote the first draft of the manuscript and compiled data pertaining to study design, cohorts and NLP systems used in the cited literature, and incorporated edits by other authors. Each author contributed to specific sections of the manuscript: RD and SV on introductory and historical overviews: RS on use of structured data fields: JD on child and adolescent populations: AB and SV on natural language processing: RD, SV, and JD on perspectives and conclusions. All authors contributed to editing and revising the manuscript and approved the final version.

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REFERENCES

1. Neeleman J, Jones P, Van Os J, Murray RM. Parasuicide in Camberwell-ethnic differences. *Soc Psychiatry Psychiatr Epidemiol*. (1996) 31:284–7. doi: 10.1007/BF00787921
2. Dutta R, Murray RM, Hotopf M, Allardyce J, Jones PB, Boydell J. Reassessing the long-term risk of suicide after a first episode of psychosis. *Arch Gen Psychiatry*. (2010) 67:1230–7. doi: 10.1001/archgenpsychiatry.2010.157
3. Dutta R, Murray RM, Allardyce J, Jones PB, Boydell J. Early risk factors for suicide in an epidemiological first episode psychosis cohort. *Schizophr Res*. (2011) 126:11–9. doi: 10.1016/j.schres.2010.11.021
4. Dutta R, Murray RM, Allardyce J, Jones PB, Boydell JE. Mortality in first-contact psychosis patients in the UK: a cohort study. *Psychol Med*. (2012) 42:1649–61. doi: 10.1017/S0033291711002807
5. Castle D, Wessely S, Der G, Murray RM. The incidence of operationally defined schizophrenia in Camberwell, 1965–84. *Br J Psychiatry*. (1991) 159:790–4. doi: 10.1192/bjp.159.6.790
6. McGuffin P, Farmer A, Harvey I. A polydiagnostic application of operational criteria in studies of psychotic illness: development and reliability of the OPCRIT system. *Arch Gen Psychiatry*. (1991) 48:764–70. doi: 10.1001/archpsyc.1991.01810320088015
7. Spitzer RL, Endicott J, Robins E. Research diagnostic criteria: rationale and reliability. *Arch Gen Psychiatry*. (1978) 35:773–82. doi: 10.1001/archpsyc.1978.01770300115013
8. Rucker J, Newman S, Gray J, Gunasinghe C, Broadbent M, Brittain P, et al. OPCRIT+: an electronic system for psychiatric diagnosis and data collection in clinical and research settings. *Br J Psychiatry*. (2011) 199:151–5. doi: 10.1192/bjp.bp.110.082925
9. Lobo SEM, Rucker J, Kerr M, Gallo F, Constable G, Hotopf M, et al. A comparison of mental state examination documentation by junior clinicians in electronic health records before and after the introduction of a semi-structured assessment template (OPCRIT+). *Int J Med Inform*. (2015) 84:675–82. doi: 10.1016/j.ijmedinf.2015.05.001
10. Davis KAS, Bashford O, Jewell A, Shetty H, Stewart RJ, Sudlow CLM, et al. Using data linkage to electronic patient records to assess the validity of selected mental health diagnoses in English Hospital Episode Statistics (HES). *PLoS ONE*. (2018) 13:e0195002. doi: 10.1371/journal.pone.0195002
11. Casey JA, Schwartz BS, Stewart WF, Adler NE. Using electronic health records for population health research: a review of methods and applications. *Annu Rev Public Health*. (2016) 37:61–81. doi: 10.1146/annurev-publhealth-032315-021353
12. Castillo EG, Olfson M, Pincus HA, Vawdrey D, Stroup TS. Electronic health records in mental health research: a framework for developing valid research methods. *Psychiatr Serv*. (2015) 66:193–6. doi: 10.1176/appi.ps.201400200
13. Perera G, Broadbent M, Callard F, Chang C-K, Downs J, Dutta R, et al. Cohort profile of the South London and Maudsley NHS Foundation Trust Biomedical Research Centre (SLaM BRC) case register: current status and recent enhancement of an electronic mental health record-derived data resource. *BMJ Open*. (2016) 6:e008721. doi: 10.1136/bmjopen-2015-008721
14. Jackson RG, Patel R, Jayatilleke N, Kolliakou A, Ball M, Gorrell G, et al. Natural language processing to extract symptoms of severe mental illness from clinical text: the clinical record interactive search comprehensive data extraction (CRIS-CODE) project. *BMJ Open*. (2017) 7:e012012. doi: 10.1136/bmjopen-2016-012012
15. Hayes RD, Downs J, Chang C-K, Jackson RG, Shetty H, Broadbent M, et al. The effect of clozapine on premature mortality: an assessment of clinical monitoring and other potential confounders. *Schizophr Bull*. (2014) 41:644–55. doi: 10.1093/schbul/sbu120
16. Downs J, Ford T, Stewart R, Epstein S, Shetty H, Little R, et al. An approach to linking education, social care and electronic health records for children and young people in South London: a linkage study of child and adolescent mental health service data. *BMJ Open*. (2019) 9:e024355. doi: 10.1136/bmjopen-2018-024355
17. Chang C-K, Chen C-Y, Broadbent M, Stewart R, O'Hara J. Hospital admissions for respiratory system diseases in adults with intellectual disabilities in Southeast London: a register-based cohort study. *BMJ Open*. (2017) 7:e014846. doi: 10.1136/bmjopen-2016-014846
18. Polling C, Tulloch A, Banerjee S, Cross S, Dutta R, Wood DM, et al. Using routine clinical and administrative data to produce a dataset of attendances at emergency departments following self-harm. *BMC Emerg Med*. (2015) 15:15. doi: 10.1186/s12873-015-0041-6
19. Velupillai S, Hadlaczky G, Baca-Garcia E, Gorrell GM, Werbeloff N, Nguyen D, et al. Risk assessment tools and data-driven approaches for predicting and preventing suicidal behavior. *Front Psychiatry*. (2019) 10:36. doi: 10.3389/fpsyt.2019.00036
20. Anderson HD, Pace WD, Brandt E, Nielsen RD, Allen RR, Libby AM, et al. Monitoring suicidal patients in primary care using electronic health records. *J Am Board Fam Med*. (2015) 28:65–71. doi: 10.3122/jabfm.2015.01.140181

21. Haerian K, Salmasian H, Friedman C. Methods for identifying suicide or suicidal ideation in EHRs. *AMIA Annu Symp Proc*. (2012) 2012:1244−53.
22. Metzger M-H, Tvardik N, Gicquel Q, Bouvry C, Poulet E, Potinet-Pagliaroli V. Use of emergency department electronic medical records for automated epidemiological surveillance of suicide attempts: a French pilot study: text-mining and epidemiology of suicide attempts. *Int J Methods Psychiatr Res*. (2017) 26:e1522. doi: 10.1002/mpr.1522
23. Carter G, Milner A, McGill K, Pirkis J, Kapur N, Spittal MJ. Predicting suicidal behaviours using clinical instruments: systematic review and meta-analysis of positive predictive values for risk scales. *Br J Psychiatry*. (2017) 210:387–95. doi: 10.1192/bjp.bp.116.182717
24. Velupillai S, Suominen H, Liakata M, Roberts A, Shah AD, Morley K, et al. Using clinical natural language processing for health outcomes research: overview and actionable suggestions for future advances. *J Biomed Inform*. (2018) 88:11–9. doi: 10.1016/j.jbi.2018.10.005
25. Arsenault-Lapierre G, Kim C, Turecki G. Psychiatric diagnoses in 3275 suicides: a meta-analysis. *BMC Psychiatry*. (2004) 4:37. doi: 10.1186/1471-244X-4-37
26. Cavanagh JTO, Carson AJ, Sharpe M, Lawrie SM. Psychological autopsy studies of suicide: a systematic review. *Psychol Med*. (2003) 33:395–405. doi: 10.1017/S0033291702006943
27. Tulloch AD, Khondoker MR, Fearon P, David AS. Associations of homelessness and residential mobility with length of stay after acute psychiatric admission. *BMC Psychiatry*. (2012) 12:121. doi: 10.1186/1471-244X-12-121
28. Bogdanowicz KM, Stewart R, Chang C-K, Downs J, Khondoker M, Shetty H, et al. Identifying mortality risks in patients with opioid use disorder using brief screening assessment: secondary mental health clinical records analysis. *Drug Alcohol Depend*. (2016) 164:82–8. doi: 10.1016/j.drugalcdep.2016.04.036
29. Lopez-Morinigo J-D, Fernandes AC, Chang C-K, Hayes RD, Broadbent M, Stewart R, et al. Suicide completion in secondary mental healthcare: a comparison study between schizophrenia spectrum disorders and all other diagnoses. *BMC Psychiatry*. (2014) 14:213. doi: 10.1186/s12888-014-0213-z
30. Lopez-Morinigo J-D, Ayesa-Arriola R, Torres-Romano B, Fernandes AC, Shetty H, Broadbent M, et al. Risk assessment and suicide by patients with schizophrenia in secondary mental healthcare: a case–control study. *BMJ Open*. (2016) 6:e011929. doi: 10.1136/bmjopen-2016-011929
31. Lopez-Morinigo J-D, Fernandes AC, Shetty H, Ayesa-Arriola R, Bari A, Stewart R, et al. Can risk assessment predict suicide in secondary mental healthcare? Findings from the South London and Maudsley NHS Foundation Trust Biomedical Research Centre (SLaM BRC) Case Register. *Soc Psychiatry Psychiatr Epidemiol*. (2018) 53:1161–71. doi: 10.1007/s00127-018-1536-8
32. Roberts E, Wessely S, Chalder T, Chang C-K, Hotopf M. Mortality of people with chronic fatigue syndrome: a retrospective cohort study in England and Wales from the South London and Maudsley NHS Foundation Trust Biomedical Research Centre (SLaM BRC) Clinical Record Interactive Search (CRIS) Register. *Lancet*. (2016) 387:1638–43. doi: 10.1016/S0140-6736(15)01223-4
33. Taylor CL, van Ravesteyn LM, van denBerg MPL, Stewart RJ, Howard LM. The prevalence and correlates of self-harm in pregnant women with psychotic disorder and bipolar disorder. *Arch Womens Mental Health*. (2016) 19:909–15. doi: 10.1007/s00737-016-0636-2
34. Downs J, Velupillai S, Gkotsis G, Holden R, Kikoler M, Dean H, et al. Detection of suicidality in adolescents with autism spectrum disorders: developing a natural language processing approach for use in electronic health records. *Proc AMIA Annu Symp*. (2017) 641−9.
35. Velupillai S, Epstein S, Bittar A, Stephenson T, Dutta R, Downs J. Identifying suicidal adolescents from mental health records using natural language processing. In: *Proceedings of MEDINFO 2019: Health and Wellbeing e-Networks for All*. (2019). p. 413–7. Available online at: http://ebooks.iospress.nl/publication/52019 (accessed February 18, 2020).
36. Bittar A, Velupillai S, Roberts A, Dutta R. Text classification to inform suicide risk assessment in electronic health records. *Stud Health Technol Inform*. (2019) 264:40–4. doi: 10.3233/SHTI190179
37. Twomey C, Prina AM, Baldwin DS, Das-Munshi J, Kingdon D, Koeser L, et al. Utility of the health of the nation outcome scales (HoNOS) in predicting mental health service costs for patients with common mental health problems: historical cohort study. *PLoS ONE*. (2016) 11:e0167103. doi: 10.1371/journal.pone.0167103
38. Hayes RD, Chang C-K, Fernandes AC, Begum A, To D, Broadbent M, et al. Functional status and all-cause mortality in serious mental illness. *PLoS ONE*. (2012) 7:e44613. doi: 10.1371/journal.pone.0044613
39. Tulloch AD, Khondoker MR, Thornicroft G, David AS. Home treatment teams and facilitated discharge from psychiatric hospital. *Epidemiol Psychiatr Sci*. (2015) 24:402–14. doi: 10.1017/S2045796014000304
40. Fok ML-Y, Stewart R, Hayes RD, Moran P. Predictors of natural and unnatural mortality among patients with personality disorder: evidence from a large UK case register. *PLoS ONE*. (2014) 9:e100979. doi: 10.1371/journal.pone.0100979
41. Das-Munshi J, Chang C-K, Dutta R, Morgan C, Nazroo J, Stewart R, et al. Ethnicity and excess mortality in severe mental illness: a cohort study. *Lancet Psychiatry*. (2017) 4:389–99. doi: 10.1016/S2215-0366(17)30097-4
42. Borschmann R, Oram S, Kinner SA, Dutta R, Zimmerman C, Howard LM. Self-harm among adult victims of human trafficking who accessed secondary mental health services in England. *Psychiatr Serv*. (2017) 68:207–10. doi: 10.1176/appi.ps.201500509
43. Cunningham H, Tablan V, Roberts A, Bontcheva K. Getting more out of biomedical documents with GATE's full lifecycle open source text analytics. *PLoS Comput Biol*. (2013) 9:e1002854. doi: 10.1371/journal.pcbi.1002854
44. Gkotsis G, Velupillai S, Oellrich A, Dean H, Liakata M, Dutta R. Don't let notes be misunderstood: a negation detection method for assessing risk of suicide in mental health records. In: *Proceedings of the Third Workshop on Computational Lingusitics and Clinical Psychology*. (2016). p. 95–105.
45. Fernandes AC, Dutta R, Velupillai S, Sanyal J, Stewart R, Chandran D. Identifying suicide ideation and suicidal attempts in a psychiatric clinical research database using natural language processing. *Sci Rep*. (2018) 8:7426. doi: 10.1038/s41598-018-25773-2
46. Song X, Downs J, Velupillai S, Holden R, Kikoler M, Bontcheva K, et al. Using deep neural networks with intra- and inter-sentence context to classify suicidal behaviour. In: *Proceedings of the Twelfth International Conference on Language Resources and Evaluation (LREC 2020)*. Marseille: LREC (2020).
47. Cha CB, Franz PJM, Guzmán E, Glenn CR, Kleiman EM, et al. Annual research review: suicide among youth—epidemiology, (potential) etiology, and treatment. *J Child Psychol Psychiatry Allied Discip*. (2018) 59:460–82. doi: 10.1111/jcpp.12831
48. Holden R, Mueller J, McGowan J, Sanyal J, Kikoler M, Simonoff E, et al. Investigating bullying as a predictor of suicidality in a clinical sample of adolescents with autism spectrum disorder. *Autism Res*. (2020). 13:988–97. doi: 10.1002/aur.2292
49. Mansour R, Tsamakis K, Rizos E, Perera G, Das-Munshi J, Stewart R, et al. Late-life depression in people from ethnic minority backgrounds: differences in presentation and management. *J Affect Dis*. (2020) 264:340–7. doi: 10.1016/j.jad.2019.12.031
50. Cai W, Mueller C, Shetty H, Perera G, Stewart R. Predictors of mortality in people with late-life depression: a retrospective cohort study. *J Affect Dis*. (2020) 266:695–701. doi: 10.1016/j.jad.2020.01.021
51. McHugh CM, Large MM. Can machine-learning methods really help predict suicide? *Curr Opin Psychiatry*. (2020) 33:369–74. doi: 10.1097/YCO.0000000000000609
52. Francis ER, Freitas DF, de Colling C, Pritchard M, Kadra-Scalzo G, Viani N, et al. *Measuring the Incidence of Suicidality in Depression Over a Ten-Year Period in a Large UK Healthcare Provider*. Manuscript submitted for publication.
53. Werbeloff N, Osborn DPJ, Patel R, Taylor M, Stewart R, Broadbent M, et al. The Camden & Islington research database: using electronic mental health records for research. *PLoS ONE*. (2018) 13:e0190703. doi: 10.1371/journal.pone.0190703
54. Rumshisky A, Ghassemi M, Naumann T, Szolovits P, Castro VM, McCoy TH, et al. Predicting early psychiatric readmission with natural language processing of narrative discharge summaries. *Transl Psychiatry*. (2016) 6:e921. doi: 10.1038/tp.2015.182

55. McCoy TH, Castro VM, Roberson AM, Snapper LA, Perlis RH. Improving prediction of suicide and accidental death after discharge from general hospitals with natural language processing. *JAMA Psychiatry*. (2016) 73:1064–71. doi: 10.1001/jamapsychiatry.2016.2172
56. Walsh CG, Ribeiro JD, Franklin JC. Predicting risk of suicide attempts over time through machine learning. *Clin Psychol Sci*. (2017) 5:457–69. doi: 10.1177/2167702617691560
57. Torous J, Walker R. Leveraging digital health and machine learning toward reducing suicide—from panacea to practical tool. *JAMA Psychiatry*. (2019) 76:999–1000. doi: 10.1001/jamapsychiatry.2019.1231

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Ultra-Brief Crisis IPT-A Based Intervention for Suicidal Children and Adolescents (IPT-A-SCI) Pilot Study Results

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In recent years, suicidal behaviors have shown substantial increase worldwide. This trend is also prominent in Israel and has led to a dramatic increase in mental health treatment demand resulting in long wait times and low treatment acceptance rate. To address the critical need in crisis intervention for children and adolescents at suicidal risk we developed an ultra-brief acute crisis intervention, based on Interpersonal Psychotherapy (IPT). IPT is an evidence-based intervention for various psychopathologies among different age groups. The current adaptation of IPT-A is comprised of five weekly sessions, followed by monthly follow-up caring email contacts to the patients and their parents, over a period of 3 months. This paper aims to review the theoretical foundation of this intervention, describe the research design, and present preliminary results of a pilot study. Preliminary Results from our samples of 26 adolescents indicate meaningful trends for both the suicidal ideation (SIQ) and depression (MFQ) outcome measures. Significant interaction was found concerning suicidal ideation but not for depression. Main limitations include small sample size and stratified controls. The treatment appears to be safe, feasible and acceptable and initial results show promising trends to support further study of the approach.

Keywords: suicide attemps, crisis intervention, depression, adolescents, suicide behavior, IPT

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INTRODUCTION

Suicidal ideation and behavior are major public health concerns. Data in recent years indicates an alarming increase in the prevalence of suicide attempts, particularly among adolescents (1). Although only a small proportion of suicide attempts are fatal, every attempt is fraught with a potential death and long-term physical and psychological effects (2). Suicidal ideation and non-suicidal self-injurious (NSSI) behaviors have been identified as precursors for suicide attempts as well as potent risk factors for eventual death. Despite the unequivocal need for immediate and focused interventions for teens presenting with suicidal ideation, NSSI, and suicidal behavior, to our knowledge, there are few evidence-based, suicide specific, interventions for these at-risk youth. Dialectical Behavioral Therapy for Adolescents (DBT-A) for example has good evidence-base and

dissemination (3–5). Other evidenced based psychotherapies include Cognitive Behavioral Therapy (CBT) (6), Mentalization Based Therapy (MBT) (7) and Attachment – Based Family Therapy (ABFT) (8).

In recent years these non-fatal suicidal behaviors have shown substantial increase despite trends in the Western world for a reduction in actual suicide rates. This is apart from the US where adolescent suicide rates have climbed probably due to the epidemic in opioid abuse (9). This increase in non-fatal suicide behavior has been seen in Israel as well (10).

The rate of presentations to the pediatric emergency room (ER) at Schneider Children's Medical Center (SCMC) for suicidal behavior (i.e., sever ideation, suicide attempts, NSSI) increased in recent years and now stands at about 400 cases per year. This increase in pediatric admissions to the ER has led to an overload on outpatient services for our adolescent depression and suicidal behavior clinic.

These circumstances, have led to a long average wait time (at least 1 year) and, low treatment acceptance rate (<10%), which is clinically unreasonable when it comes to children and youth suffering from severe depression and suicidal risk. In order to meet these needs and deal with this public health crisis, we have developed an ultra-brief acute crisis intervention consisting of five sessions which we are currently evaluating in an ongoing study. This paper aims to present the theoretical basis of this ultra-brief intervention, describe the research design, and present some preliminary results from a pilot study.

The intervention developed is based on Interpersonal Psychotherapy (IPT) and on a comparable short-term intervention for suicidal adults (11).

The selection of IPT is based on the many studies linking between interpersonal problems and suicide risk (12). Those at risk for suicide suffer from significant interpersonal challenges (13). Insecure attachment has specifically been found to be a risk factor for suicide in adolescents (14). Moreover, problems with sharing feelings with others have been found to be an important risk factor for severe suicide attempts, above and beyond the contribution of depression and hopelessness (15, 16).

IPT is a commonly used and evidence-based treatment for depression among adults (17, 18) and adolescents [IPT-A, (19, 20)] as well as for several other disorders such as anxiety (21) and eating disorders (22). It has been shown to be effective in reducing symptoms of depression and in improving overall performance and social functioning of patients (23, 24).

IPT-A, is an adaptation of the IPT protocol specifically tailored for depressed adolescents (19). It is a time-limited evidence-based psychotherapy that addresses the link between depressed mood and current interpersonal problems. The goal of IPT-A is to reduce depressive symptoms and improve interpersonal functioning by identifying an interpersonal problem area of focus and by developing communication and problem-solving strategies for dealing with the interpersonal problems (19). Mufson et al. (25) presented preliminary outcomes of a small sample of IPT-A for depressed youth engaging in suicidal behavior (IPT-A-SP). The results indicated that IPT-A is a feasible treatment for adolescents at risk for suicide. Graham et al. (26) are in the process of publishing their work on an adaptation of the IPT protocol for suicidal adults as a part of their crisis intervention treatment (**IPT-AC)**. To our knowledge, no other IPT-based adaptation suitable for suicidal youth is available or has been empirically examined.

Short Term Intervention in Suicidal Adults

Studies carried out among adults have shown that brief and focused therapy can be effective for patients at high risk of suicide. For example, Gysin-Maillart et al. (11) compared two groups of adults presenting to the ER following a suicide attempt. Both groups received treatment as usual (TAU), which included inpatient, day patient, and individual outpatient care as considered necessary by the clinicians in charge of patient management. The research group received, in addition to TAU, three 60–90-min therapy sessions that were focused on the suicide attempt. This group of patients also received personal letters from the clinic every 3–6 months for a period of 24 months. The results showed a significant decrease in suicide attempts within the research condition in comparison to the control group.

Another study followed 843 adults who were hospitalized due to depression or suicidal risk in a psychiatric ward in San Francisco and refused further treatment upon their release. The study was conducted over the course of 5 years, comparing two groups of participants; The experimental group, which received personal postcards 4 times per year for the duration of the study, and the control group which received no further contact. A follow-up procedure identified patients who died during the 5-year contact period. Suicide rates in the contact (experimental) and no-contact groups were compared. The 5-year-follow-up revealed lower suicide rates within the contact group compared to the control group (27).

Based on these two lines of studies (IPT-A and short-term interventions for suicidal adults) we set out to develop and examine a brief and focused IPT-A based acute crisis intervention, adapted for suicidal children and adolescents. To the best of our knowledge, despite the tremendous service gap and devastating consequences of the global suicide epidemic among children and adolescents, there is no study which examines a very short, practical and feasible crisis intervention for children and adolescents at risk of suicide.

The Intervention

The intervention has two main goals: (1) **Immediate intervention for depression and suicide ideation.** We offer a very short and focused treatment, allowing for immediate response in cases of suicidal risk. By being ultra-short, the protocol may be offered to more youth within a significantly shorter wait time; (2) **Building a roadmap for future treatment after the suicidal risk is reduced.** During the intervention, we build a roadmap for continued patient care in the community. We try to identify the main difficulties leading to the patient's suicidal behavior, and to assist the patient and family in understanding how these needs can be met.

The intervention is comprised of five weekly sessions followed by monthly emails to the patients and their parents over a period of 3 months. The first session is aimed at introducing the

intervention, assessing depression and suicidal risk and building a safety plan (28). The safety plan consists of a prioritized list of coping strategies that the patient can use when suicidal risk is increased. The second session is focused on reviewing the patient's interpersonal relationships (using the closeness circle and interpersonal inventory) and conceptualizing the interpersonal problem area (the focus for the intervention). Sessions 3–4 focus on developing and practicing interpersonal, emotional and behavioral coping strategies relevant for suicidal risk. Lastly, in session 5, patient and therapist go over the process and main issues which were worked on, emphasizing relapse prevention by going back to the safety plan. First and fifth sessions always involve the parents. In other sessions, parents are invited as needed. After completion of the intervention, four personal emails addressed to the patients and parents are sent by the clinic. These are sent two, four, eight, and 12 weeks following the last session. The email messages are based on a template that includes care contacts, elements of the safety plan and skills acquired during the intervention, suggestions to parents and patients and emergency contact information.

Research Design

The goal of the study is to examine the feasibility and effectiveness of an ultra-brief IPT-A based acute crisis-intervention, as first aid for suicidal children and adolescents, in an outpatient setting. The study was approved by IRB committee at Schneider Children's Medical Center (SCMC). The study was registered as clinical trial in the national institution of mental health ref. no: NCT04404322

METHODS

Participants

All study participants are patients at the SCMC depression and suicidal behavior clinic, referred due to depressive symptoms and/or suicidal ideation/behavior. Patients receive routine care and those who give informed assent and guardian consent are assessed routinely via a battery of self and parent report questionnaires. All study participants and their parents signed informed consent forms.

Since the beginning of the study about 80 children and adolescents, aged 6–18, have consented to fill study baseline and follow up assessments. Exclusion criteria include acute medical condition, intellectual disability, cognitive impairment, or linguistic limitation. We present here preliminary data of the first 26 children/adolescents recruited who have completed 2–3 measurement timepoints (Initial evaluation, Pre-treatment, Post-treatment). The sample included 10 males and 16 females, between the ages of 9–17 (Mean = 13.44, SD = 2.45).

Procedure

Patients are referred to SCMC depression and suicide clinic through the ER, outpatient providers or are self-referred. They undergo an initial evaluation and risk assessment. Following initial evaluation, each subject is assigned to one of three study groups, based on clinical considerations. In this stratified randomization system, the most serious acute cases are generally referred to our ultra-short crisis intervention (IPT- A SCI) and the rest are randomized to either one of the three groups: IPT-A SCI, Treatment as usual (TAU) and waiting list (WL). All participants and their parents complete the questionnaires via a secure electronic interface, with the aid of a trained research assist ant. Post treatment drop-out rates, thus far, seem low and stand at about 11% for the IPT-A SCI and at about 16% for patients who receive TAU.

TABLE 1 | Measurement timeline for each study group.

Time	IPT-A-SCI	TAU	WL
0	Initial evaluation	Initial evaluation	Initial evaluation
1	Pre-treatment	Pre-treatment	–
2	Post-treatment	5-week assessment	5-week assessment
3	–	Post treatment	–
4	3-months follow up (from the end of the intervention)	3-months follow up (from the end of the intervention)	3-months follow up (from the end of last evaluation)
5	6 months follow up	6 months follow up	6 months follow up
6	9 months follow up	9 months follow up	9 months follow up
7	12 months follow up	12 months follow up	12 months follow up

The IPT-A SCI follows the intervention protocol briefly presented above, which includes an intensive phase of 5 weekly 50-min sessions and 3 follow up personal emails. Questionnaires are completed at baseline (initial evaluation), prior to the first session; at the end of the intensive phase; and 3, 6, 9, and 12 months following the end of the acute intervention. TAU patients receive an integrative combination of psychodynamic, supportive and cognitive behavioral therapy, usually lasting between 10 and 30 weeks. TAU participants are assessed at the same time points with an added measurement at the end of treatment. WL patients are monitored by a trained clinician during their waiting period and complete the study questionnaire battery at the parallel time intervals. **Table 1** summarizes the measurement timeline for each study group.

Instruments

The study included a battery of validated self- and parent-report questionnaires assessing suicidal ideation [Suicide Ideation Questionnaire (SIQ) (29)] and behavior [Columbia–Suicide Severity Rating Scale (C-SSRS) (30)], interpersonal functioning [Social Adjustment Scale–Self Report (SAS-SR) (31)], depressive symptoms [Mood and Feeling Questionnaire (MFQ) (32)], anxiety [The Screen for Child Anxiety Related Emotional Disorder (SCARED) (33)], attachment patterns [Experiences In Close Relationships – Revised child version Questionnaire (ECR-RC) (34)] and self-esteem [Rosenberg Self-esteem Scale (RSE) (35)]. In this report we will only discuss the SIQ and MFQ, which are the two primary outcome measures initially identified for the study. The SIQ consists 15-item measure designed to evaluate the severity and frequency of suicidal ideation. Scale ranges from 1 ("I never had this thought") to 7 ("Almost every day") according

TABLE 2 | Means and Standard deviations of each group at different times.

Outcome	Group	T0 Mean (SD)	T1 Mean (SD)	T2 Mean (SD)	Sig differences
SIQ	IPT-A SCI	57.4 (24.7)	29.4 (24.8)	17.6 (18.3)	**T0 > T2***
	TAU	62.5 (27.8)	37.6 (35.8)	21.5 (34.54)	
	WL	57.7 (14.98)	–	68.2 (14.24)	**T0 < T2***
MFQ	IPT-A SCI	83.5 (31.3)	20.3 (17.7)	15.7 (15.08)	**T0 > T1**** **T0 > T2****
	TAU	89.5 (29.43)	28.33 (20.44)	19.33 (21.67)	**T0 > T1**** **T0 > T2****
	WL	76.0 (24.99)	–	15.5 (13.2)	**T0 > T2****

*$p < 0.05$.
**$p < 0.001$.

to their thoughts in the last month. The MFQ consists of a series of 13 descriptive phrases regarding how the subject has been feeling or acting recently, assessing depressive symptoms of children and youth.

RESULTS

In order to estimate the feasibility of this intervention, analyses were conducted on the first 26 children/adolescents who completed between 2 and 3 assessment timepoints. Initial analysis of group differences at baseline showed no differences in demographic (age and gender) characteristics or in outcome measures between the study arms. A repeated measures design was used to compare three groups of patients who completed the SIQ and MFQ at initial evaluation (T0), pre-intervention (T1) and at 5-week assessment (T2). Ten WL patients completed the initial evaluation and the 5-week follow up assessments, 10 IPT A SCI patients completed initial evaluation, pre-intervention and post-intervention assessments and 6 TAU patients completed initial evaluation, pre-intervention and 5-week follow up assessments.

Results are meaningful for both the SIQ and MFQ outcome measures. Specifically, a significant interaction was evident for suicidal ideation ($F_{(4, 46)} = 3.34$, $p < 0.05$); it appears that while WL patients exhibited a slight increase in their suicidal ideation levels between T0 and T2 ($t_{(9)} = -2.75$, $p < 0.05$), suicidal ideation decreased in the IPT-A SCI and TAU patients, between both time intervals. Paired comparisons within treatment condition using Bonferroni adjustment revealed significant differences between T0 and T2 measurements for the IPT-A SCI group ($p < 0.05$) but not for TAU. Means and standard deviations are presented in **Table 2**.

For depressive symptoms however, no interaction effect was evident and all three patient groups exhibited a reduction across timepoints. Means and standard deviations are presented in **Table 2**. Paired comparisons using Bonferroni adjustment revealed significant differences between T0 and T2 for all patients ($P < 0.001$), as well as significant reductions between T0 and T1 for the TAU and IPT-A SCI groups ($P < 0.001$). Nevertheless, the slope seems to flatten between T1 and T2, and these very preliminary results might suggest that the level of depression may not be specifically affected by the initiation of any of the interventions. **Figures 1**, **2** illustrate the above findings.

DISCUSSION

In this brief report, we have described a new adaptation of an acute ultra-brief crisis intervention for children and adolescents at suicidal risk, developed in our depression and suicide clinic at SCMC, and reviewed its theoretical foundations. It seems that the intervention is feasible and safe. The intervention group was superior to wait list group in reducing suicide ideation. The intervention, however, did not differ from the two comparison groups in reducing symptoms of depression. The difference in outcomes for the suicide ideation and depression needs further investigation. We could assume that this is due to the suicide-specific nature of the intervention protocol we present.

The treatment appeared to be acceptable to subjects and parents, and, at least in this pilot stage, dropout rates were very low, which is encouraging, since treatment studies of suicidal adolescents are notorious for high numbers of dropout (36).

IPT-A is a relevant intervention for at risk youth since it focuses on the interpersonal aspects which often precipitate acute suicidal crises. All available interventions [CBT (6) DBT (4)] include interpersonal aspects but these aspects are not necessarily the focus of the treatment. ABFT focuses on interpersonal aspects in a family format (8).

IPT frames therapy around a main interpersonal problem in the patient's life, a crisis or relational issue that is increasing interpersonal stress. According to (37) by mobilizing and working collaboratively with the patient to resolve this problem, IPT seeks to activate several interpersonal change mechanisms. These include: enhancing social support; decreasing interpersonal stress; facilitating emotional processing; and improving interpersonal skills.

None of these change mechanisms are unique to IPT, and not always all factors have the same importance in every treatment. However, IPT's uniqueness lies in seeking to activate all of these in a coherent, plausible therapeutic frame, defined by a current interpersonal crisis or predicament in the patient's lifeand in a time-limited, diagnosis-focused treatment (37).

Until recently, many studies that have examined the efficacy of IPT-A have generally excluded participants with severe and active suicidal ideation and attempts despite the possibility that IPT-A may be beneficial for this population.

We believe that IPT-based intervention can be particularly suitable for children and adolescents at risk of suicide for a number of reasons. First, the IPT framework makes it possible to focus the suicidal ideation or behavior around a specific problem area or difficulty that especially affects the patient. Second, the work in the interpersonal context is very suitable for young

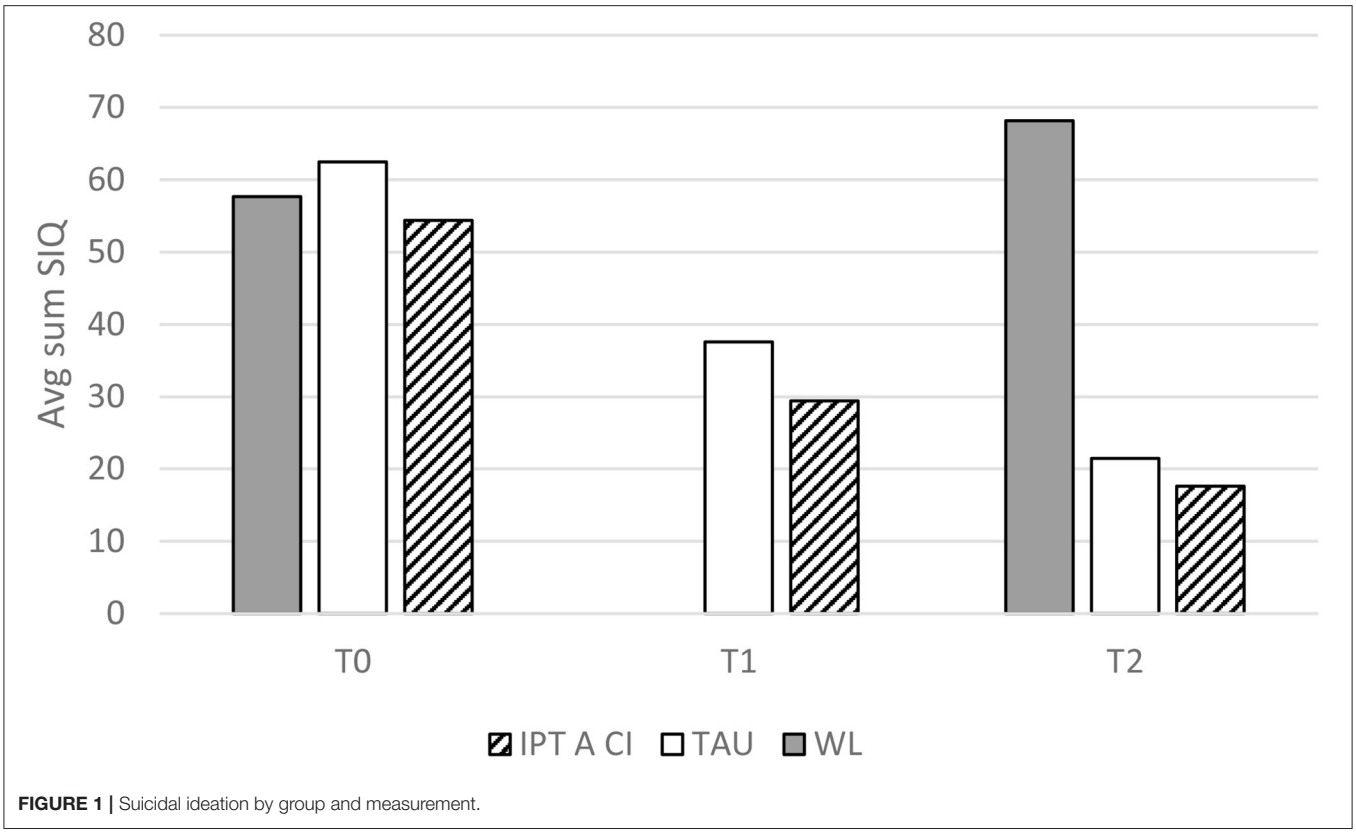

FIGURE 1 | Suicidal ideation by group and measurement.

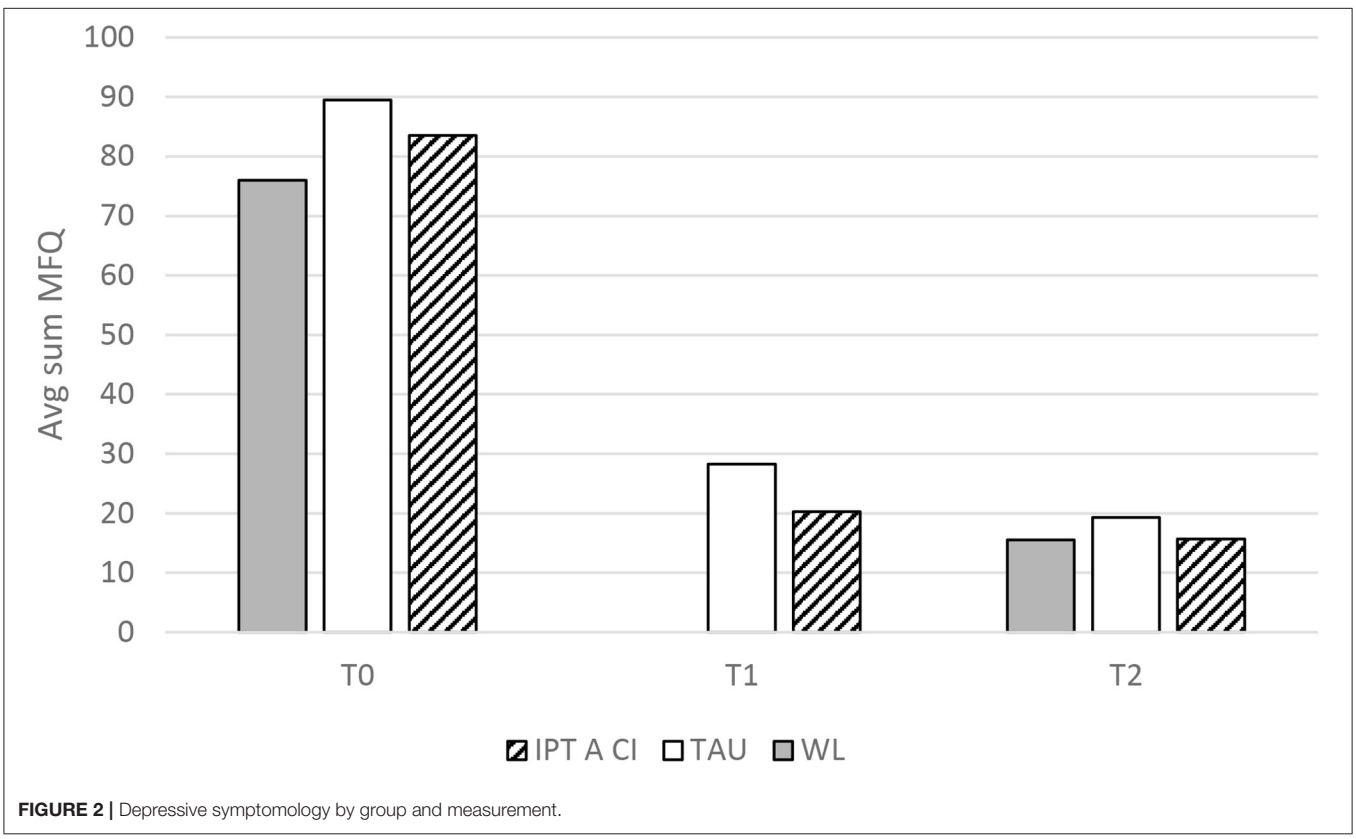

FIGURE 2 | Depressive symptomology by group and measurement.

patients at suicide risk. In the intervention this work is reflected in the construction of a safety plan and in increasing the patient's support system. Lastly, the protocol is focused and limited in time so that it can be adapted relatively easily to the model of emergency intervention

The intervention presented in the current study is the first to focus on interpersonal aspects in an ultra-short individual format. It is not our supposition that this treatment is sufficient for these adolescents, but it may be a cost-effective "first aid" intervention, which will help them through an acute crisis as well as generate hope regarding the prospect of therapy, thereby getting them to engage in longer term services.

Using this ultra-brief intervention has important public health implications. Non-fatal adolescent suicidal behavior, in all of its various forms, has become increasingly common in the last decades. These high-risk behaviors pose a major public health problem, imposing unbearable load on emergency rooms and public psychiatric services. Public mental health services in Israel struggle to handle the load, cases may be left un-treated for dangerously long periods of time. Therefore, there is a real need a for brief forms of crises interventions. Intervention like IPT-A-SCI may be able to reduce the load on child and adolescent mental health services and allow larger portions of at-risk patients to be treated. Unfortunately, we are not able to show a significant decrease in waiting time for treatment since the number of referrals is still increasing. However, we were able to increase the number of children receiving treatment by a significant number. Before the initiation of the treatment program we were providing psychotherapy to 30–40 patients per year, while during the study period we are able to treat 80–100 patients per year – a very significant increase.

Furthermore, provided our future large-scale study's results continue the promising trends evident in our pilot analyses, this protocol can be a basis for other types of crises interventions in various fields and populations. Likewise, our protocol could potentially be adapted to other populations at other age groups or suffering from other psychopathologies. In addition, IPT-A-SCI could serve as a platform for crises interventions based on other therapeutic models such as CBT or DBT, whereby a 12–16 session long protocol is condensed into a 5-session "first aid kit," maintaining the main therapeutic components and directing the patient for future care.

This study does have limitations. Firstly, the treatment sample was relatively small and in addition we only had limited number of assessments over the treatment period. We also did not have enough quality control for the individual's sessions. Finally, due to the nature of our suicidal adolescents who needed urgent treatment, we could only use stratified controls and had to give priority to the more urgent cases.

Despite the many limitations of this preliminary report, the treatment has proven safe, feasible and acceptable and initial results show promising trends. We are in the process of developing a larger, randomized control study, which will include a larger sample and the other measures included.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by IRB Helsinki Committee, Rabin Medical Center. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

REFERENCES

1. Hedegaard H, Curtin SC, Warner M. *Suicide Rates in the United States Continue to Increase*. US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Health Statistics (2018).
2. Itzhaky L, Gratch I, Galfalvy H, Keilp JG, Burke AK, Oquendo MA, et al. Psychosocial risk factors and outcomes associated with suicide attempts in childhood: a retrospective study. *J Psychiatr Res*. (2020) 125:129–35. doi: 10.1016/j.jpsychires.2020.03.008
3. Mehlum L, Tørmoen AJ, Ramberg M, Haga E, Diep LM, Laberg S, et al. Dialectical behavior therapy for adolescents with repeated suicidal and self-harming behavior: a randomized trial. *J Am Acad Child Adolesc Psychiatry*. (2014) 53:1082–91. doi: 10.1016/j.jaac.2014.07.003
4. Miller AL, Rathus JH, Linehan MM. *Dialectical Behavior Therapy With Suicidal Adolescents*. New York, NY: Guilford Press (2007).
5. Mehlum L, Ramberg M, Tørmoen AJ, Haga E, Diep LM, Stanley BH, et al. Dialectical behavior therapy compared with enhanced usual care for adolescents with repeated suicidal and self-harming behavior: outcomes over a one-year follow-up. *J Am Acad Child Adoles Psychiatry*. (2016) 55:295–300. doi: 10.1016/j.jaac.2016.01.005
6. Stanley B, Brown G, Brent DA, Wells K, Poling K, Curry J, et al. Cognitive-behavioral therapy for suicide prevention (CBT-SP): treatment model, feasibility, and acceptability. *J Am Acad Child Adoles Psychiatry*. (2009) 48:1005–13. doi: 10.1097/CHI.0b013e3181b5dbfe
7. Rousseau D, Cook-Cottone C. Trauma-informed yoga training in Kenya: A qualitative pilot study on feasibility and acceptability. *Complement Ther Med*. (2018) 40:53–60. doi: 10.1016/j.ctim.2018.07.010
8. Diamond G, Russon J, Levy S. Attachment-based family therapy: a review of the empirical support. *Family Process*. (2016) 55:595–610. doi: 10.1111/famp.12241
9. Ashrafioun L, Bishop TM, Conner KR, Pigeon ER. Frequency of prescription opioid misuse and suicidal ideation, planning, and attempts. *J Psychiatr Res*. (2017) 92:1–7. doi: 10.1016/j.jpsychires.2017.03.011
10. Israely Ministry of Health. *Suicide in Israel*. (2018). Available online at: www.health.gov.il/English/News_and_Events/.../Pages/07082017_2.aspx
11. Gysin-Maillart A, Schwab S, Soravia L, Megert M, Michel K. A novel brief therapy for patients who attempt suicide: a 24 months follow up randomuzes controlled study of the attempted suicide short intervention program (ASSIP). *PLoS Med*. (2016) 13:e1001968. doi: 10.1371/journal.pmed.1001968
12. Jacobson CM, Mufson L. Interpersonal psychotherapy for depressed adolescents adapted for self-injury (IPT-ASI): rationale,

overview, and case summary. *Am J Psychother*. (2012) 66:349–74. doi: 10.1176/appi.psychotherapy.2012.66.4.349
13. Joiner T, Kalafat J, Draper J, Stokes H, Knudson M, Berman AL, et al. Establishing standards for the assessment of suicide risk among callers to the national suicide prevention lifeline. *Suicide Life Threat Behav*. (2007) 37:353–65. doi: 10.1521/suli.2007.37.3.353
14. Falgares G, Marchetti D, De Santis S, Carrozzino D, Kopala-Sibley DC, Fulcheri M, et al. Attachment styles and suicide-related behaviors in adolescence: the mediating role of self-criticism and dependency. *Front Psychiatry*. (2017) 8:36. doi: 10.3389/fpsyt.2017.00036
15. Levi Y, Horesh N, Fischel T, Treves I, Or E, Apter A. Mental pain and its communication in medically serious suicide attempts: an "impossible situation". *J Affect Dis*. (2008) 111:244–50. doi: 10.1016/j.jad.2008.02.022
16. Horesh N, Levi Y, Apter A. Medically serious versus non – serious suicide attempts: relationshipso lethality and intent to clinical and interpersonal characteristics. *J Affect Dis*. (2012) 136:286–93. doi: 10.1016/j.jad.2011.11.035
17. Klerman GL, Weissman MM, Rounsaville BJ, Chevron E. *Interpersonal Psychotherapy for Depression*. New York, NY: Basic Books (1984).
18. Markowitz JC, Weissman MM. *Casebook of Interpersonal Psychotherapy*. Oxford: Oxford University Press (2012).
19. Mufson L, Dorta KP, Moreau D, Weissman MM. *Interpersonal Psychotherapy for Depressed Adolescents*. 2nd ed. New York, NY: Guildford Press (2004).
20. Brunstein Klomek A, Zalsman G, Mufson L. Interpersonal psychotherapy for depressed adolescents. *Isr J Psychiatry Relat Sci*. (2007) 44:40–6.
21. Mahan RM, Swan SA, Macfie J. Interpersonal psychotherapy and mindfulness for treatment of major depression with anxious distress. *Clin Case Stud*. (2018) 17:104–19. doi: 10.1177/1534650118756530
22. Waldron HL, Tanofsky-Kraff M, Wilfley DE. Interpersonal psychotherapy for clients with eating disorders. In: Choate LH, editor. *Eating Disorders and Obesity* (2015).
23. Mufson L, Weissman MM, Moreau D, Garfinkel R. Efficacy of interpersonal psychotherapy for depressed adolescents. *Arch Gen Psychiatry*. (1999) 56:573–9 doi: 10.1001/archpsyc.56.6.573
24. Spence S, O'Shea G, Donovan C. Improvements in interpersonal functioning following interpersonal psychotherapy (IPT) with adolescents and their association with change in depression. *Behav Cogn Psychother*. (2016) 44:257–72. doi: 10.1017/S1352465815000442
25. Mufson L, et al. *Presented at IOWA IPT Conference Preliminary Outcomes of IPT-A for Depressed Youth Engaging in Suicidal Behavior (IPT-A-SP)*. Iowa (2015).
26. Graham P, Irvine Fitzpatrick L, Bowyer DS, Taylor R, Tan L. *Proof of concept: interpersonal psychotherapy acute crisis (ipt ac) for deliberate self-poisoning/self-harm*. (2020). Available online at: https://services.nhslothian.scot/ProspectModel/Pages/IPT-AC.aspx
27. Motto JA, Bostrom AG. A randomized controlled trial of postcrisis suicide prevention. *Psychiatr Serv*. (2001) 52:828–33. doi: 10.1176/appi.ps.52.6.828
28. Stanley B, Brown GK. Safety planning intervention: a brief intervention to mitigate suicide risk. *Cogn Behav Pract*. (2012) 19:256–64. doi: 10.1016/j.cbpra.2011.01.001
29. Reynolds W. *Suicide Ideation Questionnaire*. Odessa, FL: Psychological Assessment Resources (1987).
30. Posner K, Brown KG, Stanley B, Brent AD, Yershova VK, Oquendo M, et al. The Columbia–suicide severity rating scale: initial validity and internal consistency findings from three multisite studies with adolescents and adults. *Am J Psychiatry*. (2011) 168:1266–77. doi: 10.1176/appi.ajp.2011.10111704
31. Weissman MM, Orvaschel H, Padian N. Children's symptom and social functioning self-report scales: comparison of mother's and children's reports. *J Nerv Ment Dis*. (1980) 168:736–40. doi: 10.1097/00005053-198012000-00005
32. Angold A, Costello EJ, Messer SC, Pickles A. Development of a short questionnaire for use in epidemiological studies of depression in children and adolescents. *Int J Methods Psychiatr Res*. (1995) 5:237–49.
33. Birmaher B, Khetarpal S, Brent D, Gully M, Balach L, Kaufman J, et al. The screen for child anxiety related emotional disorders (SCARED): scale construction and psychometric characteristics. *J Am Acad Child Adolesc Psychiatry*. (1997) 36:553–4. doi: 10.1097/00004583-199704000-00018
34. Lionetti F, Mastrotheodoros S, Palladino BE. Experiences in close relationships revised child version (ECR-RC): psychometric evidence in support of a security factor. *Eur J Dev Psychol*. (2018) 15:452–63. doi: 10.1080/17405629.2017.1297228
35. Rosenberg M. *Conceiving the Self*. New York, NY: Basic Books (1979).
36. Burns CD, Cortell R, Wagner BM. Treatment compliance in adolescents after attempted suicide: a 2-year follow-up study. *J Am Acad Child Adolesc Psychiatry*. (2008) 47:948–57. doi: 10.1097/CHI.0b013e3181799e84
37. Lipsitz JD, Markowitz JC. Mechanisms of change in interpersonal therapy (IPT). *Clin Psychol Rev*. (2013) 33:1134-47. doi: 10.1016/j.cpr.2013.09.002

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Increasing Risks of Suicide Attempt and Suicidal Drug Overdose After Head Trauma in Patients With Sleep-Disordered Breathing: A Population-Based Study

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Objective: To determine the risks of suicide attempt (SA) and suicidal drug overdose (SDO) after head trauma in patients with sleep-disordered breathing (SDB) by using the National Health Insurance Research Database of Taiwan.

Methods: We analyzed the data of patients aged ≥20 years who were diagnosed with SDB between 2000 and 2012. We further divided them into two cohorts [with admission for head injury (SBI) and without (SBN)], and we compared them against sex-, age-, comorbidity-, and index-date-matched healthy individuals. The adjusted hazard ratios (aHRs) and 95% confidence intervals of SA and SDO were calculated with adjustment of age, sex, and comorbidities.

Results: Approximately 0.61% of patients among the overall 142,063 patients with SDB had SA, with 535 and 335 patients included in the SBN and SBI cohorts, respectively. Compared with patients with SBN, a significantly higher risk of SA was observed in patients with SBI (aHR = 2.22), especially in those aged under 50 years (aHR = 2.48). Notably, a SDO incidence of 1.20% was noted in patients with SDB, and the SBI cohort had a 1.81-fold higher risk for SDO when compared with the SBN cohort.

Conclusion: The risks of subsequent SA and SDO are proportionally increased by the effects of head trauma with a moderating role of SDB, especially in those aged <50 years. SDB and head trauma can increase suicide behaviors individually and synergistically.

Keywords: cohort study, head trauma, national health insurance, sleep-disordered breathing, suicide

INTRODUCTION

More than 800,000 people die because of suicide per year worldwide, with a progressive increase over the past few decades (1). In most countries, the rates of suicide attempt (SA) increase with age. Generally, men have a lower rate of SA than women; however, men exhibit higher lethality of suicide than women (1). A study conducted in European countries has estimated the rates of suicidal lethality in men compared with women (13.9 vs. 4.1%) (2). The primary reason for this sex difference is the difference in suicidal methods adopted by men and women. Among various suicidal methods, self-intoxication is the most frequently chosen method in women (3). We believe that identifying individuals with a possibly higher risk of SA and interrupting their suicidal behaviors are the significant challenges of suicide prevention.

Sleep disorders manifesting as dyssomnia or insomnia are common health problems, which affect not only the quality but also the longevity of a patient's life (4, 5). Sleep disorders can be associated with various medical and psychological disorders (5). Among the different types of sleep disorders, sleep apnea or sleep-disordered breathing (SDB) is a significant cause of excessive daytime sleepiness and driving accidents, leading to accidental injuries in patients' daily lives (6). In addition to that, SDB can cause other disorders or traumatic brain insult (TBI) (6, 7); ∼2.9% of patients with SDB were reported to have suicidal ideation or suicide planning (8).

Accidental head trauma with TBI would typically result in paralysis, impaired consciousness, cognitive problems, and psychotraumatic stress disorder in addition to causing death. Once patients are discharged after admission for head trauma, they might experience long-term or even lifelong physical and psychological consequences (9–11). These physical and psychological disabilities could interact with the mental disturbances caused by SDB, thereby increasing suicidality in these patients. However, the magnitude of increase in the incidence and risk of SA is ambiguous after head trauma in patients with SDB. Therefore, in this study, we used the National Health Insurance Research Database (NHIRD) in Taiwan to determine the incidence and risk of SA after head trauma in patients with SDB.

METHODS

Data Source

The NHIRD has included all the medical records of insurants covered by the single-payer National Health Insurance (NHI) program of Taiwan since 1995. The purpose of creating NHIRD was to use research results as a reference for medical and health policies and enhance medical research resources. NHIRD contains all medical information, including ambulatory and inpatient services, of more than 99% of the population in Taiwan (12). We used the hospitalization files from the NHIRD to conduct this study with high validity. Diagnoses and outcomes were coded by physician specialists as per the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM). The identification number of every study subject was re-coded before the database was released by the government, and all the information of patients was encrypted for personal privacy. The Research Ethics Committee of China Medical University and Hospital in Taiwan approved this study (CMUH104-REC2-115-CR4).

Taiwan is located in East Asia and has identical mores to that of China and most of the Southeast Asian societies (13). Therefore, our study results could be beneficial for the medical care system in both Taiwan and other Asian countries.

Study Population

We enrolled patients who were ≥20 years old to clarify the association between SDB, head trauma, and the risk of SA. We defined the following four cohorts in this study: patients with SDB (ICD-9-CM code 780.5; SDB cohort), patients with SDB who had head trauma with subsequent hospital admission (ICD-9 CM codes 850–854 and 959.01; SBI cohort), patients with SDB without head trauma (SBN cohort) during 2000–2010, as well as a comparison cohort of individuals without SDB and head trauma. Patients with head trauma were defined as those who had moderate or severe head trauma with TBI, because the NHI program does not provide inpatient services to patients who have head trauma but clear consciousness and no intracranial hemorrhage or brain contusion in brain imaging studies. The date of head trauma diagnosis or SDB diagnosis was defined as index dates in the SBI or SBN cohorts. The comparison cohort was frequency matched by sex, age, and index year (**Figure 1**).

Outcome Measurement

In this study, the primary outcome was the occurrence of SA (ICD-9-CM codes E950-E959). Suicidal drug overdose (SDO, also called self-poisoning) and SA were individually analyzed in these cohorts to further interpret the risk of SA and the safety of long-term prescription in patients with SDB. Patients with SDO were enrolled for analysis if they were ever hospitalized with the ICD-9-CM codes 960–979 but without E codes. We excluded patients who were younger than 20 years and those who ever had SA or SDO before the index date. Because of their association with SA and SDO, the following comorbidities were evaluated as potential confounders in each cohort: schizophrenia (ICD-9-CM code 295), alcohol-related illness (ICD-9-CM codes 303.0, 303.9, 305.0, 790.3, 980, and E860), anxiety (ICD-9-CM codes 300, 309.24, and 293.84), mental disorder (ICD-9-CM codes 293, 294.0, 294.8, 294.9, and 297), diabetes mellitus (ICD-9-CM code 250), hypertension (ICD-9-CM code 416), hyperlipidemia (ICD-9-CM code 272.4), chronic obstructive pulmonary disease (COPD, ICD-9-CM codes 491, 492, 494, and 496), coronary artery disease (CAD, ICD-9-CM codes 410-413, 414.01–414.05, 414.8, and 414.9), stroke (ICD-9-CM codes 430-438), and cirrhosis (ICD-9-CM codes 571.2, 571.5, and 571.6). These comorbidities were considered confounders for multivariate adjustment in the analysis. All study subjects started follow-up from the index date to the date of SA or SDO

Abbreviations: aHR, adjusted hazard ratio; CI, confidence interval; NHIRD, National Health Insurance Research Database; ICD-9-CM, International Classification of Diseases, Ninth Revision, Clinical Modification.

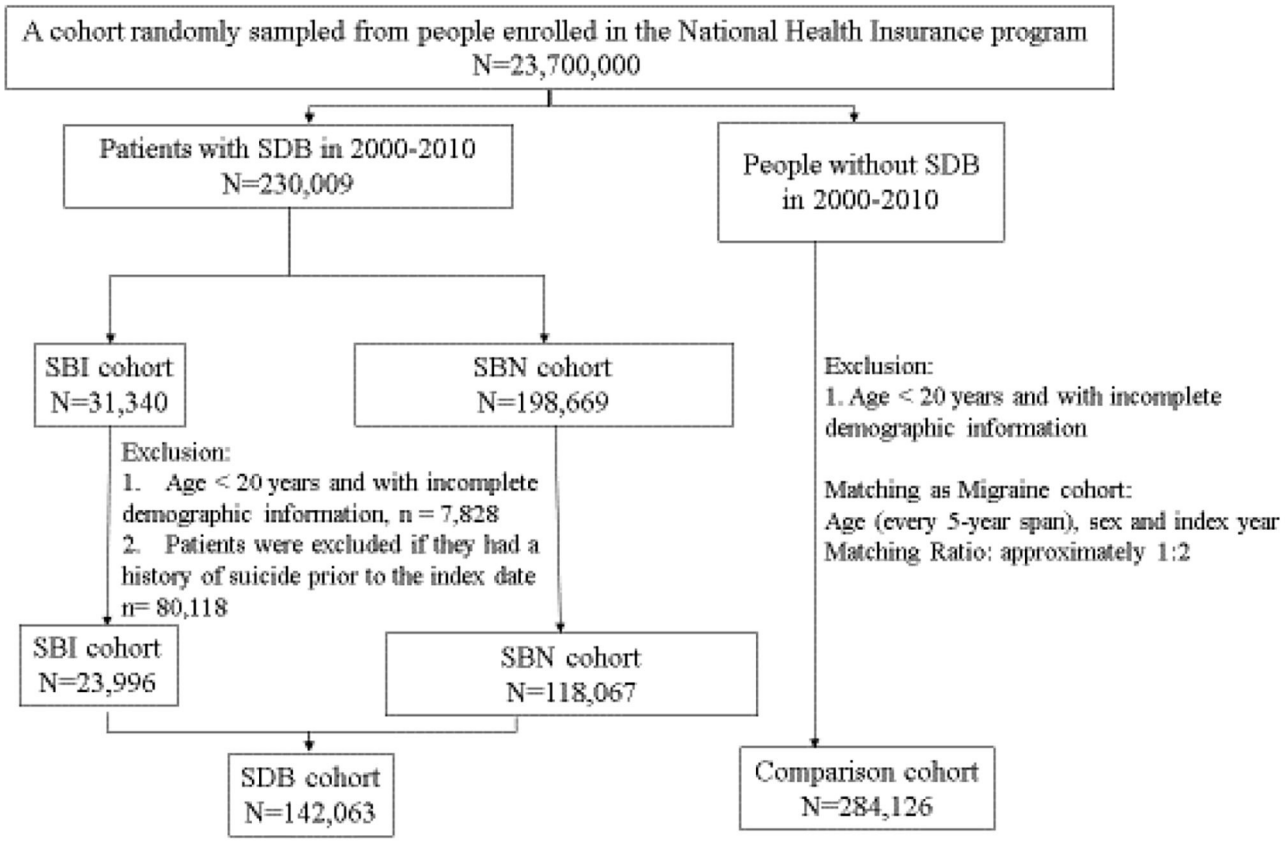

FIGURE 1 | The flowchart of the study population selected from the national health insurance research database.

occurrence, death, withdrawal from the NHIRD, or December 31, 2013, whichever occurred first.

Statistical Analysis

Distribution comparisons of categorical variables, such as sex, age, monthly income, urbanization level, occupation, and comorbidities, were performed using univariate analysis with chi-square testing. For continuous variables such as average age, Student's *t*-test was performed to compare the difference between the SDB and comparison cohorts. The urbanization level was divided into four levels based on the population density of the residential area, wherein level 1 was the most urbanized and level 4 was the least urbanized. Occupation was categorized into office worker, laborer, and others (those were defined as primarily retired, unemployed, or from low-income populations). Cox proportional hazard regression models adjusted for age, sex, monthly income, urbanization level, occupation, and comorbidities were applied to assess the risks of SA and SDO in the SDB, SBN, and SBI cohorts relative to the comparison cohort. This study also used Cox regression to compare the risks of SA and SDO between the SBN and SBI cohorts. Hazard ratio (HR), adjusted hazard ratio (aHR), and 95% confidence interval (CI) were calculated to evaluate the risks of SA and SDO. Statistical analyses were conducted with type I error $\alpha = 0.05$ using the statistical software package, SAS, version 9.4 (SAS Institute, Inc, Cary, NC).

RESULTS

The baseline demographic characteristics for these cohorts are shown in **Table 1**. SDB was diagnosed in 142,063 patients between January 1, 2000, and December 31, 2010. Of these, 23,996 (0.17%) patients had SDB and subsequent admission for head trauma, and the remaining 118,067 patients had SDB but without head trauma. The comparison cohort included 284,126 subjects without SDB and head trauma. Among the cohorts, parameters such as male sex, age <50 years, monthly income of NTD 15,000–19,999, living in a level 2 urbanization area, and occupation of office worker were dominant. Notably, patients with SDB demonstrated higher risks of various comorbidities, including schizophrenia, alcohol-related illness, anxiety, mental disorder, diabetes mellitus, hypertension, hyperlipidemia, COPD, CAD, stroke, and cirrhosis (**Table 1**).

Table 2 reveals that SA was observed in 215 (0.08%) subjects of the 284,126 individuals in the comparison cohort. Moreover, 870 (0.61%) patients among the 142,063 patients in the SDB cohort had a diagnosis of SA during the 14-year follow-up period, and 535 and 335 patients in the SBN and SBI cohorts developed SA,

TABLE 1 | Distribution of sex, age, monthly income, urbanization level, occupation, and comorbidities between the SDB, SBN, SBI, and comparison cohorts.

	SDB *N* = 142,063		SBN *N* = 118,067		SBI *N* = 23,996		Comparison *N* = 284,126		
	n	%	*n*	%	*n*	%	*n*	%	*p*-value[a]
Sex									0.99
Female	64,589	45.5	54,975	46.6	9,614	40.1	129,178	45.5	
Male	77,474	54.5	63,092	53.4	14,382	59.9	154,948	54.5	
Age (years)									0.99
≤49	53,912	38.0	44,320	37.5	9,592	40.0	107,824	38.0	
50–64	36,348	25.6	30,919	26.2	5,429	22.6	72,696	25.6	
≥65	51,803	36.5	42,828	36.3	8,975	37.4	103,606	36.5	
Age, mean ± SD[§]	46.7 ± 19.3		46.7 ± 19.3		46.0 ± 18.1		46.5 ± 19.3		
Monthly income[†]									<0.001
<15,000	41,472	29.2	33,883	28.7	7,589	31.6	77,352	27.2	
15,000–19,999	69,224	48.7	56,416	47.8	12,808	53.4	129,450	45.6	
≥20,000	31,367	22.1	27,768	23.5	3,599	15.0	77,324	27.2	
Urbanization level[‡]									<0.001
1 (highest)	32,994	23.2	29,195	24.7	3,799	15.8	82,186	28.9	
2	42,879	30.2	35,824	30.3	7,055	29.4	84,297	29.7	
3	23,466	16.5	19,382	16.4	4,084	17.0	47,795	16.8	
4 (lowest)	42,724	30.1	33,666	28.5	9,058	37.8	69,848	24.6	
Occupation category[&]									<0.001
Office worker	61,192	43.1	52,903	44.8	8,289	34.5	143,935	50.7	
Laborer	59,901	42.2	48,438	41.0	11,463	47.8	106,993	37.7	
Other	20,970	14.8	16,726	14.2	4,244	17.7	33,198	11.7	
Comorbidity									
Schizophrenia	3079	2.17	2,656	2.25	423	1.76	1,232	0.43	<0.001
Alcohol-related illness	8,161	5.74	4,777	4.05	3,384	14.1	1,168	0.41	<0.001
Anxiety	9,909	6.98	7,880	6.67	2,029	8.46	965	0.34	<0.001
Mental disorders	37,717	26.6	28,382	24.0	9,335	38.9	6,909	2.43	<0.001
Diabetes mellitus	25,061	17.6	19,757	16.7	5,304	22.1	18,276	6.43	<0.001
Hypertension	54,100	38.1	43,960	37.2	10,140	42.3	34,659	12.2	<0.001
Hyperlipidemia	18,189	12.8	14,199	12.0	3,990	16.6	8,387	2.95	<0.001
Chronic obstructive pulmonary disease	23,784	16.7	18,332	15.5	5,452	22.7	10,795	3.80	<0.001
Coronary artery disease	26,217	18.5	20,724	17.6	5,493	22.9	16,090	5.66	<0.001
Stroke	25,440	17.9	19,557	16.6	5,883	24.5	14,181	4.99	<0.001
Cirrhosis	19,962	14.1	14,005	11.9	5,957	24.8	8,137	2.86	<0.001

Chi-square test; [§]t-test; [a]Total SDB cohort vs. comparison cohort; [†]New Taiwan Dollar (NTD), 1 NTD is equal to 0.03 USD; [‡]The urbanization level was divided based on the population density of the residential area into four levels, wherein level 1 was the most urbanized and level 4 was the least urbanized; [&]Other occupation categories included those who were primarily retired, unemployed, and from low-income populations.

respectively. Patients <50 years of age in the SDB, SBN, and SBI cohorts had a specifically higher risk of SA when compared with the comparison cohort (aHR = 8.18, 95% CI = 6.09–11.0; aHR = 6.66, 95% CI = 4.93–9.00; aHR = 16.6, 95% CI = 12.0–22.9, respectively). Regarding sex stratification, the SBI cohort specifically had a higher risk of SA compared with the comparison cohort (aHR = 7.18, 95% CI = 5.45–9.46 for men; aHR = 9.96, 95% CI = 7.44–13.3 for women). Patients with SBI and monthly income below NTD15,000 and with NTD15,000–19,999 also specifically had a higher risk of SA (aHR = 8.76, 95% CI = 6.14–12.5, aHR = 8.81, 95% CI = 6.70–11.6, respectively), compared with comparisons. Compared with the comparison cohort, the SDB cohort generally had a higher risk of SA across different urbanization levels, occupations, and with or without comorbidities. However, patients with SBI specifically had a higher risk of SA irrespective of the urbanization level (aHR = 10.3, 9.76, 8.82, and 6.61 for levels 1 to 4) or occupation categories (aHR = 10.5, 7.42, and 6.84 for office worker, laborer, and others, respectively) (**Table 2**).

Table 3 presents the incidence and HR of SA between the SBN and SBI cohorts. Compared with patients with SBN, a significantly higher risk of SA was observed in patients with SBI (aHR = 2.22), especially in those aged under 50 years (aHR = 2.48). Generally, patients with SBI who were in all difference

TABLE 2 | Comparison of incidence and hazard ratio for suicide attempt stratified by age, sex, monthly income, urbanization level, occupation, and comorbidity between the SDB, SBN, SBI, and comparison cohorts.

	Comparison *N* = 284,126		SDB *N* = 142,063			SBN *N* = 118,067			SBI *N* = 23,996		
	Event (*N*)	Rate[#]	Event (*N*)	Rate	Adjusted HR (95% CI)[$]	Event (*N*)	Rate	Adjusted HR (95% CI)[&]	Event (*N*)	Rate	Adjusted HR (95% CI)[&]
All	215	1.65	870	14.8	4.75 (4.02, 5.62)***	535	11.1	4.09 (3.44, 4.86)***	335	31.4	8.44 (6.91, 10.3)***
Age, years											
≤49	58	1.11	497	19.9	8.18 (6.09, 11.0)***	264	13.2	6.66 (4.93, 9.00)***	233	46.8	16.6 (12.0, 22.9)***
50–64	43	1.27	174	11.3	4.68 (3.21, 6.82)***	120	9.34	4.27 (2.91, 6.27)***	54	21.4	7.38 (4.64, 11.7)***
≥65	114	2.58	199	10.7	2.84 (2.17, 3.71)***	151	9.78	2.69 (2.04, 3.55)***	48	15.1	3.68 (2.52, 5.37)***
P for interaction					<0.001			<0.001			
Sex											
Female	94	1.59	447	16.3	5.52 (4.31, 7.08)***	294	12.8	4.76 (3.69, 6.14)***	153	33.7	9.96 (7.44, 13.3)***
Male	121	1.70	423	13.4	4.11 (3.27, 5.17)***	241	9.48	3.53 (2.79, 4.48)***	182	29.6	7.18 (5.45, 9.46)***
P for interaction					0.08			0.35			
Monthly income[†]											
<15,000	68	1.96	268	16.1	4.63 (3.43, 6.26)***	160	11.9	3.92 (2.87, 5.35)***	108	33.7	8.76 (6.14, 12.5)***
15,000–19,999	106	1.79	496	17.1	5.30 (4.20, 6.69)***	308	13.3	4.62 (3.64, 5.87)***	188	32.2	8.81 (6.70, 11.6)***
≥20,000	41	1.13	106	7.90	3.13 (2.05, 4.79)***	67	5.70	2.75 (1.77, 4.26)***	39	23.6	6.42 (3.72, 11.1)***
P for interaction					0.94			0.18			
Urbanization level[‡]											
1 (highest)	34	0.90	141	10.4	5.52 (3.63, 8.38)***	98	8.23	4.97 (3.24, 7.60)***	43	25.6	10.3 (6.09, 17.3)***
2	62	1.60	272	15.3	5.65 (4.15, 7.69)***	174	12.0	4.96 (3.63, 6.82)***	98	30.8	9.76 (6.75, 14.1)***
3	33	1.51	140	14.1	4.52 (2.95, 6.92)***	81	9.98	3.76 (2.42, 5.85)***	59	32.5	8.82 (5.36, 14.5)***
4 (lowest)	86	2.68	317	17.9	3.79 (2.89, 4.96)***	182	13.3	3.16 (2.38, 4.18)***	135	33.6	6.61 (4.82, 9.06)***
P for interaction					0.008			<0.001			
Occupation category[&]											
Office worker	77	1.16	319	12.4	5.77 (4.38, 7.61)***	211	9.58	5.12 (3.86, 6.79)***	108	28.7	10.5 (7.49, 14.8)***
Laborer	99	2.01	402	16.2	4.37 (3.41, 5.60)***	242	12.3	3.72 (2.88, 4.81)***	160	31.1	7.42 (5.55, 9.93)***
Other	39	2.64	149	17.8	3.57 (2.38, 5.35)***	82	28.7	2.92 (1.91, 4.44)***	67	37.8	6.84 (4.27, 11.0)***
P for interaction					0.02			0.006			
Comorbidity[§]											
None	117	1.08	149	7.16	6.59 (5.13, 8.46)***	105	5.79	5.41 (4.13, 7.09)***	44	16.4	14.0 (9.76, 20.0)***
With any one	98	4.46	721	18.9	2.97 (2.39, 3.69)***	430	14.3	2.37 (1.89, 2.96)***	291	36.3	5.32 (4.19, 6.76)***
P for interaction					0.009			<0.001			

*CI, confidence interval; HR, hazard ratio; PY, person-years; [#]Incidence rate per 10,000 person-years; [$]Multivariable analysis included age, monthly income, urbanization level, and comorbidity of schizophrenia, alcohol-related illness, anxiety, mental disorders, diabetes mellitus, hypertension, hyperlipidemia, chronic obstructive pulmonary disease, coronary artery disease, stroke, and cirrhosis; [†]New Taiwan Dollar (NTD), 1 NTD is equal to 0.03 USD; [‡]The urbanization level was divided based on the population density of the residential area into four levels, wherein level 1 was the most urbanized and level 4 was the least urbanized; [&]Other occupation categories included those who were primarily retired, unemployed, and from low-income populations; [§]Individuals with schizophrenia, depression, alcohol-related illness, anxiety, mental disorders, diabetes mellitus, hypertension, hyperlipidemia, chronic obstructive pulmonary disease, coronary artery disease, stroke, and cirrhosis were classified into the comorbidity group; ***p < 0.001.*

stratified had a significantly higher risk of SA when compared with patients with SBN (**Table 3**).

Table 4 demonstrates the overall incidence of SDO in the comparison cohort and the SDB, SBN, and SBI cohorts. Of 142,063 patients with SDB, 1,121 patients with SBN and 585 patients with SBI were diagnosed with SDO, with a total incidence of 1.20%. By contrast, 596 patients had SDO among the 284,126 individuals in the comparison cohort, with an incidence of 0.21%. Compared with the comparison cohort, the SDB cohort (aHR = 3.38, 95% CI = 3.04–3.76), SBN cohort (aHR = 2.99, 95% CI = 2.68–3.34), and SBI cohort (aHR = 5.36, 95% CI = 4.69–6.12) had a significantly higher risk of SDO after adjusting for confounders. Upon comparing the SBI and SBN cohorts, the SBI cohort had a significantly higher risk of SDO, with aHR of 1.81 (95% CI = 1.63–2.02) (**Table 4**).

Table 5 presents the incidence and HRs of SDO with drug or medicinal substance, SDO with benzodiazepine-based tranquilizers, or SDO with unknown others for the SDB, SBN, and SBI cohorts. Among the categories of SDO, drug or medicinal substance was the method of choice for 293 patients—57 among 284,126 individuals of the comparison cohort, 137 among 118,067 patients in the SBN cohort, and 99 among 23,996

TABLE 3 | Comparison of incidence and hazard ratio for suicide attempt stratified by age, sex, and comorbidities between patients with SDB with and without head trauma.

	SBN (*N* = 118,067)	SBI (*N* = 23,996)
	Adjusted HR[$] (95% CI)	Adjusted HR[&] (95% CI)
All	1.00	2.22 (1.92, 2.56)***
Age, years		
≤49	1.00	2.48 (2.06, 3.00)***
50–64	1.00	1.83 (1.31, 2.56)***
≥65	1.00	1.47 (1.05, 2.04)*
P for interaction		<0.001
Sex		
Female	1.00	2.10 (1.72, 2.58)***
Male	1.00	2.06 (1.68, 2.54)***
P for interaction		0.26
Monthly income[†]		
<15,000	1.00	2.29 (1.76, 2.96)***
15,000–19,999	1.00	1.90 (1.57, 2.30)***
≥20,000	1.00	2.47 (1.61, 3.79)***
P for interaction		0.20
Urbanization level[‡]		
1 (highest)	1.00	2.10 (1.44, 3.07)***
2	1.00	1.98 (1.52, 2.57)***
3	1.00	2.35 (1.64, 3.35)***
4 (lowest)	1.00	2.06 (1.63, 2.60)***
P for interaction		0.42
Occupation category[&]		
Office worker	1.00	2.09 (1.63, 2.67)***
Laborer	1.00	1.97 (1.60, 2.43)***
Other	1.00	2.39 (1.70, 3.37)***
P for interaction		0.79
Comorbidity[§]		
None	1.00	2.63 (1.84, 3.77)***
With any one	1.00	2.25 (1.94, 2.63)***
P for interaction		0.50

*CI, confidence interval; HR, hazard ratio; [$]Multivariable analysis included age, monthly income, urbanization level, and comorbidities of schizophrenia, alcohol-related illness, anxiety, mental disorders, insomnia, diabetes mellitus, hypertension, hyperlipidemia, chronic obstructive pulmonary disease, coronary artery disease, stroke, and cirrhosis; [†]New Taiwan Dollar (NTD), 1 NTD is equal to 0.03 USD; [‡]The urbanization level was divided based on the population density of the residential area into four levels, wherein level 1 was the most urbanized and level 4 was the least urbanized; [&]Other occupation categories included those who were primarily retired, unemployed, and from low-income populations; [§]Individuals with schizophrenia, depression, alcohol-related illness, anxiety, mental disorders, and insomnia were classified into the comorbidity group; *p < 0.05, ***p < 0.001.*

TABLE 4 | Incidence of suicidal drug overdose (per 10,000 person-years) and hazard ratios estimated through the Cox method in patients with SDB with or without head trauma.

	Comparison	SDB	SBN	SBI
Variable	***N* = 284,126**	***N* = 142,063**	***N* = 118,067**	***N* = 23,996**
Person-years				
Event, *n*	596	1,706	1,121	585
Rate[#]	4.57	29.0	23.3	55.2
Crude HR (95% CI)	1 (Reference)	6.27 (5.72, 6.89)***	5.00 (4.53, 5.53)***	12.2 (10.9, 13.6)***
Adjusted HR[$] (95% CI)	1 (Reference)	3.38 (3.04, 3.76)***	2.99 (2.68, 3.34)***	5.36 (4.69, 6.12)***
Crude HR (95% CI)			1 (Reference)	2.45 (2.22, 2.71)***
Adjusted HR[$] (95% CI)			1 (Reference)	1.81 (1.63, 2.02)***

*[#]Incidence rate per 10,000 person-years; [$]Multivariable analysis included age, monthly income, urbanization level, and comorbidities of schizophrenia, alcohol-related illness, anxiety, mental disorders, insomnia, diabetes mellitus, hypertension, hyperlipidemia, chronic obstructive pulmonary disease, coronary artery disease, stroke, and cirrhosis. ***p < 0.001.*

patients in the SBI cohort. The SDB, SBN, and SBI cohorts had higher risks of drug or medicinal substance overdose than the comparison cohort (aHR = 4.16, 95% CI = 3.00–5.78; aHR = 3.45, 95% CI = 2.46–4.83; aHR = 8.14, 95% CI = 5.56–11.9, respectively). Of the 520 patients who used benzodiazepine-based tranquilizers, 111 were from the comparison cohort, 288 were from the SBN cohort, and 121 were from the SBI cohort, with aHRs of 4.75 (95% CI = 3.75–6.01), 4.42 (95% CI = 3.48–5.62), and 6.55 (95% CI = 4.87–8.80) in SDB, SBN, and SBI cohorts, respectively. Further, the SBI cohort did exhibit a significantly increased risk of SDO with drug or medicinal substance and benzodiazepine-based tranquilizers when compared with the SBN cohort (**Table 5**).

DISCUSSION

Despite recognizing the importance of reducing suicidal deaths worldwide, several developed countries have not yet invested sufficient resources in research and prevention of SA (3). Notably, there was dissociation between knowing suicidal ideation and attempt in patients with emotional or physical distress to prevent their SA efficiently (14). We observed that in the comparison cohort and the cohort of SDB without head trauma, the respective incidence of SA was 1.11 and 13.2 per 10,000 person-years, 1.27 and 9.43 per 10,000 person-years, and 2.58 and 9.78 per 10,000 person-years for individuals <50 years old, 50–64 years old, and ≥65 years old, respectively. Contrary to the general belief that older people with more somatic disorders would develop a higher risk of SA, patients younger than 50 years with SDB were observed to have a much higher risk of SA in this study. Moreover, no apparent different risks for SA were observed between male and female patients in this study.

SDO or self-intoxication is currently the frequently chosen suicidal method in Europe. Approximately 71% of female registered SAs are because of SDO, whereas 50% of male registered SAs are SDO (3). Fortunately, in Europe, more than 95% of people who attempt SDO would eventually survive (2). Although SDO is a non-violent suicidal method with a low mortality risk than the suicides through violent means, SA with SDO should be effectively prevented before a patient even attempts it, especially in Asian countries (15, 16). This

TABLE 5 | Incidence of different ways of suicidal drug overdose (per 10,000 person-years) and hazard ratios estimated through the Cox method in patients with SDB with or without head trauma.

	Comparison	SDB	SBN	SBI
Variable	***N* = 284,126**	***N* = 142,063**	***N* = 118,067**	***N* = 23,996**
Poisoning by unspecified drug or medicinal substance				
Event, *n*	57	236	137	99
Rate	0.44	4.02	2.84	9.34
Crude HR (95% CI)	1 (Reference)	9.06 (6.79, 12.1)***	6.38 (4.68, 8.69)***	21.5 (15.6, 29.8)***
Adjusted HR[$] (95% CI)	1 (Reference)	4.16 (3.00, 5.78)***	3.45 (2.46, 4.83)***	8.14 (5.56, 11.9)***
Crude HR (95% CI)			1 (Reference)	3.38 (2.61, 4.38)***
Adjusted HR[$] (95% CI)			1 (Reference)	2.39 (1.82, 3.14)***
Poisoning by benzodiazepine-based tranquilizers				
Event, *n*	111	409	288	121
Rate	0.85	6.96	5.98	11.4
Crude HR (95% CI)	1 (Reference)	8.07 (6.55, 9.96)***	6.90 (5.54, 8.59)***	13.5 (10.4, 17.5)***
Adjusted HR[$] (95% CI)	1 (Reference)	4.75 (3.75, 6.01)***	4.42 (3.48, 5.62)***	6.55 (4.87, 8.80)***
Crude HR (95% CI)			1 (Reference)	1.96 (1.58, 2.42)***
Adjusted HR[$] (95% CI)			1 (Reference)	1.48 (1.19, 1.86)***
Poisoning by others				
Event, *n*	428	1,061	696	365
Rate	3.28	18.1	14.5	34.4
Crude HR (95% CI)	1 (Reference)	5.44 (4.86, 6.08)***	4.32 (3.83, 4.88)***	10.6 (9.19, 12.2)***
Adjusted HR[$] (95% CI)	1 (Reference)	2.92 (2.57, 3.33)***	2.57 (2.25, 2.94)***	4.64 (3.94, 5.46)***
Crude HR (95% CI)			1 (Reference)	2.48 (2.18, 2.81)***
Adjusted HR[$] (95% CI)			1 (Reference)	1.83 (1.60, 2.09)***

[$] *Multivariable analysis included age, monthly income, urbanization level, and comorbidities of schizophrenia, alcohol-related illness, anxiety, mental disorders, insomnia, diabetes mellitus, hypertension, hyperlipidemia, chronic obstructive pulmonary disease, coronary artery disease, stroke, and cirrhosis; ***$p < 0.001$.*

study evidenced the proportional increases in the risks of SA and SDO in the SDB and SBI cohorts. The results implied that prescribed medical substances and tranquilizers could be dangerously abused for suicide (by overdosing on medications) in patients with SDB, even by using the prescription drugs from the medical care system. It should be due to the restricted access to firearms by law in Taiwan and most Asian countries. Therefore, prescription for several medications should hereafter be carefully dispensed in patients with SDB and head trauma.

SDB is known to be typically under-diagnosed and under-treated, and it has strong adverse effects on traffic and work accidents (17). Compared with a study in the United States that reported that 2.81% of adults with abnormal sleep had various degrees of accidental injuries (17), this study revealed a relatively higher incidence (16.89%) of Taiwan residents with SDB who were admitted for moderate or severe head trauma in the 14-year duration. Those with SDB and head trauma were predominantly noted in those <50 years old. The incidence of head trauma and the prevalence of young age in patients with SDB had not been considered significant earlier. Nonetheless, SDB itself could increase the HRs of SA and SDO 4.75 and 3.38 times compared with healthy individuals. After patients with SDB experience head trauma, their HRs of SA and SDO considerably increase to 8.44 and 5.36 times. Therefore, we suggest that head trauma can generally increase the risks of SA and SDO in patients with SDB. Any such admission in Taiwan should be treated with more prudence by clinicians and social workers to prevent patient suicidality, especially in men <50 years old.

Nonetheless, the actual mechanisms of the effects of SDB and admission for head trauma on suicidality and how these mechanisms together increase the risks of SA and SDO warrant further investigational studies. Considering the neuro-psychological pathology of psychotrauma and TBI, there were biological evidences that brain insult could increase the neuro-inflammation reactions involving the blood–brain barrier, glutamate regulation, microglia activation, and autoimmune response (18, 19), which can affect patients' physical endurance, sleep, chronic cognition, and associated psychosocial sequelae through the dysregulation of cortical reactivity (20–22). These pathologies would lead to a pre- and post-TBI gap in re-engaging patients' desired lives after head trauma, thereby contributing to suicidality. However, the relationship between SDB and suicidality is a topic of debate as per current studies. Oxidative stress because of intermittent hypoxemia of SDB (23) and decreased serotonin synthesis owing to the effects of hypoxemia on tryptophan hydroxylase can probably cause suicidality (24). To the best of our knowledge, only one study specifically examined the relationship between SDB, trauma, and suicidality (25). This study revealed a notably bidirectional relationship between SDB severity in posttraumatic patients and their suicidal ideation, but without any information regarding SA in patients.

Our study has documented that the risks of subsequent SA and SDO are proportionally increased by the effects of head trauma with a moderating role of SDB. The study is the first to analyze SA and SDO associated with SDB and head trauma. However, there were several limitations in this study. First of all, this was a retrospective study using the NHI inpatient data related to head trauma and SDB. We identified SA, SDO, head trauma, and SDB based on the inpatient records of the ICD-9-CM coding system. The accuracy of NHI claims data is assured by the severe penalty if fraud and false claiming is found. However, a rare chance of minor SA, SDO, and head trauma in patients with SDB not being enrolled for exists, which can result in little underestimation of the risks of SA and SDO. Second, we could not directly contact patients to understand the details of their disease severity of SDB and head trauma, their suicidal ideation, or treatment for their disorders because patients' identities were anonymized in the NHIRD. These details could be confounding to the individual severity of personal stress and suicidality. Finally, even though the study design controlled numerous confounders as we have already known, some unknown confounders may not be measured. However, this large-scale, unselective study has helped us to understand more about the risks and correlated risk factors for SA and SDO in patients with SDB with and without head trauma, thereby helping to build a more effective prevention system in the future.

CONCLUSIONS

The risks of subsequent SA and SDO are proportionally increased by the effects of head trauma with a moderating role of SDB, especially in those aged <50 years. SDB and head trauma would raise SA and SDO individually and synergistically. Furthermore, our findings provide crucial information that long-term medical substances or tranquilizers in patients with SDB and head trauma should be prescribed with prudence in the future.

DATA AVAILABILITY STATEMENT

The datasets analyzed in this article are not publicly available. Requests to access the datasets should be directed to the Taiwan Ministry of Health and Welfare (MOHW). The Ministry of Health and Welfare must approve our application to access this data. Any researcher interested in accessing this dataset can submit an application form to the Ministry of Health and Welfare requesting access. Please contact the staff of MOHW (Email: stcarolwu@mohw.gov.tw) for further assistance. All relevant data are within the paper.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Research Ethics Committee of China Medical University and Hospital in Taiwan approved this study (CMUH104-REC2-115-CR4). Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

TH and C-HK: conception/design. C-HK: provision of study material and patients. All authors: collection and assembly of data, data analysis and interpretation, manuscript writing, and final approval of manuscript.

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REFERENCES

1. World Health Organization. *Preventing Suicide: a Global Imperative*. Geneva, Switzerland: World Health Organization (2014).
2. Mergl R, Koburger N, Heinrichs K, Székely A, Tóth MD, Coyne J, et al. What are reasons for the large gender differences in the lethality of suicidal acts? an epidemiological analysis in four European countries. *PLoS ONE.* (2015) 10:e0129062. doi: 10.1371/journal.pone.0129062
3. Hegerl U. Prevention of suicidal behavior. *Dialogues Clin Neurosci.* (2016) 18:183–90. doi: 10.31887/DCNS.2016.18.2/uhegerl
4. Vgontzas AN, Liao D, Pejovic S, Calhoun S, Karataraki M, Basta M, et al. Insomnia with short sleep duration and mortality: the Penn state cohort. *Sleep.* (2010) 33:1159–64. doi: 10.1093/sleep/33.9.1159
5. Ohayon MM. Observation of the natural evolution of insomnia in the American general population cohort. *Sleep Med Clin.* (2009) 4:87–92. doi: 10.1016/j.jsmc.2008.12.002
6. Garbarino S, Guglielmi O, Sanna A, Mancardi GL, Magnavita N. Risk of occupational accidents in workers with obstructive sleep apnea: systematic review and meta-analysis. *Sleep.* (2016) 39:1211–8. doi: 10.5665/sleep.5834
7. Yaffe K, Laffan AM, Harrison SL, Redline S, Spira AP, Ensrud KE, et al. Sleep-disordered breathing, hypoxia, and risk of mild cognitive impairment and dementia in older women. *JAMA.* (2011) 306:613–9. doi: 10.1001/jama.2011.1115
8. Bishop TM, Ashrafioun L, Pigeon WR. Association between sleep apnea and suicidal thought and behavior. *Sleep.* (2017) 40:A414–5. doi: 10.1093/sleepj/zsx050.1111
9. Rosenberg H, McDonald S, Dethier M, Kessels RP, Westbrook RF. Facial emotion recognition deficits following moderate-severe Traumatic Brain Injury (TBI): re-examining the valence effect and the role of emotion intensity. *J Int Neuropsychol Soc.* (2014) 20:994–1003. doi: 10.1017/S1355617714000940
10. van Dijke A, Hopman JAB, Ford JD. Affect dysregulation, psychoform dissociation, and adult relational fears mediate the relationship between childhood trauma and complex posttraumatic stress disorder independent of the symptoms of borderline personality disorder. *Eur J Psychotraumatol.* (2018) 9:1400878. doi: 10.1080/20008198.2017.1400878
11. Fine NB, Achituv M, Etkin A, Merin O, Shalev AY. Evaluating web-based cognitive-affective remediation in recent trauma survivors: study rationale and protocol. *Eur J Psychotraumatol.* (2018) 9:1442602. doi: 10.1080/20008198.2018.1442602

12. Database NHIR. *Taiwan*. Available online at: http://nhird.nhri.org.tw/en/index.html (accessed March 8, 2019).
13. Chen KL, Tseng MH, Hu FC, Koh CL. Pediatric evaluation of disability inventory: a cross-cultural comparison of daily function between Taiwanese and American children. *Res Dev Disabil.* (2010) 31:1590–600. doi: 10.1016/j.ridd.2010.05.002
14. Lanius RA. Trauma-related dissociation and altered states of consciousness: a call for clinical, treatment, and neuroscience research. *Eur J Psychotraumatol.* (2015) 6:27905. doi: 10.3402/ejpt.v6.27905
15. Verma V, Paul S, Ghose A, Eddleston M, Konradsen F. Treatment of self-poisoning at a tertiary-level hospital in Bangladesh: cost to patients and government. *Trop Med Int Health.* (2017) 22:1551–60. doi: 10.1111/tmi.12991
16. Chang CH, Chen SJ, Liu CY, Tsai HC. Suicidal drug overdose following stroke in elderly patients: a retrospective population-based cohort study. *Neuropsychiatr Dis Treat.* (2018) 14:443–50. doi: 10.2147/NDT.S157494
17. Bhattacharyya N. Abnormal sleep duration is associated with a higher risk of accidental injury. *Otolaryngol Head Neck Surg.* (2015) 153:962–5. doi: 10.1177/0194599815604103
18. Rosenblat JD, Cha DS, Mansur RB, McIntyre RS. Inflamed moods: a review of the interactions between inflammation and mood disorders. *Prog Neuropsychopharmacol Biol Psychiatry.* (2014) 53:23–34. doi: 10.1016/j.pnpbp.2014.01.013
19. Strawbridge R, Young AH, Cleare AJ. Biomarkers for depression: recent insights, current challenges and future prospects. *Neuropsychiatr Dis Treat.* (2017) 13:1245–62. doi: 10.2147/NDT.S114542
20. Klimova A, Bryant RA, Williams LM, Felmingham KL. Dysregulation in cortical reactivity to emotional faces in PTSD patients with high dissociation symptoms. *Eur J Psychotraumatol.* (2013) 4. doi: 10.3402/ejpt.v4i0.20430
21. Beadle EJ, Ownsworth T, Fleming J, Shum DHK. The nature of occupational gaps and relationship with mood, psychosocial functioning and self-discrepancy after severe traumatic brain injury. *Disabil Rehabil.* (2019) 22:1414–22. doi: 10.1080/09638288.2018.1527954
22. Schiehser DM, Delano-Wood L, Jak AJ, Hanson KL, Sorg SF, Orff H, et al. Predictors of cognitive and physical fatigue in post-acute mild-moderate traumatic brain injury. *Neuropsychol Rehabil.* (2017) 27:1031–46. doi: 10.1080/09602011.2016.1215999
23. Lavie L. Oxidative stress in obstructive sleep apnea and intermittent hypoxia–revisited–the bad ugly and good: implications to the heart and brain. *Sleep Med Rev.* (2015) 20:27–45. doi: 10.1016/j.smrv.2014.07.003
24. Young SN. Elevated incidence of suicide in people living at altitude, smokers and patients with chronic obstructive pulmonary disease and asthma: possible role of hypoxia causing decreased serotonin synthesis. *J Psychiatry Neurosci.* (2013) 38:423–6. doi: 10.1503/jpn.130002
25. Gupta MA, Jarosz P. Obstructive sleep apnea severity is directly related to suicidal ideation in posttraumatic stress disorder. *J Clin Sleep Med.* (2018) 14:427–35. doi: 10.5664/jcsm.6992

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Suicidal Ideation Mediates the Relationship Between Affect and Suicide Attempt in Adolescents

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Suicide, as one of the leading causes of death for the adolescent population, both in Chile and globally, remains a complex and elusive phenomenon. This research studies the association between positive and negative affect in relation with suicidal ideation and suicidal attempt, given that affectivity is a fundamental basis on which people make evaluations on their satisfaction with life. First, it examines the reliability, structure, and validity of Watson's positive and negative affect scale (PANAS) scale in a representative random sample of Chilean high school students (N = 4,568). The scale evidences strong reliability coefficients and a confirmatory factor analysis, excluding one positive (excited) and one negative (nervous) item. The scale shows a satisfactory goodness of fit. Secondly, it investigates the association of PANAS positive and negative affect scores with suicidal ideation as well as reported attempt in adolescents, controlling for the potential effect of age and sex (N = 420 high school students). Low positive and high negative affect, but not sex and age, show a significant association with suicidal ideation. Suicidal ideation totally mediates the association of affect with suicide attempt, as expected. Results are discussed regarding prevention and it considers how positive and negative affect can be relevant as indicators for prevention and treatment using widely available technology.

Keywords: positive affect, negative affect, suicidal ideation, suicide attempt, adolescents, positive and negative affect schedule (PANAS)

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INTRODUCTION

This study examines affect dimensions, measurements, and the association between positive and negative affect regarding suicidal ideation. Almost 800,000 people suicide each year, and in older adolescents it is the second leading cause of death (WHO, 2019). Some studies show that suicidal attempts can be partially explained by the levels of satisfaction with life (Flores et al., 2019) and other hedonic well-being variables such as affects (Sisask et al., 2008; Dunkley et al., 2017). Affectivity is defined based on the "range, intensity, lability, and appropriateness of emotional response" (American Psychiatric Association, 2013, p. 646) experienced by individuals.

As has been studied by Watson and Stanton (2017), affect shows a positive versus negative dimension, and on the other hand, it exhibits a high versus low activation or arousal dimension. These structures emerge when analyzing self-reports and other measures of affect. Positive affect implies high (excited, joyful) versus low (bored) arousal positive valence states, while negative affect includes high (annoyed, nervous) versus low (calm, relaxed) arousal valence states (Watson and Stanton, 2017). Positive and negative affect are not opposite but relatively independent dimensions. With the exception of strong negative emotional states, middle-high levels of positive and negative affect may co-exist (Diener et al., 1999; Watson, 2000; Larsen and Prizmic, 2008). The positive and negative affect scale (PANAS) is one of the best-known measures of hedonic well-being and affect balance (Watson et al., 1988; Robles and Páez, 2003; Thompson, 2007). This scale contains 20 mood and emotion descriptors (e.g., active, excited, hostile) which are relatively pure markers of either high negative affect (NA) or high positive affect (PA). Usually the 10 items for positive mood and 10 items for negative mood are aggregated to yield the separate PA and NA scale scores for each subject. Items are usually answered using a five-point scale. In the Spanish language version, in a sample of students from Spain, the Cronbach alpha for NA was 0.85 and 0.88 for PA with the means being 21.67 (SD = 6.6) and 34.07 (SD = 7.0), respectively (Ramírez-Maestre et al., 2017).

Positive and negative affect are associated with rumination. Studies show an association between rumination and low positive affect (i.e., sadness-depression), while longitudinal studies show more diverse results (Zvolensky et al., 2016; Brookes et al., 2017; Li et al., 2017). Concerning the relation between rumination and negative affect, there is strong evidence for a positive association between rumination and anxiety, but not with other components of high negative affect (Thomsen, 2006). A form of repetitive non-reflective negative rumination or brooding is related to suicidal ideation and negative affect (Surrence et al., 2009; Rogers and Joiner, 2017). Also, suicide-specific rumination has been shown to be related to suicide attempts more than many other common risk factors for suicide (Rogers and Joiner, 2018). Four facets of suicidal ideation and suicide are usually differentiated in the international literature (Nock et al., 2009): passive suicidal ideation (wishing not to live, to be dead, to die), active suicidal ideation (wishing to kill oneself, planning or thinking about how to kill oneself), attempt or autolysis or inflicting harm to try to take one's life, and consummated suicide or successful attempt to voluntarily take one's life. It is important to mention that each of these stages corresponds to a different phenomenon, each with a different explanation (Klonsky et al., 2016).

A cross-cultural study in 17 nations found a cross-national lifetime prevalence of 9.2% of passive suicidal ideation, 3.1% of active ideation or plans, and 2.7% of attempts. Across all countries, 60% of transitions from ideation to plan and attempt occur within the first year after ideation onset (Nock et al., 2009). A meta-analysis found a strong but highly heterogeneous association between suicidal ideation and later suicide, r = 0.32 (McHugh et al., 2019). Suicidal ideation is associated to affective symptoms in general and amongst young people in particular (Joiner et al., 2005; Van Orden et al., 2010; Teismann et al., 2018; von Brachel et al., 2019). In adolescents hospitalized for psychiatric illness, negative emotions such as anxiety, anger, and hopelessness (Pinto and Whisman, 1996) have a strong relationship with suicidal behaviors. The main issue with this approach is that it is essentially focused on people with psychological or psychiatric disorders (Gould et al., 1998; Prinstein et al., 2000; Sareen et al., 2005; Hauser et al., 2013; Koutek et al., 2016; Barros et al., 2017; Miché et al., 2018; Hill et al., 2019), with less empirical evidence for non-clinical adolescents. Those who have centered research on non-clinical adolescents have found that stress (related to negative affect) and hopelessness and social isolation (associated to low positive affect), are significant predictors of suicidal ideation (Wilburn and Smith, 2005; Van Orden et al., 2010). A meta-analysis based on general population samples found that hopelessness (r = 0.31), depression (r = 0.24), and anxiety (r = 0.16) were three of the five most significant predictors of suicidal ideation (Franklin et al., 2017). This suggests that low positive (related to depression and hopelessness) and high negative affect (associated to both depression and anxiety) are relevant determinants of this type of negative rumination.

In this study, we want to contrast a two-dimensional model of affect and examine its association with satisfaction with life and suicidal ideation. It is expected that positive affect has strong associations with satisfaction with life. Likewise, it is expected that high negative and low positive affect should show a strong association with a form of negative rumination like suicidal ideation, while high positive and low negative affect should show a strong association with functionality and adaptive coping strategies (Yamasaki et al., 2006; Spoor et al., 2007; Nicolas et al., 2014). Finally, we expect that suicidal ideation plays a mediator role between affect and suicide attempt.

MATERIALS AND METHODS

This study was approved by the Faculty of Psychology of [BLINDED]. The research was conducted with resources from [BLINDED] projects N° [BLINDED] and [BLINDED]. The principal aim of the study was to determine the relationship between subjective well-being and academic achievement.

Participants

Research was developed in two steps. First, a probabilistic and stratified sampling was conducted. The sampling units were schools, stratified by type of educational establishment (private, subsidized and public), and by socioeconomic level, from the cities of Santiago, Valparaíso, and Concepción. The sample size was associated with a maximum observed error of ±1.4% assuming a maximum variance and a confidence level of 95%. At the regional level, the absolute error was ±2.4%. In each randomly selected school, all students of second year of high school were surveyed. A total of 4,964 students (50.6% male) answered the questionnaire. Their mean age was 15.59 years (SD = 0.823). Students that answered the entire PANAS

questionnaire were 4,467 (50.7% male; 11% attrition rate) and their mean age was 15.58 years (SD = 0.79).

The second stage aims to study the relationship between suicidal ideation and PANAS, and surveyed students that declared their willingness to participate again in the next academic year (6 months later). From these students (N = 503), 420 (35.6% male; 16.60 years (SD = 0.59); 16% attrition rate) answered the entire second questionnaire that included suicidal ideation and suicide attempt items.

Procedures

In both surveys, participation was voluntary. In the first stage, principals and parents were informed. Parents filled a written informed consent form. Each document detailed the study objectives, the institutions responsible for its implementation, confidentiality and how information would be used. It also stated that participation was voluntary and asked for explicit authorization. Each student filled the questionnaire and a professional interviewer in the classroom, from a university research center, was trained in order to explain the questionnaire and answer possible questions. The application was at the end of the academic year and the next application, for the second stage, was at the beginning of the next academic year. In the first application participants answer PANAS and Satisfaction with Life scales.

In the second stage, an online-survey was administered using the Survey Monkey server. Questionnaires were sent to students' e-mail, including the explanation of the research and an informed consent, which was a request to advance with the questions of the survey. In the second application participation answered PANAS, suicidal ideation scale, and attempted suicide items.

Measurements

Positive and Negative Affect

The Spanish version of PANAS includes 20 adjectives; 10 of them assess Positive Affect (e.g., I feel "excited," "interested") and 10 assess Negative Affect (e.g., I feel "scared," "nervous"). They are rated on five-point Likert scales, ranging from 1 (not at all) to 5 (very much). The participants were asked to report moods and emotions that they had felt during the last week. Separate scores were computed for Positive Affect and Negative Affect. This scale was applied in the first and second questionnaires. PANAS Time 1 with Time 2 disattenuated correlation coefficient score was 0.80 (Time 1: PA α = 0.83; NA α = 0.81).

Satisfaction With Life

The five-item scale developed by Diener et al. (1999) assesses people's satisfaction with life. It comprises five statements (e.g., "I feel satisfied with my life") to be rated on a seven-point Likert scale, ranging from 1 (not at all) to 7 (very much). Cronbach's alpha for this sample was 0.89.

Suicidal Ideation Scale

A three-item instrument was developed to assess suicidal thoughts and attempts of young respondents. All the suicidal ideation items were related to active ideation. The three items are: "Have you thought that life was not worth it?," "Have you ever wished you were dead?," and "Have you ever thought about ending your life?" during the last academic semester (around 6 months from administration of the instrument); each one was evaluated through a four-point scale, ranging from 1 (never) to 4 (often). Reliability was satisfactory (Cronbach's α = 0.89).

Reported Suicide Attempt

It was evaluated by the item "Have you ever attempted to commit suicide?" during the last academic semester (around 6 months from administration of the instrument), with possible answers 1 (never), 2 (once), 3 (a few times), and 4 (many times).

Analysis

First, descriptive statistics are presented. Then, internal consistency of the scale and subscale are reported. A confirmatory factorial analysis was performed using maximum likelihood as the extraction method. Then, convergent validity was assessed, calculating the correlation between PANAS and satisfaction with life scale. Second, using the online survey, a structural equation model was developed in which positive and negative affect were exogenous variables while suicidal ideation was an endogenous variable. Descriptive analyses, internal consistency, correlations, and exploratory factorial analysis were carried out using the software IBM-SPSS v.20. Confirmatory factorial analysis and structural equation modeling were performed with Mplus v. 6.12. Finally, using Hayes' procedure (2017), a mediational analysis was carried out, using positive affect and negative affect as predictors; suicidal ideation as mediator; attempt to commit suicide as dependent variable, and age and sex as co-variables. In order to test the mediational effects, we used the SPSS Process macro for bootstrapping indirect effects (Hayes, 2017), which provides indirect effect estimates for mediators, standard errors (SEs), and the confidence intervals (CIs) derived from the bootstrap distribution. Bootstrapped CIs are superior to standard forms of estimating SEs of indirect effects.

RESULTS

Descriptive statistics are shown in **Table 1**, where it is possible to distinguish the predominance of positive affect. Positive affect scale has a mean of 3.29 (SD = 0.83), while negative affect has a mean of 2.46 (SD = 0.82). This difference was statistically significant in the first and second application – in this paper only, second applications analysis are shown [t (419) = −9.648, $p < 0.001$]. Gender differences were not significant in positive affect [t (418) = −0.887, $p > 0.05$] nor in negative affect [t (418) = 1.791, $p > 0.05$]. Age was associated with negative affect (r = −0.11, $p < 0.05$).

As it can be observed, the scale of suicidal ideation has a mean of 1.78 (SD = 0.83). The percentage of participants who answered "never" to each item was 33% for "Have you thought that life was not worth it?," 42% to "Have you ever wished you were dead?," and 56% to "Have you ever thought about ending your life?." Likewise, 80% answered never to "Have you ever attempted to commit suicide." On the other hand,

TABLE 1 | Descriptive statistics.

	Sample		Boys		Girls	
	M	*SD*	*M*	*SD*	*M*	*SD*
Positive affect	3.29	0.83	3.44	0.78	3.21	0.85
Negative affect	2.46	0.82	2.29	0.82	2.55	0.80
Suicidal ideation	1.78	0.83	1.69	0.71	1.83	0.88

8% answered often to "Have you ever thought about ending your life?," and 4.1% answered many times to "Have you ever attempted to commit suicide?." Gender differences were not statistically significant t (418) = 0.613, $p > 0.05$. Age was not associated with suicidal ideation ($p > 0.05$).

PANAS Validity

The reliability and internal factor structure of the PANAS was studied through Cronbach's alpha and confirmatory factor analysis (CFA), to assure its validity. Scale reliabilities were satisfactory, as Cronbach's alpha was 0.80 for NA and 0.82 for PA (see **Tables 2** and **3**). If the item "excited" is removed from the positive affect scale, the internal consistency improves (α = 0.83) and if the "anxious" item is removed from the negative affect scale, Cronbach's alpha rises to 0.81.

A confirmatory factor analysis (see **Figure 1**) found that the original two-dimensions model with 20 items shows an unsatisfactory fit with the data: χ^2 = 2363.026, p = 0.000; χ^2/degrees of freedom = 13.982; CFI = 0.826; TLI = 0.804, with goodness of fit indices below the conventional 0.90, and RMSEA = 0.076.

In the positive dimension, "excited" and, in the negative dimension, "anxious," show low loads in the corresponding factors (0.37 and 0.31, respectively), so they were excluded to explore improvements in the data fit, considering also the internal consistency analysis. In addition, considering the modification indexes of the initial model, two pairs of items were covaried, one in the set of positive affects and the other in the set of negative affects. These pairs of items were, respectively, strong-active (affects that usually move together, depending on the mood) and scared-frightened (which in Spanish translate into two verbs that differ little semantically). The results of a second CFA (**Figure 2**) supported the PANAS two-factor structure; resulting in an 18-item scale with acceptable fit χ^2 = 1062.389, p = 0.000; χ^2/degrees of freedom = 8,048; CFI = 0.918; TLI = 0.905; RMSEA = 0.056. The correlation coefficient between the latent variables PA and NA was −0.27 ($p < 0.001$).

Convergent criterion validity was also examined. Affect balance scores were computed as PANAS positive minus PANAS negative. Negative or zero scores were achieved by 19.3% of the sample. This is a reasonable percentage of people with a negative mood state in the last week and shows that around eight participants out of 10 reported a positive affect balance. Affect balance correlates with Diener's Satisfaction with Life Scale in the first application, with r (4450) = 0.50, $p < 0.001$, confirming criterion validity.

TABLE 2 | Internal consistency analysis of positive affect items.

Positive Affect items	Correlation item total score	Multiple square correlation	Cronbach's alpha deleting item
PA1Attentive	0.470	0.259	0.814
PA2 Interested	0.455	0.236	0.814
PA3 Alert, awake	0.516	0.284	0.808
PA4 Excited, stimulated	0.329	0.114	0.830
PA5 Enthusiastic	0.604	0.383	0.800
PA6 Inspired	0.544	0.308	0.805
PA7 Proud	0.394	0.168	0.822
PA8 Resolved, decided	0.555	0.322	0.804
PA9 Strong, energetic	0.635	0.492	0.795
PA10 Active	0.648	0.507	0.794

TABLE 3 | Internal consistency analysis of negative affect items.

	Correlation item-total score	Multiple square correlation	Cronbach's alpha deleting item
NA1 Fearful, scared	0.540	0.424	0.785
NA2 Anguished	0.542	0.345	0.784
NA3 Hostile	0.313	0.130	0.809
NA4 Irritable	0.449	0.238	0.795
NA5 Frightened	0.608	0.482	0.778
NA6 Concerned, altered	0.536	0.296	0.785
NA7 Ashamed	0.491	0.283	0.790
NA8 Guilty	0.511	0.277	0.788
NA9 Nervous	0.596	0.384	0.777
NA10 Anxious	0.283	0.136	0.813

Structural Equation Model and Mediational Model

The model including suicidal ideation times 2, negative and positive affect times 1, as well as gender and age (see **Figure 3**), shows a satisfactory goodness of fit: χ^2 = 427.679, p = 0.000; χ^2/degrees of freedom = 1.892; CFI = 0.917; TLI = 0.907; RMSEA = 0.057. Positive affect has a negative structural coefficient (−0.29) with suicidal ideation, whereas negative affect shows a stronger positive coefficient (0.37). For both coefficients, low and high confidence interval did not include zero and were significant (low CI −0.41 and high CI −0.15 and low CI 0.26, and high CI 0.48 respectively). Sex and age were not significantly associated with the dependent variable. Finally, the model explains 30% of variance of the endogenous variable.

Finally, a mediational analysis was carried out, using Hayes' procedure. The analysis considered positive affect and negative affect as predictors, suicidal ideation as mediator, attempt to commit suicide as dependent variable, and age and sex as co-variables. Positive affect correlates r = −0.20 with suicidal attempt, r = −0.27 with negative affect, r = −0.30 with affect

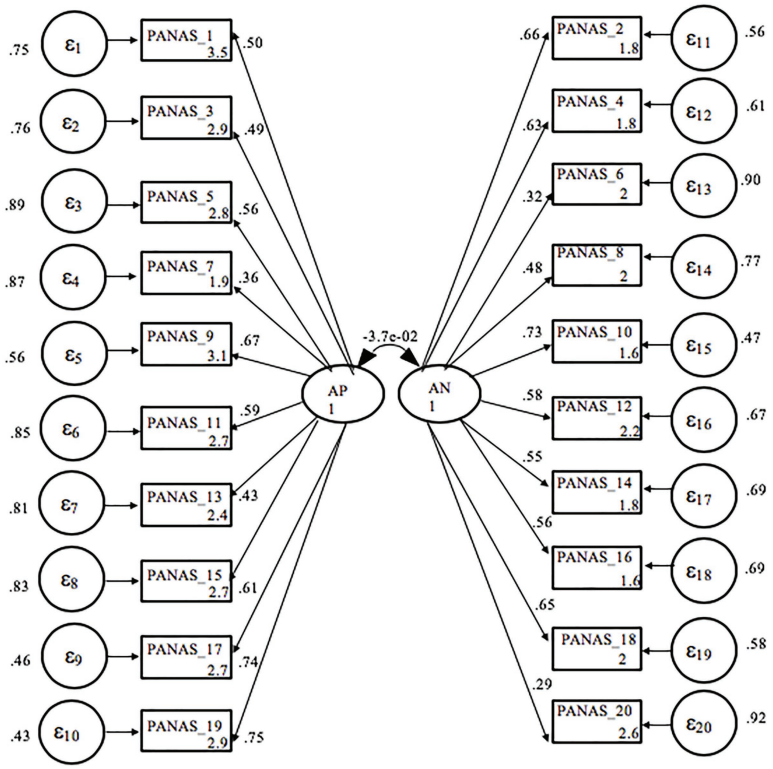

FIGURE 1 | Confirmatory factor analysis including 20 original items and the correlation between positive and negative affect. AP, positive affect; AN, negative affect; εi = standard error for each observed variable.

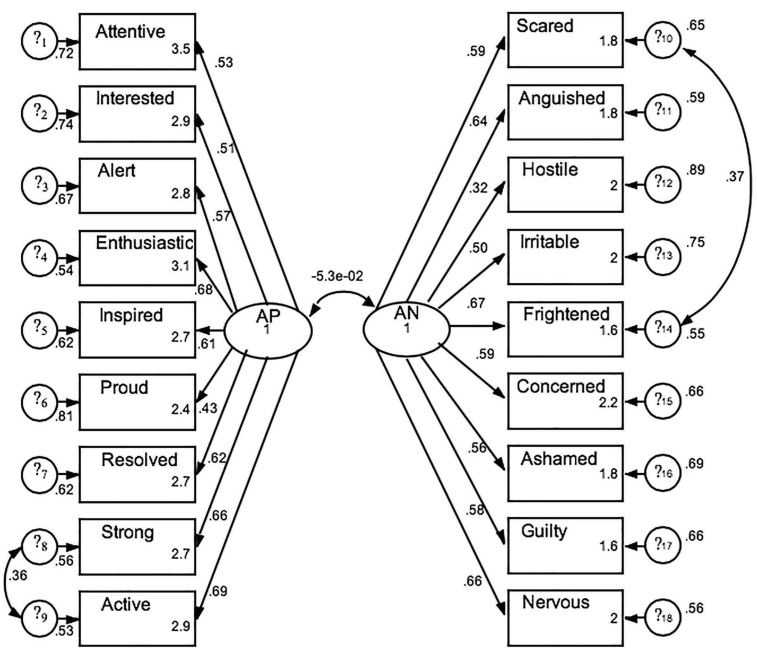

FIGURE 2 | Confirmatory factor analysis including 18 items with better fit and the correlation between positive and negative affect. AP, positive affect; AN, negative affect; $?_i$ = standard error for each observed variable.

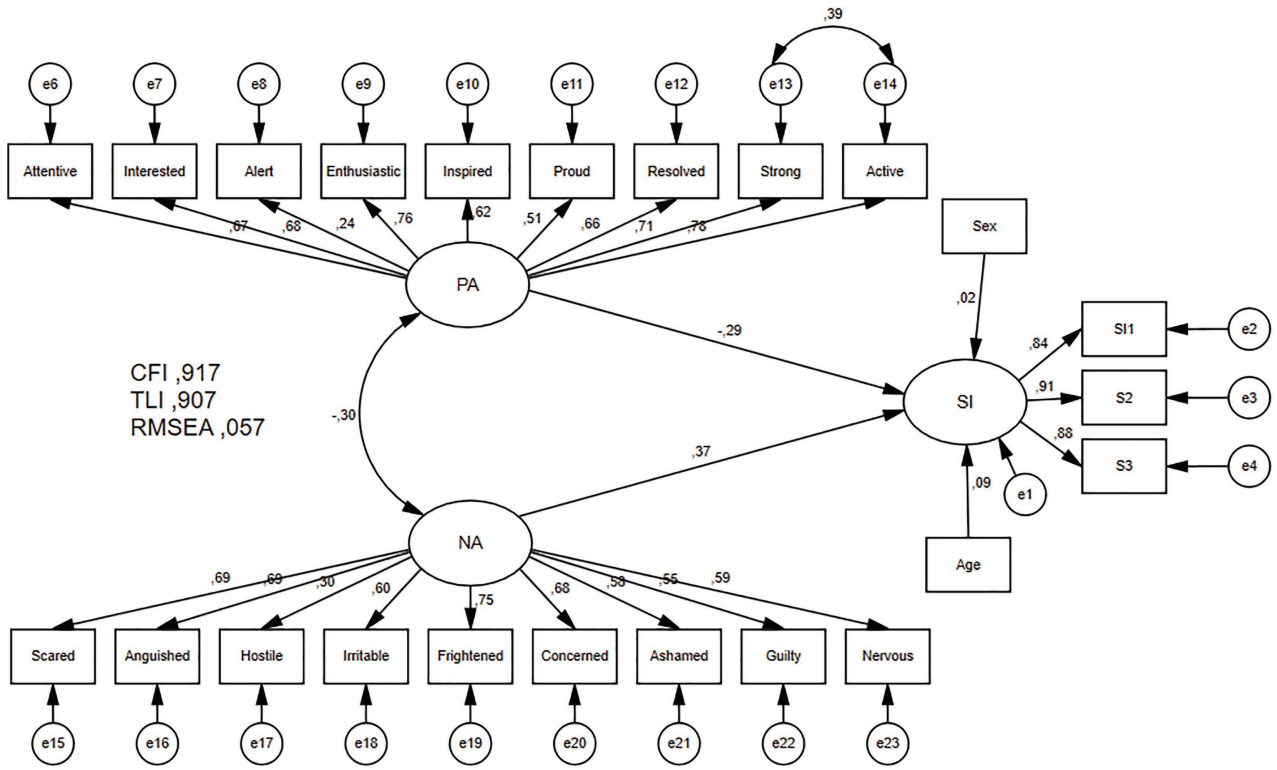

FIGURE 3 | Structural equation model for the relationship between positive affect and negative affect and the association of these variables with suicidal ideation. PA, positive affect; NA, negative affect; SI, suicidal ideation; *ei*, standard error for each observed variable. CFI, comparative it index; TLI, Tucker Lewis index; RMSEA, root mean square error of approximation.

TABLE 4 | Indirect effects of affects on suicidal attempt through suicidal ideation.

	B	SE	BootLLCI	BootULCI
Indirect affect of PA	−0.10	0.03	−0.16	−0.05
Indirect affect of NA	0.17	0.03	0.11	0.24

balance, and $r = 0.65$ with suicidal ideation, all with $p < 0.001$. An indirect effect is significant if the CI does not include zero values. Ideation ($B = 0.17$) and sex ($B = -0.14$) show significant coefficient predicting suicidal attempt. Ideation mediated the effect of affect on suicide attempt, reducing the coefficient of affect to non-significance (total mediation). Indirect effects of positive and negative affects on suicidal attempt through suicidal ideation are presented (separately) in **Table 4**:

DISCUSSION

Regarding the validity of the PANAS scale, it can be said that reliabilities were satisfactory for NA and PA. However, higher reliabilities did not preclude the existence of a different structure from what was expected theoretically. Despite the strong reliabilities of PA and NA, the results of a CFA supported the PANAS two-factor structure only partially. "Excited" in the PA positive dimension and "anxious" in the NA negative dimension showed low loads in the corresponding factors and were excluded to improve data fit. The result of a second CFA using only 18 items supported the PANAS two-factor structure. In relation to criterion validity, PA and NA show a low positive correlation, in agreement with the relative independence of positive and negative affect. As was also expected and confirming criterion validity, affect balance correlates strongly, but below 0.70, with satisfaction with life. Finally, distribution of affect balance scores confirms that 80% show a positive affect balance, in agreement with previous studies of emotional and mood states in the normal population (Watson, 2000; Larsen and Prizmic, 2008; Fredrickson, 2009).

Regarding the report of suicidal behaviors, convergent with previous studies, 8.1% report strong suicidal ideation and 4.1% report clear attempt – similar to 3.1% of plans and 2.7% of attempts in the cross-cultural study by Nock et al. (2009). Regarding the association between affect and suicidal ideation, results are consistent with previous research, indicating that positive and negative emotions are associated with suicidal ideation, although in opposite directions (Hirsch et al., 2007; Bae et al., 2013; Teismann et al., 2019). Negative affect shows a strong association with suicidal ideation, convergent with the strong association of negative affect with rumination. On

the other hand, positive affect exhibits a negative association with ideation, confirming that positive emotions play a functional role. Moreover, confirming the relevance of suicidal ideation, this rumination mediates totally the association of affect with suicidal attempt.

The main contribution of this study is that it addresses a specific population segment in which other factors (like bullying) are usually used to approach the problem. The fact that negative affect correlates more strongly with suicidal ideation than positive affect confirms the strong association of negative rumination with anxiety and other high arousal negative emotions usually activated by stress. Low positive affect also shows an association, although weaker, with suicidal ideation. These findings suggest that factors like negative emotional states affect suicidal ideation more strongly than factors like low social integration (which are associated with positive emotional states), as has been previously suggested (Joiner et al., 2005). However, positive affect also shows an important inhibitory role on suicidal ideation and by this path, suicidal attempts decrease. While sex does not affect suicidal ideation, multivariate mediational analysis confirms that women report more suicide attempts compared to men in our sample, congruent with other studies (Kaltiala et al., 1999; Allison et al., 2001; Undheim, 2013). However, meta-analysis done by McHugh et al. (2019) suggests that suicidal ideation is not sensitive enough to be very helpful as a screening test for suicide in non-psychiatric settings. This result shows the limits of suicidal ideation relevance.

This study has clear limitations. It is only based on self-reports, and the suicide attempt indicator was composed of only one item. The attrition rate was high, so we cannot characterize the people who dropped out of the study and potential self-selection bias is a clear limitation. This could have been addressed with an incentive system for participants in the second stage. To better understand the phenomenon in question, it would have been desirable to consider variables that are associated in a relevant way to the problem, such as mental disorders or the sociodemographic characteristics of the participants. This also constitutes a limitation of the study. Finally, another study limitation is social desirability responding, particularly in the specific issue of suicide (Caputo, 2017), where participants could tend to underreport their suicidal behaviors, due to the low acceptance of suicide in Western culture.

In general terms, it can be concluded that when evaluating the health of adolescents (particularly mental health), it is necessary to consider their affective states, especially negative affective states, which are more strongly associated with suicidal ideation and suicide attempts. Following the line of the results of this study and previous studies, special attention should also be paid to the subpopulation of female adolescents, who present a higher frequency in suicide attempts, although male adolescents should not be neglected, because, according to the old and well-known gender paradox in suicide (Canetto and Sakinofsky, 1998), while women have higher rates of suicide attempts, men have higher mortality associated with this phenomenon. Future lines of research should address in more detail the ways in which negative and positive affective states are associated with suicidal ideation; this considering that, in this study, suicidal ideation was the key mediating variable between affect and suicide attempts. Thus, there would be additional elements to develop effective interventions to prevent suicide in adolescents.

DATA AVAILABILITY STATEMENT

The datasets generated for this study are available on request to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethics committee of the School of Psychology of the Pontificia Universidad Católica de Valparaíso. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

AR: processed the experimental data, performed the analysis, drafted the manuscript, and designed the figures. JO and DP: involved in planning and supervised the work, processed the experimental data, performed the analysis, drafted the manuscript, and designed the figures. AM-S: performed the measurements, aided in interpreting the results, and worked on the manuscript. MB and VL: performed the measurements, sample design, aided ininterpreting the results and worked on the manuscript. All authors contributed to the article and approved the submitted version.

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REFERENCES

Allison, S., Roeger, L., Martin, G., and Keeves, J. (2001). Gender differences in the relationship between depression and suicidal ideation in young adolescents. *Aust. N. Z. J. Psychiatry* 35, 498–503. doi: 10.1046/j.1440-1614.2001.00927.x

American Psychiatric Association (2013). *Diagnostic and statistical manual of mental disorders. 5th Edn.* Washington, DC: American Psychiatric Pub.

Bae, S., Lee, Y., Cho, I., Kim, S., Im, J., and Cho, S. (2013). Risk factors for suicidal ideation of the general population. *J. Korean Med. Sci.* 28, 602–607. doi: 10.3346/jkms.2013.28.4.602

Barros, J., Morales, S., Echávarri, O., García, A., Ortega, J., Asahi, T., et al. (2017). Suicide detection in Chile: proposing a predictive model for suicide risk in a clinical sample of patients with mood disorders. *Braz. J. Psychiatry* 39, 1–11. doi: 10.1590/1516-4446-2015-1877

Brookes, M. L., Sharpe, L., and Dear, B. F. (2017). Rumination induces a pattern of attention characterized by increased vigilance followed by avoidance of affective pain words. *Eur. J. Pain* 21, 1197–1208. doi: 10.1002/ejp.1020

Canetto, S. S., and Sakinofsky, I. (1998). The gender paradox in suicide. *Suicide Life Threat. Behav.* 28, 1–23.

Caputo, A. (2017). Social desirability bias in self-reported well-being measures: evidence from an online survey. *Universitas Psychologica* 16, 245–255. doi: 10.11144/Javeriana.upsy16-2.sdsw

Diener, E., Suh, E. M., Lucas, R. E., and Smith, H. L. (1999). Subjective well-being: encounter of two traditions. *J. Pers. Soc. Psychol.* 82, 1007–1022.

Dunkley, D. M., Lewkowski, M., Lee, I. A., Preacher, K. J., Zuroff, D. C., Berg, J. L., et al. (2017). Daily stress, coping, and negative and positive affect in depression: complex trigger and maintenance patterns. *Behav. Ther.* 48, 349–365. doi: 10.1016/j.beth.2016.06.001

Flores, R. G., Cruz, D. M., Quiroz, C. O., and Fernández-Nistal, M. T. (2019). Satisfacción con la vida y uso de sustancias como predictores de intento suicida en adolescentes. *Enseñanza e Investigación en Psicología* 1, 1–8.

Franklin, J. C., Ribeiro, J. D., Fox, K. R., Bentley, K. H., Kleiman, E. M., Huang, X., et al. (2017). Risk factors for suicidal thoughts and behaviors: a meta-analysis of 50 years of research. *Psychol. Bull.* 143, 187–232. doi: 10.1037/bul0000084

Fredrickson, B. (2009). *Positivity*. New York: Crown Publishers.

Gould, M., King, R., Greenwald, S., Fisher, P., Schwab, M., Kramer, R., et al. (1998). Psychopathology associated with suicidal ideation and attempts among children and adolescents. *J. Am. Acad. Child Adolesc. Psychiatry* 37, 915–923. doi: 10.1097/00004583-199809000-00011

Hauser, M., Galling, B., and Correll, C. (2013). Suicidal ideation and suicide attempts in children and adolescents with bipolar disorder: a systematic review of prevalence and incidence rates, risk factors, and targeted interventions. *Bipolar Disord.* 15, 507–523. doi: 10.1111/bdi.12094

Hayes, A. F. (2017). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. New York: Guilford Publications.

Hill, R. M., Penner, F., Vanwoerden, S., Mellick, W., Kazimi, I., and Sharp, C. (2019). Interpersonal trust and suicide ideation among adolescent psychiatric inpatients: an indirect effect via perceived burdensomeness. *Suicide Life Threat. Behav.* 49, 240–252. doi: 10.1111/sltb.12433

Hirsch, J., Duberstein, P., Chapman, B., and Lyness, J. (2007). Positive affect and suicide ideation in older adult primary care patients. *Psychol. Aging* 22, 380–385. doi: 10.1037/0882-7974.22.2.380

Joiner, T. E., Brown, J. S., and Wingate, L. R. (2005). The psychology and neurobiology of suicidal behavior. *Annu. Rev. Psychol.* 56, 287–314. doi: 10.1146/annurev.psych.56.091103.070320

Kaltiala, R., Rimpelä, M., Marttunen, M., Rimpelä, A., and Rantanen, P. (1999). Bullying, depression, and suicidal ideation in Finnish adolescents: school survey. *Br. Med. J.* 319, 348–351. doi: 10.1136/bmj.319.7206.348

Klonsky, E. D., May, A. M., and Saffer, B. Y. (2016). Suicide, suicide attempts, and suicidal ideation. *Annu. Rev. Clin. Psychol.* 12, 307–330. doi: 10.1146/annurev-clinpsy-021815-093204

Koutek, J., Kocourkova, J., and Dudova, I. (2016). Suicidal behavior and self-harm in girls with eating disorders. *Neuropsychiatr. Dis. Treat.* 12:787. doi: 10.2147/NDT.S103015

Larsen, R., and Prizmic, Z. (2008). "The regulation of emotional well-being: overcoming the hedonic treadmill" in *The science of subjective well-being*. eds. M. Eid and R. J. Larsen (New York: Guilford), 258–289.

Li, Y. I., Starr, L. R., and Hershenberg, R. (2017). Responses to positive affect in daily life: positive rumination and dampening moderate the association between daily events and depressive symptoms. *J. Psychopathol. Behav. Assess.* 39, 412–425. doi: 10.1007/s10862-017-9593-y

McHugh, C. M. A., Ryan, C. R., Hickie, I. B., and Large, M. M. (2019). Association between suicidal ideation and suicide: meta-analyses of odds ratios, sensitivity, specificity and positive predictive value. *Br. J. Psychol. Open* 5:e18. doi: 10.1192/bjo.2019.15

Miché, M., Hofer, P. D., Voss, C., Meyer, A. H., Gloster, A. T., Beesdo-Baum, K., et al. (2018). Mental disorders and the risk for the subsequent first suicide attempt: results of a community study on adolescents and young adults. *Eur. Child Adolesc. Psychiatry* 27, 839–848. doi: 10.1007/s00787-017-1060-5

Nicolas, M., Martinent, G., and Campo, M. (2014). Evaluation of the psychometric properties of a modified positive and negative affect schedule including a direction scale (PANAS-D) among French athletes. *Psychol. Sport Exerc.* 15, 227–237. doi: 10.1016/j.psychsport.2014.01.005

Nock, M. K., Hwang, I., Sampson, N., Kessler, R. C., Angermeyer, M., Beautrais, A., et al. (2009). Cross-national analysis of the associations among mental disorders and suicidal behavior: findings from the WHO world mental health surveys. *PLoS Med.* 6:e1000123. doi: 10.1371/journal.pmed.1000123

Pinto, A., and Whisman, M. (1996). Negative affect and cognitive biases in suicidal and nonsuicidal hospitalized adolescents. *J. Am. Acad. Child Adolesc. Psychiatry* 35, 158–165. doi: 10.1097/00004583-199602000-00008

Prinstein, M., Boergers, J., Spirito, A., Little, T., and Grapentine, W. (2000). Peer functioning, family dysfunction, and psychological symptoms, in a risk factor model for adolescent inpatients' suicidal ideation severity. *J. Clin. Child Psychol.* 29, 392–405. doi: 10.1207/S15374424JCCP2903_10

Ramírez-Maestre, C., Correa, M., Rivas, T., López-Martínez, A. E., Serrano-Ibáñez, E. R., and Esteve, R. (2017). Psychometric characteristics of the Flourishing Scale-Spanish Version (FS-SV). The factorial structure in two samples: students and patients with chronic pain. *Personal. Individ. Differ.* 117, 30–36. doi: 10.1016/j.paid.2017.05.035

Robles, R., and Páez, F. (2003). Estudio sobre la traducción al español y las propiedades psicométricas de las escalas de afecto positivo y negativo (PANAS). *Salud Mental* 26, 69–75.

Rogers, M. L., and Joiner, T. E. (2017). Rumination, suicidal ideation, and suicide attempts: a meta-analytic review. *Rev. Gen. Psychol.* 21, 132–142. doi: 10.1037/gpr0000101

Rogers, M. L., and Joiner, T. E. (2018). Suicide-specific rumination relates to lifetime suicide attempts above and beyond a variety of other suicide risk factors. *J. Psychiatr. Res.* 98, 78–86. doi: 10.1016/j.jpsychires.2017.12.017

Sareen, J., Cox, B., Afifi, T., de Graaf, R., Asmundson, G., ten Have, M., et al. (2005). Anxiety disorders and risk for suicidal ideation and suicide attempts: a population based longitudinal study of adults. *Arch. Gen. Psychiatry* 62, 1249–1257. doi: 10.1001/archpsyc.62.11.1249

Sisask, M., Värnik, A., Kõlves, K., Konstabel, K., and Wasserman, D. (2008). Subjective psychological well-being (WHO-5) in assessment of the severity of suicide attempt. *Nord. J. Psychiatry* 62, 431–435. doi: 10.1080/08039480801959273

Spoor, S. T., Bekker, M. H., Van Strien, T., and van Heck, G. L. (2007). Relations between negative affect, coping, and emotional eating. *Appetite* 48, 368–376. doi: 10.1016/j.appet.2006.10.005

Surrence, K., Miranda, R., Marroquin, B. M., and Chan, S. (2009). Brooding and reflective rumination among suicide attempters: cognitive vulnerability to suicidal ideation. *Behav. Res. Ther.* 47, 803–808. doi: 10.1016/j.brat.2009.06.001

Teismann, T., Brailovskaia, J., and Margraf, J. (2019). Positive mental health, positive affect and suicide ideation. *Int. J. Clin. Health Psychol.* 19, 165–169. doi: 10.1016/j.ijchp.2019.02.003

Teismann, T., Forkmann, T., Brailovskaia, J., Siegmann, P., Glaesmer, H., and Margraf, J. (2018). Positive mental health moderates the association between depression and suicide ideation: a longitudinal study. *Int. J. Clin. Health Psychol.* 18, 1–7. doi: 10.1016/j.ijchp.2017.08.001

Thompson, E. R. (2007). Development and validation of an internationally reliable short-form of the positive and negative affect schedule (PANAS). *J. Cross-Cult. Psychol.* 38, 227–242. doi: 10.1177/0022022106297301

Thomsen, D. T. (2006). The association between rumination and negative affect: a review. *Cognit. Emot.* 20, 1216–1235. doi: 10.1080/02699930500473533

Undheim, A. (2013). Involvement in bullying as predictor of suicidal ideation among 12- to 15-year-old Norwegian adolescents. *Eur. Child Adolesc. Psychiatry* 22, 357–365. doi: 10.1007/s00787-012-0373-7

Van Orden, K., Witte, T., Cukrowicz, K., Braithwaite, S., Selby, E., and Joiner, T. (2010). The interpersonal theory of suicide. *Psychol. Rev.* 117, 575–600. doi: 10.1037/a0018697

von Brachel, R., Teismann, T., Feider, L., and Margraf, J. (2019). Suicide ideation as a predictor of treatment outcomes in cognitive-behavioral therapy for unipolar mood disorders. *Int. J. Clin. Health Psychol.* 19, 80–84. doi: 10.1016/j.ijchp.2018.09.002

Watson, D. (2000). *Mood and temperament*. New York: Guilford Press.

Watson, D., Clark, L. A., and Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: the PANAS scale. *J. Pers. Soc. Psychol.* 54, 1063–1070. doi: 10.1037/0022-3514.54.6.1063

Watson, D., and Stanton, K. (2017). Emotion blends and mixed emotions in the hierarchical structure of affect. *Emot. Rev.* 9, 99–104. doi: 10.1177/1754073916639659

Wilburn, V., and Smith, D. (2005). Stress, self-esteem, and suicidal ideation in late adolescents. *Adolescence* 40, 33–45.

WHO (2019). Meltal health and substance use. Available at: https://www.who.int/teams/mental-health-and-substance-use/suicide-data#:~:text=Close%20to%20800%20000%20people,and%20occurs%20throughout%20the%20lifespan (Accessed June 7, 2019).

Yamasaki, K., Sakai, A., and Uchida, K. (2006). A longitudinal study of the relationship between positive affect and both problem-and emotionfocused coping strategies. *Soc. Behav. Personal. Int. J.* 34, 499–510. doi: 10.2224/sbp.2006.34.5.499

Zvolensky, M. J., Paulus, D. J., Bakhshaie, J., Garza, M., Ochoa-Perez, M., Lemaire, C., et al. (2016). Interactive effect of negative affectivity and rumination in terms of mental health among Latinos in primary care. *J. Racial Ethn. Health Disparities* 3, 646–657. doi: 10.1007/s40615-015-0183-y

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Experts by Experience: Qualitative Evaluation of Adolescent Participation in the Development of a Technological Intervention to Prevent Youth Suicide in Chile

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Adolescent suicide is a pressing problem in Chile that has not yet been sufficiently addressed, as suicide rates have stagnated in recent years. One possible explanation could be linked to the adult-centered paradigm that continues to prevail in relation to adolescent health initiatives. In light of this, programs that seek to promote youth mental health should consider incorporating adolescents in the design process using participatory methodologies, to ensure that these initiatives are well-suited for the population. In line with this recommendation, a group of seven adolescents, 13 to 20 years of age, were incorporated into a research team to actively guide the design, development, and validation of a technology-based intervention, known as Project Clan, which was piloted to reduce adolescent suicide in schools in Chile. This group was known as the "Group of Experts," in acknowledgment of their role as experts by experience on adolescence. A qualitative case study was conducted to explore their lived experiences, through semistructured individual in-depth interviews with six members of the group. Results showed that the adolescents had a high level of interest in mental health and had experienced problems of their own or accompanied friends who were struggling, which motivated their participation in the study. They had a critical view of the previous interventions they had received through educational institutions and valued their role in the promotion of their peers' mental health through the Group of Experts. They also highlighted the importance of creating tools that complement their daily lives and provide an alternative to existing social networks, by respecting their anonymity, providing a secure place for divulgation and self-expression, and facilitating access to professional support. We conclude that programs that address issues that affect adolescents should incorporate adolescents in the decision-making and design processes to ensure the acceptability and effectivity of their interventions.

Keywords: adolescence, suicide prevention, health promotion, technology, Chile

INTRODUCTION

A central pillar of health promotion, as defined by the World Health Organization's Ottawa Charter of 1986, is the empowerment of individuals and communities to be actively involved in improving their own health, ensuring they have the power to shape their own well-being (1). This participation can take multiple forms, from helping to set priorities or planning activities to actually guiding the implementation of strategies and interventions, in collaboration with policy makers, health professionals, and other stakeholders. One noted method of community involvement is through research initiatives, and most specifically, through participatory methods, such as Participatory Action Research (PAR), which rejects the traditionally passive role of study subjects and instead views them as fellow researchers, active decision makers, and change agents (2). PAR acknowledges the value of considering individuals' lived experiences to determine how to most appropriately address issues that concern them, and in the field of health research, this approach has been used to engage vulnerable groups, such as indigenous populations or those in low-income communities, in order to conduct needs assessments, evaluate services, and establish feasible solutions to pressing problems impacting these individuals (3). Similarly, given the growing concern worldwide for youth mental health, adolescents have been enlisted in participative studies to improve the design of interventions that seek to promote their peers' well-being (4, 5).

In Chile, adolescent mental health is a major public health concern (6). According to the latest national data, nearly a fourth of Chileans between 4 and 18 years of age meet the criteria for a psychiatric disorder (7), and bullying and depressive symptoms are prevalent in Chilean schools (8). Chile is also one of the countries with the highest suicide growth rates in recent decades (9), and its adolescent population is no exception, with suicide being the second leading cause of death in this group (10). A 2010 study by Ventura-Juncá and collaborators found that more than 60% of youth have experienced suicidal ideation and that nearly 20% have already attempted suicide at some point in their lives (11). Nevertheless, fewer than half of those participants with suicidal risk were able to receive treatment from mental health professional, due to multiple access barriers. These obstacles to seeking care are not only physical—due to the lack of services or financial or time-related factors—but can also be psychological, in terms of the associated social stigma (12).

In response to this concerning epidemiological data, the Chilean Ministry of Health declared the reduction of adolescent suicide to be one of its sanitary goals for the 2011 to 2020 decade (13), and the Ministry's National Program for the Prevention of Suicide, launched in 2013, calls for the elaboration and implementation of interventions to reduce suicide risk and promote student well-being (10). Unfortunately, the real impact of these well-intentioned initiatives has been modest, and suicide rates have stabilized in recent years (9). In part, this stagnation could be due to the fact that few interventions have been implemented and evaluated in educational establishments, the frontline settings where suicide prevention programs are most needed, given the aforementioned treatment gap associated with adolescents' access to formal health services (7, 14), as well as their lack of satisfaction with the quality of these services (15). School-based interventions, meanwhile, have been shown to be appealing to students, teachers, and parents, and they significantly impact academic and psychosocial outcomes long term (16).

On the other hand, the stagnation in suicide rates could also be linked to the adult-centered paradigm that continues to prevail in relation to adolescent health initiatives (17, 18). Under this paradigm, adolescence is considered to be a preparatory period of transition before adulthood, and the specific interests and needs of this age group tend to be rendered invisible. At the same time, adolescents are apt to be defined in association with risky or disruptive behavior, such as unprotected sexual activity, drug trafficking and consumption, school desertion, and violence, and programs targeted toward this group tend to be focused solely on the early detection of risk factors and the elimination of "risky behavior" (19). While these approaches are important, they have not yet been sufficiently updated or accompanied by a more positive perspective of adolescence, which acknowledges and encourages adolescents' strengths, experiences, and knowledge, to promote their comprehensive, healthy, and safe development and overall well-being (20). The dominating adult-centric and risk-centered paradigms of adolescence are also notably at odds with the Chilean Ministry of Health's own promotion of the rights and participation of its adolescent service users, as laid out in the National Program for the Comprehensive Health of Adolescents and Youth Action Plan for 2012 to 2020 (21). Additionally, UNICEF emphasizes the urgent need to promote adolescent participation in decision-making spaces, noting the "strategic importance of this group for the development of our societies" [(22), p. 4], as adolescents are becoming mature, active citizens, who can contribute with valuable and transformative ideas. UNICEF's open call to encourage adolescent's active participation is in line with current paradigms that view adolescence as a crucial period of growth and learning (20) and with the concept of "experts by experience," a term born out of the recovery movements led by mental health service users, which highlights the importance of valuing user' lived experiences and perspectives and allowing them to inform and guide treatment and policy decisions (23, 24). The use of "experts by experience" has also expanded beyond the field of mental health services, to encompass individuals affected by other health problems or certain social groups, such as adolescents with juvenile idiopathic arthritis or clients of long-term elder homes (25, 26).

It is thus clear that in order to best address the urgent issues of youth mental health and suicidal risk, non-suicidal self-injury (such as cutting), and suicidal behavior—as understood by the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* (27–29)—programs must be adapted to the adolescent population in Chile, by bringing the interventions in their regular daily settings (rather than limiting them to clinical environments) and by incorporating them as central actors in the process of designing and validating the strategies. With this context in mind, the authors applied for and were granted Chilean public research funding for a project to develop and evaluate an intervention program, using information and communications technology

(ICT), to prevent adolescent suicide among students in school settings through a randomized controlled trial. At the onset of the project period, seven adolescents were recruited to join the research team to lead the development of the intervention model, as experts of the adolescent experience, in recognition of their unique understanding of their peers' interests, needs, concerns, and expectations, in relation to youth mental health, adolescent suicide, and possible interventions to address these issues. Over the course of a year and a half (March 2017 to September 2018), this group of adolescents, who were known as the "Group of Experts," met monthly with three members of the research team (authors SS, ET, and FS) for 2- to 3-h meetings and kept in regular contact between in-person meetings via WhatsApp in order to develop the intervention model and oversee its transformation into an online web platform and mobile application, in collaboration with computer engineers and programmers, which resulted in the final version of the intervention, a virtual community known as Project Clan ("Proyecto Clan" in Spanish). The name Project Clan was chosen through brainstorming discussions with the Group of Experts, in reference to the values of peer support, inclusivity, and respect that underlie the intervention. The interventions' features range from traditional suicide prevention strategies (e.g., chat and phone line with trained mental health professionals and short articles with evidence-based information and tips), which seek to reduce the mental health access barriers, to more novel components (e.g., forums, a central "wall" to post anonymously, the creation of avatars instead of using photographs) that are focused on facilitating interactions between participants and encouraging their sense of belonging. Further details about the project and trial, which was the first of its kind in Latin America, can be found in Mascayano et al. (30).

The inclusion of the seven adolescent members of the Group of Experts in the research group added a central PAR component to the investigation, because the adolescents' ideas and proposals were the basis for the intervention model, and their active and ongoing engagement and feedback led to the creation of Project Clan. To better understand the significance and origins of the adolescents' contributions to the project, a qualitative study was conducted in parallel to the larger project and is presented in this article. Specifically, the aims of this study were to determine how the group members' past experiences related to adolescent mental health, suicide, and the use of ITCs transformed them into "experts by experience" and informed the creation of the intervention model.

MATERIALS AND METHODS

Procedures

We used a qualitative case study design to evaluate the incorporation of adolescents in the development of Project Clan. As indicated by Stake, care studies are "the study of the particularity and complexity of a single case, coming to understand its activity within important circumstances" (31). The foremost objective of case studies is to describe and explore the characteristics of the participants and secondarily to apply this exploration to more deeply understand a specific phenomenon involving the participants (32, 33). This case study focused on the adolescents who comprised the Group of Experts during the development of the Project Clan intervention, from 2017 to 2018, to prevent adolescent suicide and promote mental health and well-being in Santiago, Chile. These cases are particularly difficult to distinguish and separate from their context, in line with Tight's description of case studies (34). Additionally, Tight adds that case studies, which are qualitative by nature, tend to rely on small samples and utilize a particular type of evidence; in this case, we use semistructured, individual in-depth interviews to study the adolescents' experiences.

The interviews were conducted by an external researcher (author A.C.), a medical anthropologist who did not participate in the development of Project Clan and who did not previously know the members of the Group of Experts. The interviews focused on three thematic areas: (a) personal experiences related to adolescent mental health (or those of their peers); (b) use and perception of online social media and social networks; and (c) experiences with and contributions to Project Clan.

The study's base assumption was that the adolescents' previous experiences with youth mental health issues and use of ICTs and social networks strengthened their contributions to the intervention model.

Participants

The participants of this case study were the adolescents who were selected to form part of the Group of Experts for the larger suicide-prevention project. This selection process was based on two focus groups, which were held in January and March 2017, with a total of 17 participants, between 13 and 20 years of age (from eighth grade to second-year college students). Each focus group lasted ∼90 min and covered topics ranging from adolescent suicide and mental health, how these issues are addressed in school settings, and the use of ICTs. On the basis of these discussions and the adolescents' gender, territorial, and socioeconomic diversity, and interest in participating in the study, a subgroup of seven adolescents—three males and four females—were selected and agreed to participate in the Group of Experts.

The specific sample for this case study was formed through a purposive non-probability method (35). On the basis of this method, the sample was limited to six of the adolescents who formed a consistent part of the Group of Experts throughout the entire process of developing the intervention model. This criterion excluded one of the female members of the group, who attended only two meetings at the beginning of the project and then had to withdraw because of academic obligations. **Table 1** presents deidentified details of the six members of the Group of Experts who participated in this study. In the *Results*, the adolescents will be identified by codes, referring to their gender (e.g., [M1] is male participant number one).

Tools

The six members of the Group of Experts were initially informed about this study and invited to participate during their regular meetings with the research team in early 2018, and the adolescents were then contacted by author A.C. through a

TABLE 1 | Group of Experts.

Code (Gender)	Age (years) at time of interview	High school
F1	14	Subsidized artistic school (in MR)
F2	17	Public school of academic excellence (in MR)
F3	18	Public school of academic excellence (in MR)
M1	20	Public school (in region)
M2	20	Subsidized school (in region)
M3	17	Public school (in MR)

F, female; M, male; MR, Metropolitan Region (location of capital city of Santiago).

TABLE 2 | Semi-structured interview guide.

1. Connection with the project
- How and why were you contacted to be a part of the project?
- What was your initial reaction after learning about the project? How did you feel? What did you think?
- What did you know previously about topics related to youth mental health? Have you had any close experiences related to this issue? Had you talked about it before with friends or family members or in school?
- What do you think about the use of technologies to promote mental health?

2. Group
- How was the group formed? Who was a part of it, and what was your relationship like?
- What problems did you talk about as a group?
- What differences did you have as a group (related to socioeconomic class/school/gender/city of origin)?

3. Adolescent mental health
- What do you think about your generation? What problems does it face? How do you view the Chilean youth of today?
- How do adolescents relate with older and younger generations? (indifferences, committed, etc.)
- Do you believe there is a mental health problem in Chile? Among adolescents?
- What do adolescents think about health professionals? Teachers? The interventions they offer?

4. Use of technology
- What is your relationship with technology like? What sites or applications do you use, and for how much time? In terms of your group of friends or family members around your age, what technology do they use? Which sites/apps? For how long?
- What role do you think technology plays in your social and emotional life? For other adolescents?

5. Project
- What do you think about Project Clan, the development process, and final result?

telephone call or via WhatsApp. In this first contact, the study and its purpose were explained in greater detail, and meeting places and times were coordinated to carry out the informed consent process and conduct the interviews. The interviews were held between April and August 2018, and interview locations were determined based on the preference of each adolescent, to optimize his/her comfort and thus facilitate data collection. Four interviews were held in the adolescents' university or school, and two were held in cafés of public libraries in Santiago.

The semistructured interviews lasted between 60 and 120 min and covered various topics in relation to the project, the conformation of the Group of Experts, the participants' personal history and association to adolescent mental health issues, and their use of ICTs. All of the questions included in the semistructured interview guide (**Table 2**) were previously validated by the core research team of Project Clan. Each participant was interviewed once, and the conversations were audio recorded and literally transcribed.

Data Analysis

The interviews were analyzed according to the tenets of thematic analysis, a strategy that identifies thematic patterns in collected data (36, 37). Thematic analysis involves the systematization of qualitative information from a coding process that is based on previously defined categories (deductive approach), as well as categories that emerge from the collected data that are consistent with the hypotheses and thematic questions of the case study (inductive approach) (38). Thematic analysis is particularly pertinent for exploratory qualitative studies, because of its cyclical and reflective nature, which also maintains systematicity and rigor.

Authors A.C., S.S., and E.T. independently reviewed and codified the transcripts, using the program ATLAS.ti, and they met regularly to compare and discuss their analyses and emerging categories and review any discrepancies. Through this iterative process, they arrived to a consensus about the final categories and the principal findings.

Ethical Considerations

Prior to beginning each interview, the participants—and in the case of minors, their parents or guardians—went through an informed consent process, in the context of the larger project, which was approved by the Ethical Committee of Human Subjects Research of the Faculty of Medicine, Universidad de Chile. The adolescents did not receive any sort of payment or reward for participating in the study, and any incurred costs (transportation, beverage) were covered by the project or reimbursed, to ensure that their participation did not represent a financial burden.

RESULTS

The categories used to analyze the data coincided with the three initial thematic areas of the case study. In addition, a fourth emergent category was added, dedicated to the analysis of other mental health interventions that the adolescents had been exposed to previously. These different interventions assumed a central importance in the participants' explanations of their past experiences, as they noted that these interventions motivated their participation in the Group of Experts and informed their vision and principal recommendations for Project Clan.

These four main categories are as follows:

- Relation to and experience with mental health
- Prior interventions
- Relationship to social media and social networks

- Reaction to and experience with Project Clan

Main findings of each of these categories are detailed below and also summarized in **Table 3**.

Relation to and Experience With Mental Health

This thematic category focused on how the participants learned about adolescent mental health issues, through their own experiences and those of their peers. These experiences pushed them to want to acquire tools and competencies to effectively help others in times of need.

Peers' Experiences Driving Participants' Desire to Help

The adolescents involved in Project Clan had a high level of interest in topics related to mental health and had personal experiences to share pertaining to their own mental health struggles, their friends', and/or those of another close contact. Each participant, without exception, gave detailed accounts about the various ways in which they have seen their school-aged years impacted by mental health issues, from bullying in classrooms or on social media, the problematic use of drugs and alcohol, to the presence of depressive and anxiety symptoms linked to family problems and the acceptance of sexual identity, as well as cases of self-cutting and suicide among their classmates. In the face of these experiences, most of the participants positioned themselves as peers: "When you know about these things, that a friend, a classmate is suffering, you want to help, to say something that could help him or her feel better" [M1].

Nevertheless, the interviewed adolescents admitted that, although they wanted to support their peers, they did not have adequate skills, tools, or training to meaningfully offer any sort of assistance:

> [I had a friend that cut himself, on his arms, and] I always told him that he didn't have to do that and that he had to realize that he had friends who were there and cared for him, but more than that, I didn't know what else to do… the problem is that I only knew about what was happening because my friend trusted me, and I wasn't about to go to telling everyone, so I just tried to help him however I could, but for me, it wasn't justified to go tell a teacher, because then I would be sharing things he didn't want others to know. [F1]

The adolescents shared that, although they were frequently witness to their friends' mental health problems, they did not know how to adequately address these issues, apart from accompanying their friends and giving advice to the best of their ability. They also expressed feeling impotent, as they were unable to resolve the situation:

> You knew about bullying, that people bugged your friends, but you didn't really know what to do. Everyone wants to fit in, so you try not to worry too much about it, and that's it. I hated seeing this, and at least I didn't react this way, but it bugged me… But, actually, the truth is, I didn't do much. I didn't know what to do. [F2]

The participants' desire to have been more prepared to help, while still respecting their friends' request for secrecy, was a significant part of their motivation for participating in the study and forming part of the Group of Experts to create Project Clan. As one participant explained:

> Suicides were common at my school, and I had some friends that also seemed to be heading in that direction. [With Project Clan,] I really liked that I could somehow help them, to get them to trust me and share their problems, so that I could help solve them or at least help my friends keep going and see that everything can get better. [M2]

Personal Experiences and Desire to Understand Their Own Growth Process

Likewise, the participants' own experiences, having overcome difficult moments related to depression, cutting, anxiety, and bullying, also motivated them to help their peers.

TABLE 3 | Main findings of the study by category.

I. Relation to and experience with mental health	II. Prior interventions	III. Relationship to social media and social networks	IV. Reaction to and experience with Project Clan
1. Based on their experiences with their peers, the adolescents wanted tools to prevent and help their friends and classmates with mental health problems.	1. The mental health interventions that have been offered to the participants in school settings were considered to be "adult-centric" and incongruent with their social and economic realities and family contexts.	1. While the participants constantly used social media, they were also aware of the associated risks, in terms of privacy invasion and the addictive nature of the platforms.	1. The adolescents thought it was necessary to create a platform and interventions that were different from the social media platforms and networks that already existed, which motivated their participation in the project.
2. Based on their own experiences, the participants expressed wanting to more deeply understand their own changing feelings and emotions related to adolescence.	2. The participants recognized an access gap between adolescents and mental health services, due in part to persisting stigma.	2. The adolescents said they had utilized strategies to protect themselves from these risks, by regulating their use and reporting inappropriate behavior.	2. The adolescents recommended the construction of a personalized, visually attractive platform that protects their anonymity, through the use of avatars, for example. They also advocated for the incorporation of mental health professionals ("Clan Councilmembers") to reduce barriers to access mental health services.

> When they told me about the project, I was interested because I know about mental health. I've been going to see psychologists, psychiatrists, everything, since I was about 10. They had me read things, to learn about it, and everything was lame and boring. They had me answer surveys, tests, and I always wondered what it was good for. "I'm still sad, this isn't working," I thought. So, when they told me about a platform where I could play, keep track of my mood, and talk with other people, I thought that it could be exciting, even for someone who doesn't have problems. It's not a typical site run by psychologists. [F3].

In this same vein, another participant who went through a similar process during his adolescence shared that he wished that he would have had access to something like the project's platform to support him when he when he felt alone and helpless.

> I was bullied when I was younger, and that experience affected my mental health during high school. That is what got me to contribute to the project and help… Because during that period, it was like… mistake after mistake. I told the school administration what happened and nothing. In fact, they told me "hit them back." In the end, I was alone… But that could have been completely avoided. Over time I've come to understand that people have choices, and if for example, a kid bullies others, there's some reason behind it. Maybe his parents abuse him, maybe his parents are separated and fight every day, but I only came to understand that when I grew up and matured. It could have been avoided. [M1]

The participants' testimonies reveal their familiarity with a range of issues that are central to adolescent mental health. Moreover, their discourse displays how these topics have become an integral part of their daily lives and interactions. As they constructed their identities, the participants' views on mental health evolved and matured, and they gained new tools to help them overcome obstacles. With Project Clan, they were motivated to share their collective and personal experiences and knowledge to assist their peers.

Prior Interventions

This second category, which emerged from the first thematic area, is related to the adolescents' experiences with prior intervention programs and activities they had seen or participated in through their school or other settings, as well as their reflections about the traditional approaches to youth mental health promotion in Chile. Their opinions of these interventions influenced their proposals for the platform, which sought to remedy some aspects to the approaches they considered to be most critical and at fault, such as an adult-centric and risk-centered perspective of adolescence, their interests, and issues; and indifference about the sociofamiliar contexts of students. Likewise, these reflections reflect that the adolescents felt removed and distanced from traditional mental health services, in part due to stigma about the use of clinical services.

Drawbacks of Adults-Centric and Risk-Centered Interventions

The participants had a deeply critical view of the few, if any, mental health interventions they received during middle and high school, from teachers, school counselors, or administrators. Despite their peers'—and their own—psychological struggles, the adolescents reported that some of their schools showed almost complete indifference to their difficulties, as did most of the adults in their lives. The Chilean education system is heterogeneous, and the quality of education received depends largely on socioeconomic level, with some schools strongly shaped by market interests, rather than the educational needs of the population (29). In this context, the participants' schools had varied responses to the students' mental health issues. While some students participated in workshops about bullying and drug use, others shared that they did not receive any mental health orientation, be it during classes or through extracurricular activities. Despite these differences, the participants said that all of the interventions were offered through an adult-centric lens, with professors simply providing them with information to correct the students' supposed ignorance about substance abuse and other "risky behaviors."

> In my school, they occasionally tried to do things like, I don't know, an antidrug program, because you could often see people using or selling drugs inside the school, so they organized these super inadequate programs, led by someone who had never used drugs in his life. I think that someone who has never used drugs isn't going to be able to help someone who uses, because he's never been there. What's more, they brought in a sociologist to talk to us, who was clearly very upper class. It was like he came from this completely different, comfortable reality, and comes down to study us poor students. Like, "let's find them a solution." But it was from a position of absolutely zero experience, and so obviously just listening to him made you fall asleep (…). So the programs the schools have are so deficient that it's funny but also sad. [M3]

The participants also explained that, because of their schools' deficient strategies for addressing these important topics, they did not feel comfortable reaching out to adults when there was a problem. They stated that they believed that their teachers do not have the tools or time to adequately assist them. One participant explained that his teachers' failure to respond to bullied classmates made the classmates downplay what they were going through and even believe that the bullying was not an issue.

> The teachers knew [about the bullying] but did nothing. A few times I tried to do something, but then I realized that even the bullied kids, when you talked to them to try to ask how they were or tell them to do something, even they would tell us, "nah, I don't care," like playing dumb. "We were just playing. It doesn't matter." Things like that. So, it just went on and no one intervened. [M2]

At the same time, they feared that if they opened up to their parents about their problems and crises, they would be viewed as problematic or "crazy" and be sent to a clinical psychologist, which they viewed as another obligation that would only serve to "increase the pressure [they] are under" [F2].

The Gap Between Adolescents and Traditional Mental Health Services

The treatment and support access barriers facing adolescents, marked by their mistrust and rejection of the schools' insufficient efforts to address important issues, are further increased by

the stigmatization of mental health services. The participants expressed skepticism about how health professionals and other adults could help them, and many of them shared that while in school, they avoid talking with these individuals about their or their friends' issues, even when faced with serious problems.

> There are people that don't show how they feel. They seem happy, but inside they are not okay. But these people, these students, are afraid of showing how they really feel, because when they tell you "go talk to the psychologist," it's scary, because you think "What are they going to tell me? What are they going to ask?" and so people don't go, even if they feel really bad. There's the option, but they are not going to take it, because they feel like it's going to be weird, and make them feel worse. [F1]

This same participant also expressed serious doubts about the effectiveness of traditional mental health services:

> I had a friend who was cutting himself, and I never told his mom because I thought his mom was going to hospitalize him (…). He always told me that it was a good idea not to tell his mom, because she would have done tons of things that wouldn't have helped him… It wouldn't have been worth it to spend money on a psychologist. [F1]

Relationship to Social Media and Social Networks

The participants' use, perception and relationship with ITCs, and specifically online social networks, revealed the adolescents' awareness of the benefits of these networks but also the risks inherent in the use of these platforms. They also valued the importance of anonymity in seeking support on mental health issues.

Benefits and Risks Related to Social Networks

The adolescents indicated that mental health promotion should be undertaken through an intersectoral collaborative approach, while avoiding vertical, risk-centered interventions that do not address adolescents' interests and realities and that underestimate their experiences. Additionally, they agreed that digital resources, in particular social networks, could be a strategic tool on which to base interventions targeted toward their peers, given the prevalence and familiarity of their use.

In this respect, during the interviews, the participants stated that technology was a fundamental part of their social life, and they expressed frequently using technology to form and sustain relationships. All of them had accounts in the social network applications most commonly used in Chile, such as Facebook, WhatsApp, Instagram, and SnapChat, and reported using these applications for multiple hours each day. In fact, WhatsApp was a means of communication used to contact the adolescents to coordinate these interviews. It must be noted that the adolescents recognized the risks involved in the extensive and unregulated use of technology, its centrality notwithstanding, in terms of its prejudicial effects on both physical and mental well-being. With respect to the latter, the participants acknowledged that the excessive use of social networks can damage self-esteem and their ability to form long-lasting bonds. For example:

> The thing is, nowadays, people do things that aren't necessary, that don't make any sense. Like, now, for example, if I take a picture of us drinking coffee in the interview, I feel like that's unnecessary. Why does everyone else have to know what I'm doing? And I think that this sort of attitude just makes us worried about other people think about us, and also, we tend to worry a lot about the lives of everyone else. [M3]

The probability that social networks have a negative impact on adolescents seems to depend on how much weight and importance teenagers give them, while forming their identities and worldviews.

> I think that if we did a survey, we'd find that everyone is concerned about what other people think of them, and this can really impact your life, because sometimes people take it poorly, and begin to feel even worse and harm themselves, since they only believe and care about what other people think, and they even forget their own view of themselves. So, a lot of people get messed up because of this, because of other people's comments in social media. [F1]

Protection Strategies Related to Use of Social Networks

In response to this risk, a number of participants, especially the females, discussed ways in which they have protected themselves and their classmates against the negative effects of social media:

> In my school, there was a problem with bullying associated with a fake page that some people made, which said horrible things about everyone, and so we went to talk to the head teacher, who asked us what we were going to do to fix this. So, we repeatedly reported the page until it was shut down for offensive content. We organized together, and it worked. It shows that when something or someone gets out of line, we can do something about it. [F1]

This type of bullying, or similar risks, such as the possibility of being tricked or contacted for inappropriate reasons, are directly related to the use of social media, which is why the participants believe that the use of social networks should be regulated especially during early adolescence (10 to 13 years), the period in which they admitted to first using these applications. As one female participant explained:

> I was only allowed to begin using social networks when I was 12, and I was always supervised. (…). My mom controlled my phone, and I'd obviously say "Oh Mom, don't mess around in my life," but now in hindsight I feel that it was the right thing, because even now sometimes people I don't know talk to me, or use my photos to create a fake profile, or I people sent me semipornographic photos. [F2]

The participants' awareness of the benefits and potential of digital resources and social networks, along with their associated risks, put them in a unique position to contribute to the creation of the technology-based intervention model to promote adolescent mental health and prevent suicidal behavior.

Reaction to and Experience With Project Clan

The final category focused on the adolescents' initial impressions about the project proposal, the formation of the Group of Experts, and the contributions they made to the design of the intervention.

An Online Platform to Promote Mental Health: A Different Approach

With regard to this last category, the proposal of an intervention based on an online platform solicited diverse initial reactions. On the one hand, some of participants reported thinking that it could be "fun" and "different" and that it could be useful and interesting for their peers. These appreciations were based on the participants' impression that currently existing online material about mental health is purely informational and not helpful: "They tell you not to kill yourself, but that doesn't really mean anything for you" [F3].

A number of other participants, however, were at first doubtful that the new platform could offer something not already available through preexisting and popular social networks, in terms of forming connections and interacting with others.

> At first, I thought that there are thousands of social networks. It has to have something that really attracts people's attention, or else it isn't going to work… plus, it's about a topic that people don't normally talk about openly, and presenting that information, even if it is done in a nice way doesn't automatically mean that people will use it. [F2]

The adolescents' awareness of the challenges involved in creating the online intervention model served as a starting-off point from which the group addressed issues and made decisions related to the platforms' proposed components and strategies. Moreover, the participants viewed an opportunity to develop a space that would promote, rather than weaken, their peers' mental health. They felt that current social networks facilitate unhealthy comparisons and often lead low self-esteem and loss of self-worth:

> I see it a lot among girls that they compare their photo to someone else's, think about if they have a good body. If they go to the gym, they take a picture, and then someone else compares herself and feels bad. It's all really false, and we have become so dependent on that. [M3]

Recommendations: The Importance of Design, Anonymity, Peer Support Options, and Readily Accessible Mental Health Counseling

Numerous challenges emerged during the creation of the intervention model. The participants believed that the imagery and styling of the site would be crucial to appeal to their peers and discussed how to balance designing a visually attractive and dynamic platform that would be able to maintain the interest of adolescents, while also promoting their mental health, by strengthening protective factors and identifying risk factors.

> When we were planning it, I said that it's necessary to give the users the power to change the format of the platform. It gives a greater sense of ownership… of "Oh, I'll change the color" …it makes it more personal for me, because depression is already a super personal thing… having something that is also nice to look out, without someone many weird words and messages like "you must do this" and also with colors that are more calming than red, blue, and yellow. [F2]

To astutely address these issues, the Group of Experts also decided that anonymity of the participating adolescents should be a central characteristic of the site.

> I think it's great [the anonymity], because then you remove the prejudices involved in looking at a photo, when you say, "Oh no he's fat, he's ugly, or he's trashy, so I won't talk to him." So, with anonymity, you take away that prejudice due to physical appearance, which is the first judgment one makes. [F2]

The participants' awareness of the importance of anonymity is due precisely to their interactions with one another in the Group of Experts. As that group is heterogeneous, they began to ask themselves about the opportunities that Chilean adolescents in this day and age actually have to get to know different realities and, at the same time, talk about their common interests and experiences they share as teenagers.

> We got the idea of using anonymity because we looked at each other and asked ourselves, "What would you think if I someone like me talked to you, for example?" And the other person would say, "It'd be really weird, because it's not like we have a similar style," and then I had to admit that I'd probably act the same way, too. "I'd also think it was strange if someone like you, with your physical appearance, talked to me." So, it was like, and if we make the platform anonymous? And then we decided to do it. [F2]

However, even though anonymity has its benefits—permitting free expression and facilitating new connections by avoiding the stereotypes imposed by photographs and physical appearance on social media—the participants also realized that it was essential that images be somehow incorporated into each person's profile, as self-representation is so important to adolescents, especially in digital platforms: "It was hard to imagine a platform without images. Today, everything revolves around images, publicity, television, series, Instagram. We are also saturated with images. How are we going to get people to use the site if there aren't images?" [M2]. To respond to this need, the participants proposed using avatars or virtual characters that each person could create based on his/her interests:

> We created elements for the avatars that couldn't be distinguished based on gender or age, so that everyone could identify with the character. The idea was to be as inclusive as possible and that people could choose characteristics according to how they felt or wanted to be represented. [F2]

Through the creation of avatars, the Group of Experts sought to reconcile the importance of anonymity with adolescents' need for personalization. It was also decided that the possibility of

writing completely anonymous messages on a central public wall—without even the avatars linked to one's comments—would be attractive to users who want to express themselves without fear of judgment.

Similarly, the participants recommended including a gamification aspect in the platform by awarding active participation and progress in the intervention's activities with points, as a way to encourage sustained use of the platform. This idea was proposed by members of the Group of Experts who had previous experience with video games, in which players gain points as their advance and compete against each other Although the promotion of competition between the platform users was initially debatable, all of the participants agreed that the point system would stimulate use, adherence to, and interest in the platform, through a compensation mechanism, in which increased participation would unblock elements for the avatars.

> Yes, I think that [the use of earning points for participating] can work, because these points could generate and incentivize a sort of competition, which is linked to progress. You could have conversations with others to ask them like, "And you, what did you do? How many points do you have?" And they listen, and in the end, there is this shared understanding, and everyone wants to advance to the next level. [M1]

They voiced that they appreciated that that their level of success and progress in the platform depended on them and their degree of engagement, and not on the effect their actions had on others, in direct contrast to the basis of their interactions in other sites, in which they write a tweet or upload a photo to Instagram or Facebook, and then view their success based on how many "retweets" or likes they receive.

Additionally, the participants' past experience viewing traditional clinical services as sterile, stigmatizing, and removed from their reality informed their recommendations that the adolescent users should be able to have rapid, easy access to trained psychologists—known as the "Clan Councilmembers"—who they could engage with through a private chat system or more publicly in different public forums with multiple participants. They believed that facilitating the online connection would make their peers more apt and open to seek out help, and that the online presence would serve to create a more horizontal therapeutic relationship. As expressed by M1: "we had an idea that a psychologist should be available 24/7, to pay attention to these problems, who you could always talk to, without being ashamed."

Finally, during the course of developing the Project Clan model, in line with their expressed desires to help their peers (see Section 3.1.1), the participants advocated for the inclusions of functions that would facilitate communication and peer support between adolescents, such as forums, as well as informative sections about how adolescents can help their friends, classmates, and other acquaintances with mental health issues or other problems.

Thus, based on the Group of Expert's recommendations, the Project Clan platform offered an attractive, secure, and completely anonymous space for free expression, while also promoting the creation of strong social and therapeutic relationships.

DISCUSSION

The objective of this case study was to determine how the adolescent members of the Group of Experts' past experiences related to mental health, suicide, and the use of ITCs transformed them into "experts by experience" and informed the creation of the Project Clan intervention model to promote their peers' mental health and well-being and reduce suicide risk. The results of the four identified categories—the participants' past experiences with mental health, their experience with prior mental health interventions, their relationship to social media and social networks, and experience with Project Clan– are discussed at continuation.

Firstly, in their testimonies, the adolescent participants expressed great interest in mental health and their concern for the well-being of their peers. They shared that during high school, they were often confronted with difficult situations affecting their mental health or their friends'. However, despite wanting to find solutions to these problems, they felt unequipped to adequately respond to these important issues, due to their lack of knowledge and resources, and their being naturally assigned a passive, secondary role in the management of their own well-being. As a result of this, they felt impotent in the face of what they viewed to be a major concern for their generation. In contrast to this frustrating situation, their participation in the "Group of Experts" gave them a platform from which they could finally channel their desire to effectively help their classmates (17). Their prior experiences of feeling helpless and ignorant informed the Project Clan model, with its focus not only on one's own struggles and growth process, but also on gaining the necessary tools and information to assist their peers, by knowing how best to identify and help friends in need. These findings are in line with the central role that peer groups play in adolescent psychosocial development (39); during adolescence, one's peers greatly influence the crystallization of identify and emotional regulation, and there is an important association between social support and subjective well-being among adolescents (40). This is also highlighted in their recommendation of including forums and a messaging system in the platform, to offer a space for participants to support one another, in a safe community environment.

These components of the platform, and the formation of the Group of Experts itself, is related to the ideals of peer support, which is "based on the belief that people who have faced, endured, and overcome adversity can offer useful support, encouragement, hope, and perhaps mentorship to others facing similar situations" [(41), p. 443]. Peers are defined as individuals who have shared difficult, similar experiences, which could vary from cancer survival, to the unexpected death of a parent, to mental illness (42). In the context of Project Clan, with its focus on suicide prevention and mental health promotion, the Group of Experts shared the experience of going through middle- and high-school, facing the related stressors and pressures, and having similar goals and interests as the study's participants; on the basis of this experience, they offered mutual support and orientation.

Thus, Project Clan is constituted as a peer support model. Several reviews have noted that peer-support services are of use to connect individuals with mental health issues with others, so that they can share experiences and provide emotional and social support (43–45). Furthermore, being involved in such services is often related to improved empowerment and increased hope in the future among peer workers (44). We must note, however, that the evidence of the effects of these services is still inconsistent across studies (46) and future research needs to examine the mechanisms through which peer-based interventions work.

Secondly, with respect to past mental health interventions the participants experienced, they shared that the few programs they had been offered tended to be vertical and adult-centric, thereby confirming the findings of the reviewed literature, which discussed the dominant prevalence of the adult- and risk-centered paradigms of adolescence (17–19, 47). The participants stated that the interventions they had previously seen did not comply with the criteria they considered essential for the acceptability and relevance of an intervention model (48, 49), and they also viewed traditional mental health services as distant, stigmatizing, and ineffective, reflective of the documented treatment gap between adolescents and clinical services (7, 14). Our results show that the adolescents wanted to ensure the creation of an intervention which respected and understood their point of view, which could be seamlessly inserted into their daily lives and which nurtured the establishment of horizontal, rather than vertical, caring relationships, with peers and professionals, thus reducing access barriers.

Thirdly, in terms of their relationship with technology, the adolescents acknowledged the central role that online social networks play in their daily lives, as evidenced in their frequent use of these platforms, which they use to establish and maintain their interpersonal relationships. This is reflective of the Chilean context, where over 90% of youth connect to the internet at least once a day, especially to social networks (50), and where adolescents view online resources as an important facilitator for numerous aspects of their lives (51). The participants envisioned Project Clan as a platform that had the potential to span and connect their cyber relationships with their offline, in-person activities, more so than the social media networks they currently use. At the same time, during the interviews, the participants were able to identify risks associated with the use of ITCs –from privacy concerns to mental health problems due to online bullying, abuse, oversharing, and constantly comparing oneself to others– and they shared strategies they have used to reduce these risks, which they also translated into recommendations for the intervention.

The adolescents' reflections are also supported by the existing literature. On the one hand, extensive use of social networks can lead to dependence and distress associated with anxiety and loneliness among adolescents, and there are legal and privacy concerns associated with uncontrolled use of these platforms; on the other, ITCs offer enormous potentialities for engaging adolescents and reducing access barriers to mental health services, by removing the physical distance to access quality information and orientation from mental health professionals, and by providing this support at little or no cost, all from the privacy of one's phone or computer, without the associated social taboos (52–55). The diverse and varied impact of ITC use, over the short- and long-term, needs to be intensively and continuously investigated, and to this end, there is an important, growing field of qualitative research which explores, for instance, how the use of ITCs, such as online blogs, can pose both risk and protective factors for suicidal and self-injurious practices among adolescents (56, 57).

Finally, on the basis of the above, the participants were able to capitalize on and relay these personal experiences and reflections to their role as "Experts by Experience" to create the Project Clan intervention model. They viewed Project Clan as an opportunity to contribute to a new type of online platform, which would provide a space for adolescents to find reliable information and practical advice related to mental health, share experiences, find peer and professionals, and strengthen their mental health, in contrast to existing sites they cited as harmful. The adolescents made a series of recommendation to ensure the platform's aesthetic, components, and functionality were attractive and useful for their peers, and one of the most crucial aspects for them was protecting the future users' anonymity, which would allow users to interact with others, explore new interests, and express themselves, without the fear of judgment or prejudice. Another key element is related to the centrality of adolescent self-representation and their need to create a social media identity, just as they are in the process of forming their own identity as maturing individuals in society (20, 55). The participants were able to satisfy both these needs—self-representation and anonymity—through their idea of creating avatars. Moreover, based on their desire to be able to help their peers, they incorporated spaces, such as forums, in the platform for the adolescent users to offer one another advice, in addition to the information targeted at giving tips to classmates and friends of those in needs. These strategies are in line with the literature that demonstrates the importance of peer groups and social support for adolescent well-being, which is a protective factor for mental health problems and to prevent bullying, for instance (40, 58, 59). Lastly, they viewed the psychologists—the so called "Clan Councilmembers"-–who would be available to give users individual and group orientation and support through the platform, as a positive contribution, which would serve to reduce treatment access barriers in Chile (7, 14).

Limitations and Future Studies

The establishment of the Group of Experts to create the Project Clan model is a first approach to putting into action the Chilean Ministry of Health and UNICEF's calls for increased adolescent participation in decision making spaces (21, 22). Unfortunately, the project, and thus the Group of Experts, was only temporary, and this study also has some associated limitations. For one, given that the adolescent participants were recruited on the basis of their involvement in a specific and time-limited initiative, the study is not entirely replicable, and the results of our case study should be interpreted as a documentation of the members of the Group of Expert's unique lived experiences and their relationship and application to Project Clan, which sought to promote adolescent mental health in Chile. Second, while we

hope that the findings could be applied to promote the benefits of adolescent participation through similar interventions in the future, the generalizability of these findings and the experts' experiences to the general adolescent population is not clear; the study sample was formed based on a purposive non-probability method (35), recruiting adolescents who participated in the Group of Experts and were chosen for that group because of their particular motivation and interest to participate in the research project; their views do not necessarily represent those of their entire peer group. Finally, because the Group of Experts disbanded once the intervention was launched in schools, the long-term impact of the adolescents' experiences participating in the development of the Project Clan intervention model on their own well-being and future conduct and undertakings is unknown. Future research to evaluate adolescent participation in projects and programs should have a longer follow-up period, to study possible long-lasting effects, both on the adolescents and on the eventual recipients of the programs.

Furthermore, measures should be taken to ensure the permanent incorporation of adolescents in established organizations dedicated to addressing issues that concern this age group (from health or education to recreational interests) or that will impact them as they age (e.g., climate change, labor and retirement policies, among others). Current legislation in Chile does not recognize this progressive autonomy of adolescents, to allow them to organize before they legally come of age, and there are few institutional mechanisms in place to monitor adolescent participation in the construction of public policies and the protection of their rights, in accordance with UNICEF's recommendations (22). Mere consultancy roles are not representation, and involvement in time-limited, specific one-time initiatives, such as with our project, is not sufficient. Future initiatives—from research studies to committees and executive boards—should actively promote real and effective adolescent participation (22, 60, 61).

Finally, although this is not a clinical study, there are also possible clinical applications of the Project Clan initiative. The "Experts by Experience" approach could be applied through the incorporation of peer workers in mental health services. In the words of psychiatrist and peer support advocate Peter Stastny, mental health peer support is based on the idea that individuals who have "experienced and overcome a particular type of adversity can be useful sources of support, encouragement, and help to others experiencing similar situations" (62). Peer workers have been applied in a variety of clinical interventions, for an array of psychiatric conditions, from substance dependence to depression to psychosis (63). Peer support services are widely spread and accepted in high-income countries (64), although, unfortunately, peer workers are rarely involved in planning or providing mental health care in lower-income settings, such as Latin America.

One exception is a study we conducted in Santiago, Chile, which incorporated peer workers into a community mental health intervention, called Critical Time Intervention—Task Shifting (CTI-TS), to support users with schizophrenia (65). A qualitative study that evaluated the users' experience with CTI-TS found that the users felt a special connection and reciprocity with the peer workers, who had also experienced psychosis (66). One user commented that being with the peer worker was like "talking with someone who get and who gets you, with needing to talk or explain much," whereas another said, "I felt reflect in the peer and tried to be like her, because she went through a situation like mine; she was always smiling, and didn't seem to be someone with problems, and so seeing her doing so well gave me strength." We believe that adolescents who have had mental health problems, including suicidal conduct, and recovered can be a powerful source of support and orientation for their peers who are struggling with similar issues, and these connections can extend from innovative public health programs such as Project Clan to outpatient mental health centers, through the establishment of support groups, mentoring, and peer support services.

CONCLUSIONS

Project Clan is one of the first initiatives in Chile to actively include adolescents in the central decision-making processes and creation of a program that aims to improve the mental health and well-being of their peers. The adolescents involved in this project were recruited as "experts by experience" of their peers and treated as equal collaborators alongside investigators, in the entire process of creating and designing the intervention model. This is in contrast to their usual consultancy role in other programs, which tend to invite adolescents to participate in focus groups to reflect and comment on already prepared products, rather than have them brainstorm and design the tools themselves (4). The integration of adolescents in the early stages of the study permitted the transformation and translation of their experiences into an intervention model that responds to their needs, visions, and expectations for suicide prevention and mental health promotion (3).

Project Clan offers an intervention model that breaks with the traditional paradigm of mental health services, which tend to be vertical, face-to-face, solitary, and removed from daily life and in which adolescents have passive roles, as patients in a clinic or the audience of an adult-centric or risk-centered presentation or workshop. The Group of Experts channeled the adolescents' lived experiences to create a model that brings effective tools and support into the ICTs that accompany them in their daily lives, while also promoting the creation of a safe and inclusive community. The incorporation of the adolescents as a PAR component in the development of Project Clans offered the target population the agency to actively impact and improve their own well-being and that of their peers by sharing their expertise. The experience indicates that by opening up true decision-making spaces to adolescents, stakeholders can help ensure the appropriateness of their efforts for this important and increasingly empowered sector of the population.

DATA AVAILABILITY STATEMENT

Transcripts (in Spanish) of the interviews conducted for this study are available upon reasonable request to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethical Committee of Human Subjects Research of the Faculty of Medicine, Universidad de Chile. Written informed consent to participate in this study was provided by the participants' legal guardians.

AUTHOR CONTRIBUTIONS

SS, AC, ET, FM, MB, and RA contributed to conception and design of the study. SS, ET, FS, RP, and MJ worked closely with the Group of Experts. AC conducted the interviews and carried out the initial analysis. AC and SS wrote the first draft of the manuscript. ET, FM, and RP contributed to sections of the manuscript. All authors contributed to manuscript revision and read and approved the submitted version.

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REFERENCES

1. Ottawa Charter for Health Promotion. *Health Promotion International*. Ottawa: Oxford University Press (1986). p. 405.
2. Loewenson R, Laurell AC, Hogstedt C, D'Ambruoso L, Shroff Z. *Participatory Action Research in Health Systems: A Methods Reader*. Harare: EQUINET (2014).
3. Baum F, MacDougall C, Smith D. Participatory action research. *J Epidemiol Community Health*. (2006) 60:854–7. doi: 10.1136/jech.2004.028662
4. Orlowski SK, Lawn S, Venning A, Winsall M, Jones GM, Wyld K, et al. Participatory research as one piece of the puzzle: a systematic review of consumer involvement in design of technology-based youth mental health and well-being interventions. *JMIR Hum Factors*. (2015) 2:e12. doi: 10.2196/humanfactors.4361
5. Ozer EJ, Piatt AA. *Adolescent Participation in Research: Innovation, rationale and next steps. Innocenti Research Briefs 2017-07, Methods: Conducting Research with Adolescents in Low- and Middle-Income Countries, no 5*. Florence: UNICEF Office of Research – Innocenti. (2017).
6. Plan Nacional de Salud Mental: 2017-2025 [National Mental Health Plan: 2017-2027]. Santiago: Ministerio de Salud (2017).
7. Vicente B, Saldivia S, de la Barra F, Kohn R, Pihan R, Valdivia M, et al. Prevalence of child and adolescent mental disorders in Chile: a community epidemiological study. *J Child Psychol Psychiatry*. (2012) 53:1026–35. doi: 10.1111/j.1469-7610.2012.02566.x
8. Fleming LC, Jacobsen KH. Bullying and symptoms of depression in Chilean middle school students. *J Sch Health*. (2009) 79:130–7. doi: 10.1111/j.1746-1561.2008.0397.x
9. OECD. *OECD Factbook 2015-2016: Economic, Environmental and Social Statistics*. Paris: OECD Publishing (2016).
10. *Programa Nacional de Prevención del Suicidio: Orientaciones Para su Implementación [National Program for Suicide Prevention: Orientation for its implementation]*. Santiago: Ministerio de Salud (2013).
11. Ventura-Juncá R, Carvajal C, Undurraga S, Vicuña P, Egaña J, Garib M. Prevalencia de ideación e intento suicida en adolescentes en la región metropolitiana de santiago de chile [prevalance of suicide ideation and attempts in adolescents in the metropolitan region of Santiago, Chile]. *Rev Med Chile*. (2010) 138:309–15. doi: 10.4067/S0034-98872010000300008
12. Aboujaoude E, Salame W, Naim L. Telemental health: a status update. *World Psychiatry*. (2015) 14:223–30. doi: 10.1002/wps.20218
13. *Estrategia Nacional de Salud para el cumplimiento de los Objetivos Sanitarios de la Década 2011-2020 [National Health Strategy to accomplish the Sanitary Goals for the 2011-2020 Decade]*. Santiago: Ministerio de Salud (2011).
14. Echávarri O, Maino MP, Fischman R, Morales S, Barros J. *Aumento Sostenido del Suicidio En Chile: un Tema Pendiente [Sustained Increased in Suicide in Chile: a Pending Issue]*. Santiago: Centro de Políticas Públicas Pontificia Universidad Católica (2015).
15. Minoletti A, Toro O, Alvarado R, Carniglia C, Guajardo A, Rayo X. Respeto a los derechos de las personas que se atienden en servicios de psiquiatría ambulatoria en Chile [Right of people treated in outpatient psychiatric services in Chile]. *Rev Med Chile*. (2015) 143:1585–92. doi: 10.4067/S0034-98872015001200012
16. ACAMH. *What We Know Already. School-Based Interventions*. London, UK: The Association for Child and Adolescent Mental Health (2017). Available online at: https://www.acamh.org/topic/school-based-interventions/
17. Duarte K. ?'Juventud o juventudes? Acerca de cómo mirar y remirar a las juventudes de nuestro continente [?'Youth or youths? how to look and see the youth of our continent]. *Última Década*. (2000) 8:59–77. doi: 10.4067/S0718-22362000000200004
18. Chávez Romo MC. La estigmatización de la adolescencia como grupo poblacional en riesgo y sus repercusiones en la construcción de ciudadanía [The stigmatization of adolescents as an at risk group and its repercussions in the construction of citizenship]. *Sinéctica*. (2014) 42:1–17.
19. Krauskopf D. Los marcadores de juventud: la complejidad de las edades [The markers of youth: the complexity of ages]. *Ultima Década*. (2015) 23:115–28. doi: 10.4067/S0718-22362015000100006
20. Michaud PA. Adolescents and risks: why not change our paradigm? *J Adolesc Health*. (2006) 38:481–83. doi: 10.1016/j.jadohealth.2006.03.003
21. *Programa Nacional de Salud Integral de Adolescentes y Jóvenes: Plan de Acción 2012 −2020 [National Program for the Comprehensive Health of Adolescents and Youth: Action Plan 2012 – 2020*. 2nd Edn. Santiago: Ministerio de Salud (2013).
22. *Superando el Adultocentrismo [Overcoming Adultcentrism]*. Santiago, Chile: UNICEF (2013). Available online at: https://unicef.cl/web/wp-content/uploads/2012/12/UNICEF-04-SuperandoelAdultocentrismo.pdf
23. Law H, Morrison AP. Recovery in psychosis: a delphi study with experts by experience. *Schizophr Bull*. (2014) 40:1347–55. doi: 10.1093/schbul/sbu047
24. Scottish Recovery Network. *Experts by Experience: Guidelines to Support the Development of Peer Workers in the Mental Health Sector*. (2011). Available online at: https://scottishrecovery.net/wp-content/uploads/2011/09/srn_exe_form.pdf (accessed 18 June, 2020).
25. Stinson JN, Toomey PC, Stevens BJ, Kagan S, Duffy CM, Huber A, et al. Asking the experts: exploring the self-management needs of adolescents with arthritis. *Arthritis Rheum*. (2008) 59:65–72. doi: 10.1002/art.23244
26. de Graaff MB, Stoopendaal A, Leistikow I. Transforming clients into experts-by-experience: a pilot in client participation in Dutch long-term elderly

care homes inspectorate supervision. *Health Policy*. (2019) 123:275–80. doi: 10.1016/j.healthpol.2018.11.006
27. Gargiulo A, Plener PL, Baus N, Margherita G, Brunner R, Kaes M, et al. Non-suicidal self-injury (NSSI) and suicidal behavior disorder (SBD) in DSM-5. *Minerva Psichiatr*. (2014) 55:83–90.
28. Grandclerc S, De Labrouhe D, Spodenkiewicz M, Lachal J, Moro MR. Relations between non-suicidal self-injury and suicidal behavior in adolescence: a systematic review. *PLoS ONE*. (2016) 11:e0153760. doi: 10.1371/journal.pone.0153760
29. American Psychiatric Association. Suicidal behavioral disorder. In: *Diagnostic and Statistical Manual of Mental Disorders*. 5th Edn. Washington, DC: American Psychiatric Association. Suicidal behavioral disorder. (2013). doi: 10.1176/appi.books.9780890425596
30. Mascayano F, Schilling S, Tapia E, Santander F, Burrone MS, Yang LH, et al. Using information and communication technologies to prevent suicide among secondary school students in two regions of chile: a randomized controlled trial. *Front Psychiatry*. (2018) 9:236. doi: 10.3389/fpsyt.2018.00236
31. Stake R. *The Art of Case Study Research*. Thousand Oaks, CA: SAGE Publications, Inc., (1995).
32. Yin R. *Case Study Research and Applications: Design and Methods*. Thousand Oaks, CA: SAGE Publications, Inc., (2017).
33. Debout C. L'étude de cas qualitative [Qualitative case study]. *Soins*. (2016) 61:57–60. doi: 10.1016/j.soin.2016.04.018
34. Tight M. *Understanding Case Study Research: Small-Scale Research with Meaning*. Thousand Oaks, CA: SAGE Publications, Inc., (2017).
35. Teddlie C, Yu F. Mixed methods sampling: a typology with examples. *J Mix mixed Methods Res*. (2007) 1:77–100. doi: 10.1177/1558689806292430
36. Creswell JW, Creswell JD. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. 5th Edn. Thousand Oaks, CA: SAGE Publications, Inc (2018).
37. Gavin H. *Understanding Research Methods & Statistics in Psychology*. London: SAGE (2008). doi: 10.4135/9781446214565
38. Saunders B, Sim J, Kingstone T, Baker S, Waterfield J, Bartlam B, et al. Saturation in qualitative research: exploring its conceptualization and operationalization. *Qual Quant*. (2018) 52:1893–907. doi: 10.1007/s11135-017-0574-8
39. Gaete V. Adolescent psychosocial development. *Rev Chil Pediatr*. (2015) 86:436–43. doi: 10.1016/j.rchipe.2015.07.005
40. Rodríguez-Fernández A, Ramos-Díaz E, Ros I, Fernández-Zabala A, Revuelta L. Bienestar subjetivo en la adolescencia: el papel de la resiliencia, el autoconcepto y el apoyo social percibido [Subjective well-being in adolescence: the role of resilience, self-concept and perceived social support]. *Suma Psicol*. (2016) 23:60–9. doi: 10.1016/j.sumpsi.2016.02.002
41. Davidson L, Chinman M, Sells D, Rowe M. Peer support among adults with serious mental illness: a report from the field. *Schizophr Bull*. (2006) 32:443–50. doi: 10.1093/schbul/sbj043
42. Cyr C, McKee H, O'Hagan M, Priest R. *Making the Case for Peer Support: Report to the Peer Support Project Committee, of the Mental Health Commission of Canada*. 2nd Edn. Ottawa, ON: Mental Health Commission of Canada (2016). Available online at: https://www.mentalhealthcommission.ca/sites/default/files/2016-07/MHCC_Making_the_Case_for_Peer_Support_2016_Eng.pdf
43. Ali K, Farrer L, Gulliver A, Griffiths KM. Online peer-to-peer support for young people with mental health problems: a systematic review. *JMIR Ment Health*. (2015) 2:e19. doi: 10.2196/mental.4418
44. Repper J, Carter T. A review of the literature on peer support in mental health services. *J Ment Health*. (2011) 20:392–411. doi: 10.3109/09638237.2011.583947
45. Cabassa LJ, Camacho D, Vélez-Grau CM, Stefancic A. Peer-based health interventions for people with serious mental illness: a systematic literature review. *J Psychiatr Res*. (2017) 84:80–9. doi: 10.1016/j.jpsychires.2016.09.021
46. Gillard S. Peer support in mental health services: where is the research taking us, and do we want to go there? *J Ment Health*. (2019) 28:341–4. doi: 10.1080/09638237.2019.1608935
47. Rothchild J. Childhood without life, life without childhood: theological and legal critiques of current juvenile justice policies. *J Soc Christ Ethics*. (2013) 33:83–103. doi: 10.1353/sce.2013.0006
48. Gallardo I, Leiva L, George M. Evaluación de la aplicación piloto de una intervención preventiva de salud mental en la escuela: variaciones en la desadaptación escolar y en la disfunción psicosocial adolescente [evaluation of a pilot application of a preventive mental health application in schools: variations in school disadaptation and adolescent psychosocial disfunction]. *Psykhe*. (2015) 24:1–13. doi: 10.7764/psykhe.24.2.649
49. Leiva L, George LM, Squicciarini AM, Simonsohn A, Guzmán J. Intervención preventiva de salud mental escolar en adolescentes: desafíos para un programa público en comunidades educativas [Preventative intervention school mental health in adolescents: challenges for a public program in educational communities] *Univ Psychol*. (2015) 14:1285–98. doi: 10.11144/Javeriana.upsy14-4.ipsm
50. *Informe Final: IX Encuesta de Acceso y Usos de Internet [Final Report: IX Survey of Internet Access and Use]*. Santiago: Subsecretaría de Telecomunicaciones de Chile (2017).
51. Hoffmann M, Rojas G, Martínez V. Prevención, detección, tratamiento o seguimiento en salud mental de adolescentes a través del uso de Internet: una revisión sistemática cualitativa [Prevention, detection, treatment or follow up in adolescent mental health through internet use: a qualitative systematic review]. *Rev Med Chile*. (2014) 142:494–500. doi: 10.4067/S0034-98872014000400011
52. Chandrasekhar CP, Ghosh J. Information and communication technologies and health in low income countries: the potential and the constraints. *Bull World Health Organ*. (2001) 79:850–5. Available online at: https://apps.who.int/iris/handle/10665/268427
53. Sánchez-Carbonell X, Beranuy M, Castellana M, Chamarro A, Oberst U. La adicción a Internet y al móvil: ?'moda o trastorno? [addiction to internet and telephones: trend or disorder?]. *Adicciones*. (2008) 20:149–60. doi: 10.20882/adicciones.279
54. Las Heras J. La adicción de los adolescentes a internet: ?'La incipiente epidemia del siglo 21? [Adolescents' addiction to internet: the incipient epidemic of the 21st century?] *Claves Polít Públicas*. (2012) 8:1–7. Available online at: https://bit.ly/3aK8hEr
55. Uhls YT, Ellison NB, Subrahmanyam K. Benefits and costs of social media in adolescence. *Pediatrics*. (2017) 140 (Suppl. 2): S67–70. doi: 10.1542/peds.2016-1758E
56. Gargiulo A, Margherita G. Narratives of self-harm: the experience of young women through the qualitative analysis of blogs. *Mediterr J Clin Psychol*. (2019) 7:1–19. doi: 10.6092/2282-1619/2019.7.2055
57. Margherita G, Gargiulo A. A comparison between pro-anorexia and non-suicidal self-injury blogs: from symptom-based identity to sharing of emotions. *Psychodyn Pract*. (2018) 24:346–63. doi: 10.1080/14753634.2018.1535326
58. Cabieses B, Obach A, Molina X. La oportunidad de incorporar el bienestar subjetivo en la protección de la infancia y adolescencia en Chile [The opportunity to incorporate subjective wellbeing in the protection of chilhood and adolescence in Chile]. *Rev Chil Pediatr*. (2020) 91:183–9 doi: 10.32641/rchped.v91i2.1527
59. Shephard B, Orodoñez M, Mora C. Estudio descriptivo: programa de prevención y disminución del acoso escolar – "Bullying". Fase diagnóstica: prevalencia. [descriptive research: program for prevetntion and reduction of bullying. diagnostic phase: prevalence] *Rev Med HJCA*. (2015) 7:155–61. doi: 10.14410/2015.7.2.ao.30
60. Hans B. The power of an untapped resource: exploring youth representation on your board or committee. In: Alaska ICE, editor. *The Initiative for Community Engagement of the Association of Alaska School Boards and the Alaska Department of Health and Social Services*. Anchorage: Alaska Initiative for Community Engagement (2000).
61. Bates K, Young KS. *Youth on Board: Why and How to Involve Young People in Organizational Decision-Making*. Somerville: National Center for Nonprofit Boards and Youth on Board. Available online at: https://969a20f6-6e95-4985-a903-0edd6a815f41.filesusr.com/ugd/756302_29e631af6fbd4633ba3028cba685dc81.pdf
62. Stastny P. Introducing peer support work in Latin American mental health services. *Cad. Saúde Colet*. (2012) 20:473–81. doi: 10.1590/S1414-462X2012000400011

63. Agrest M, Stastny P. Apoyo de pares: experiencias y perspectivas internacionales [Peer support: international experiences and perspectives]. *VERTEX Rev Arg de Psiquiat*. (2013) 24:410–6.
64. Ibrahim N, Thompson D, Nixdorf R, Kalha J, Mpango R, Moran G, et al. A systematic review of influences on implementation of peer support work for adults with mental health problems. *Soc Psychiatry Psychiatr Epidemiol*. (2020). 55:285–93. doi: 10.1007/s00127-019-01739-1
65. Mascayano F, Alvarado R, Andrews HF, Baumgartner JN, Burrone MS, Conover S, et al. Implementing a protocol of a pilot randomized controlled trial for a recovery-oriented intervention for people with psychoses in 2 Latin American cities. *Cad Saude Publica*. (2019) 35:e00108018. doi: 10.1590/0102-311x00108018
66. Agrest M, Le P, Yang L, Mascayano F, Alves-Nishioka S, Dev S, et al. Implementing a community-based task-shifting psychosocial intervention for individuals with psychosis in Chile: perspectives from users. *Int J Soc Psychiatry*. (2019) 65:38–45. doi: 10.1177/0020764018815204

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Evidence for Specific Associations Between Depressive Symptoms, Psychotic Experiences, and Suicidal Ideation in Chilean Adolescents From the General Population

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Associations between psychotic experiences and suicidal ideation are not yet fully understood, and the potential role of depressive symptoms in this relationship remains unclear. The current study examined relationships between depressive symptoms (DS), psychotic experiences (PE) and suicidal ideation (SI) using two complementary approaches on cross-sectional data from a community sample of adolescents aged 13–19 years (N = 1,591). First, we investigated the association between the three domains using mediation analysis, showing that depressive symptoms partly mediate the relationship between psychotic experiences and suicidal ideation. Second, we looked at associations between the three domains at item level using network analysis. Specific associations between symptoms of the three domains were found, indicating depressive symptoms of sadness, avolition, pessimism, and self-criticalness/worthlessness as the most central symptoms in the network. Suicidal ideation was associated with the depressive symptoms pessimism and worthlessness, to social anxiety, and to perceptual anomalies. Our results show that the mediating effect of depressive symptoms between psychotic experiences and suicidal ideation may be due to associations between specific aspects of SI, depressive symptoms and psychotic experiences. These findings can contribute to the planning of health services and programs aimed at the timely detection of psychopathology and suicidal risk in young people.

Keywords: suicide, adolescents, network and mediation analysis, depressive symptoms, psychotic experiences

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INTRODUCTION

Youth mental health is a global challenge, with onset of mental illness peaking in adolescence (1). Adolescents are at increased risk for both psychotic experiences (PE) (2) and suicidal ideation (SI) (3) which are prevalent in the general (4) and clinical populations (5). Both are associated with psychological distress and higher prevalence of mental disorders (6) and are regarded as early markers for subsequent psychiatric vulnerability in adolescents (7–9). Especially the combination of

the two seems problematic in this young population. Suicidal risk has been associated with PE (10) in general populations (11, 12) and clinical samples (13, 14), particularly when PE are persistent (15, 16). However, the underlying mechanisms explaining the links between PE and SI remain uncertain (17, 18). Some researchers posit that the association between PE and SI is independent of third variables (19, 20), and other argue that the relationship is influenced by third variables such as shared risk factors (21) or mental distress (22).

One factor that has been suggested as a potential mechanism between PE and SI is depressive symptoms (DS) (23). Depressive symptoms are highly prevalent in adolescents (24) and have been proposed as a potential underlying mechanism between PE and SI (25). Even at subthreshold levels, DS are associated with poor social well-being (26), social and educational impairments (27) and increased risk for psychopathology and suicide (28). Literature also supports strong associations between DS and PE (29) suggesting that they are interwoven co-occurring phenomena at both clinical and subclinical levels (30, 31).

Taken together, there is ample evidence suggesting that the three domains of PE, DS, and SI are closely intertwined. However, it remains unclear how exactly they are associated. According to Granö et al. (32), visual distortions could explain SI in adolescents; even when depressive symptoms (and other psychotic symptoms) were controlled for. Fujita et al. (14) reported that auditory verbal hallucinations, but not depressive symptoms, increased the risk for suicidal attempts in adolescents with suicidal ideation. Gill et al. (5) found that the associations between negative symptoms and SI persisted when controlled for depressive symptoms in a high-risk sample of adolescents and young-adults, and Nishida et al. (33) observed that the association between PE and suicidal feelings and behaviors remains significant when controlled for anxiety and DS and use of substances in a general sample of adolescents. Similar results were found in help-seeking adolescents (3). By contrast, Sullivan et al. (34), observed that PE and DS were independently associated with suicidal behavior (SB), and that the association with DS was substantially stronger. Additionally, they reported that PE alone were not a strong predictor of later SB when compared with the predictive power of DS. According to Hielscher et al. (35), the associations between delusional experiences and non-accidental self-injuries were non-significant when depression was entered into the model, which supports prior studies revealing that depressive symptoms mediate the association (12).

Disentangling the associations among PEs, SI, and DS could be helpful to better understand the trajectories and clinical outcomes of these overlapping phenomena. Timely evaluations and interventions to reduce their severity might decrease their impact. Intensity of depression is associated with poorer outcomes of PE in both subjects at risk for psychosis (36) and general population (37), and lower depression levels are associated with reductions in PEs in high risk subjects (38). We currently know that lower DS has better outcomes for PE (39) and that less stressful PE has lower risk for SI (40). However, if we want to know which strategy would be most helpful, we need to disentangle the routes of association between these three phenomena in more detail.

In sum, PE, DS as well as SI are (i) common in adolescents, (ii) by themselves indicative of mental health problems, and (iii) risk factors for further psychopathological development. However, the role of DS within the SI-PE associations remains controversial (35). Therefore, we examined relationships among them using two complementary approaches. First, to explore the associations among these variables, we conducted regression-based mediation analyses (41), hypothesizing that DS would mediate the link between PEs and SI. Second, we hypothesized that a potential mediating role might consist of specific associations among particular subtypes of PE, SI, and DS (29) and investigated this using network analysis, which allows for the exploration of interactions among specific symptoms (42). We hypothesized that DS would be a mediating role in the association between PE and SI. This role of DS seems to be adequate considering that SI is one of the more severe symptoms of depression (43), being the latter a predictor of SI and suicide attempts (44), but not vice versa. We expected to find positive relationships among SI, PE, and DS. In line with previous findings (45, 46) we hypothesized that DS would take up a central role in the overall symptoms network, and that some specific affective symptoms (i.e., low energy, hopelessness and self-depreciating feelings) would show higher centrality values (i.e., play a more central role in the symptom network).

METHOD

Participants

We conducted a cross-sectional study with adolescents recruited between April and August 2015 in 6 Chilean public secondary public schools in the urban area of the city of Talca. One thousand seven hundred and seventy three students and their parents voluntarily agreed to participate in the study and provided written informed consent. We excluded 182 subjects who did not complete all measures. Little's test (45) showed that these excluded individuals did not differ from included participants on demographic (gender and age) or clinical severity (total score on depressive, anxiety and stress symptoms (DASS-21). We performed the analyses with a final sample of 1591 adolescents (mean age = 16.01, SD = 1.45, women = 53.4%).

Measures

Psychotic Experiences (PE)

As previously reported (47), we used a deductive method of item generation (48) where we combined two pre-existing scales that were used in prior studies with adolescents: the Community Assessment of Psychic Experiences—Positive scale [CAPE-P15 (49)], and the Brief Self-report Questionnaire for Screening Putative Pre-psychotic States [BQSPS (50)]. We assessed the following domains: bizarre experiences (BE, 6 items), perceptual anomalies (PA, 3 items), social anxiety (SA, 3 items), and negative symptoms (NS, 3 items). Both reliability and internal consistency were adequate when assessed through the coefficients of Cronbach's alpha and Macdonald's Omega [i.e., $\omega > 0.65$ (51); **Table 1**].

TABLE 1 | Internal consistency values for each subscale.

Dimension	Cronbach's α	McDonald's ω
Bizarre experiences	0.78	0.78
Perceptual anomalies	0.79	0.81
Social anxiety	0.68	0.69
Negative symptoms	0.65	0.69
Suicidal ideation lifetime	0.85	0.87
Depression	0.89	0.90

Depressive Symptoms (DS)

We assessed DS with the Depression and Anxiety Scale (DASS-21) (51), a 21-item self-report questionnaire with three subscales assessing depressed mood, anxiety and stress. In the present study, we only used the subscale for depressive symptoms (DS). The reliability of the instrument is good for this sample (Cronbach's alpha = 0.89; McDonal's ω = 0.90) (**Table 1**).

Suicidal Ideation (SI)

We assessed SI using 6 items of the Columbia Suicide Severity Rating Scale (C-SSRS) (52), adapted for being used as a self-report questionnaire (53). Severity of SI was rated on a 6-point ordinal scale in which 1 = wish to be dead, 2 = non-specific active suicidal thoughts, 3 = thoughts about how to commit suicide, 4 = suicidal thoughts and intentions, 5 = suicidal thought with detailed plan, and 6 = intentions to conduct plan. Frequency of SI was addressed by asking participants when these thoughts happened: ever in life (SI_L) and/or during last month (SI_M). We only reported the former (SI_L) because there were few reports of suicidal ideation during the last month. The internal consistency of SI_L is good for the current population (Cronbach's alpha = 0.85; McDonal's ω = 0.87).

Procedure

The translating process of the questionnaires has been previously described (47). We conducted the study in public schools who agreed to participate after meetings with directive committees. Researchers participated in different parents' meetings to present the project. After its approval and once written informed consents were obtained from both adolescents and their caregivers, the participants completed the questionnaires, administered in classroom settings by trained psychologists. Ethical approval was obtained from the Bioethics Committee of the University of Talca.

Data Analysis

Prior to the main analysis, we first examined the associations among the variables, using Spearman's correlation coefficient. To answer the first research question of the indirect effect of depressive symptoms on the relationship between PE and SI, we conducted a mediation analysis through the modeling macro PROCESS v.2.13 (54). This statistical package uses least squares regression-based path analytic framework for mediation analysis that follows the Baron and Kenny procedure (41). This analysis was carried out using the bootstrapping resampling method through 5,000 bootstrap resamples (55). An advantage of the bootstrapping approach for this analysis is that it overcomes the sample size requirements used by the Sobel test to assess mediation (56, 57). Bootstrapping resampling estimates the indirect effect and its 95% confidence intervals. When the bias-corrected confidence intervals (BC CIs) do not contain 0, it is assumed that there is a mediating effect among the proposed variables. In this model, the predictor variable was PE, the outcome variable was SI, and the mediator variable was DS. No other variables were controlled for. Additionally, to investigate whether the mediating role of DS was not explained by more general distress, we performed two single mediation models, where the mediators between PE and SI were anxiety (AS) in the first model and stress symptoms (S) in the second model. Finally, we computed a multiple mediation model testing DS, AS and S as mediators between PE and SI.

Next, to examine the second research question on simultaneous relationships among single items, we used network analysis. We estimated an Ising network model for binary data, previously used to analyze psychopathology (58). The model assumes that the activation of a node depends on the activation of its neighboring nodes. The binary network was fitted using the R-package IsingFit 0.3.1. For model estimation, as previously done (46), we recoded the responses of questionnaires as follows: For PE: 0 = "not present" (scores 1–2), 1 = "present" (scores 3–5). For SI: 0 = "not present" (scores 1–2), 1 = "present" (scores 3–6). For DS: 0 = "not present" (1, 2), 1 = "present" (3–5).

After the estimation of the Ising model, we examined the resulting network using the qgraph package, version 1.6.3. Given recent concerns on the suitability of using centrality indices when applying network analyses to psychopathology, and following the suggestion of Bringmann et al. (59), we focused only on the strength centrality index as a measure of relative importance in the whole network. Strength is defined as the sum of the weights of the links of a node with other nodes and represents how well-connected a node is to the rest of the network (44). We eliminated spurious associations between nodes and excluded small associations from the graphs using the graphical LASSO (Least Absolute Shrinkage and Selection Operator) implemented in the R package q graph (60). Next, we analyzed the network stability by the correlation stability coefficient (CS-coefficient), which quantifies the maximum amount of cases that can be dropped to retain with 95% certainty, a correlation with the original centrality of higher than (by default) 0.7. Values should be at least 0.25 for the centrality to be stable, and preferably above 0.5 (60). Finally, we tested the accuracy of the edges in the network by bootstrapping the 95% confidence intervals of the edge weights to test if the edges do significantly differ from one-another.

RESULTS

Descriptive Statistics

Tables 2–5 show raw and dichotomized scores of, respectively, PE, DS, and SI. Of the PE, NS had the highest prevalence (69.2%), followed by SA (63.2%), BE (52.5%), and PA (15.3%). The prevalence of DS was 50.4%. The prevalence of SI was 19%.

TABLE 2 | Prevalence (%) of psychotic experiences, depressive symptoms, and suicide ideation in the study sample (at least one time, lifetime).

	Psychotic experiences				DS	SI
	BE	PA	SA	NS		
Males	340 (45.8)	99(13.3)	441 (59.4)	503 (67.7)	309 (41.6)	80 (10.8)
Females	497 (58.5)	144 (16.9)	565 (66.5)	599 (70.5)	494 (58.1)	223 (26.2)
Total	837 (52.5)	243 (15.3)	1006 (63.2)	1102 (69.2)	803 (50.4)	303 (19)

PE, Psychotic experiences (Total); BE, Bizarre experiences; PA, Perceptual anomalies; SA, Social anxiety; NS, Negative symptoms; DS, Depressive symptoms; SI, Suicidal ideation.

Correlation Analysis

Spearman's correlations are displayed in **Supplementary Table 1**. DS were significantly correlated with SI ($r = 0.49$, $p < 0.001$), with PE ($r = 0.63$, $p < 0.001$) and, specifically, PE factors BE ($r = 0.52$, $p < 0.001$), SA ($r = 0.44$, $p < 0.001$), NS ($r = 0.43$, $p < 0.001$). PA ($r = 0.35$, $p < 0.001$). Likewise, PE and SI were significantly linked ($r = 0.43$, $p < 0.001$).

Mediation Analysis

We observed positive and significant associations amongst PE and DS, DS and SI, and PE and SI, and a significant indirect effect for DS. This means that DS effectively mediates the association between PE and SI (b = 0.227, 95% BCa CI [0.183, 0.274]) (**Table 6** and **Figure 1**). When DS were added in the model, the association between PE and SI remained significant, suggesting a partial mediation. PE accounted for medium to high amounts of variance in suicidality, with $R^2 = 0.44$ and in depressive symptoms, with $R^2 = 0.63$.

The additional analyses exploring anxiety symptoms (AS) and stress (S) separately as single mediators between PE and SI yielded that both AS (b = 0.168, 95% BCa CI [0.128, 0.212]) and S (b = 0.15, 95% BCa CI [0.108, 0.192]) had a significant indirect effect (**Supplementary Tables 2, 3**). However, the multiple mediation analysis revealed that DS was the only mediator that remained similar and stable in both analyses (b = 0.195, 95% BCa CI [0.137, 0.254]). S did not longer mediate the association (b = −0.009, 95% BCa CI [−0.061, 0.046]); AS did show a mediating effect, but this was a very small indirect effect (b = 0.049, 95% BCa CI [0.022, 0.254]) (**Supplementary Table 4**).

Network Analysis

Figure 2 presents results of the Ising analysis. As expected due to the clustering of items within each instrument, there are more connections within each domain than between domains. The results show different connectivity patterns within both domains of DS and PE, and differential connections among the nodes belonging to these clusters and SI. The strongest within-domain interconnectedness was observed for DS. Within DS, the strongest link was found between DASS3 ("I felt I had nothing to live for") and DASS7 ("I felt life had no meaning"). Within PE, the strongest link was observed between auditory perceptual anomalies (PA1: "hearing voices when you are alone?") and visual perceptual anomalies (PA2: "seeing objects, people or animals than others cannot?").

Regarding the connectedness between different clusters of PE, the strongest links were between PA1 ("hearing voices when alone?") and bizarre experiences (BE5: "thoughts in your head are not your own?"), followed by BE3 ("people look at you oddly because of your appearance?") and social anxiety (SA1"I cannot get close to people"), and between BE3 and DASS6 ("I felt I wasn't worth much as a person"). Furthermore, we observed links between DASS3 and NS2 ("I feel mentally insufficient and easily fatigued while thinking or reading"), and between BE3 and DASS4 ("I felt down-hearted and blue") **Supplementary Figure 1** shows differences between edges that were non-zero in the estimated network.

Suicidal ideation was associated with four depressive symptoms (DASS3, DASS7, DASS6, and DASS4), and with several PE: two perceptual anomalies (PA2, PA1), one social anxiety symptom (SA1, "I feel I cannot get close to people"), and two bizarre experiences (BE2 and BE3). The strength values of these associations are shown in **Table 7**.

Strength Centrality Index

As can be seen in **Table 8** and **Figure 3**, DS displayed higher strength values. The strongest nodes in the network were DASS4 ("I felt down-hearted and blue"), DASS3 ("I felt I had nothing to live for"), DASS7 ("I felt life had no meaning"), DASS6 ("I felt I wasn't worth much as a person"), and DASS2 ("It was difficult for me to motivate myself to do things").

Network Stability

Supplementary Figure 2A depicts the stability of the centrality indices. The correlation stability coefficient for the strength was 0.60 which is good [63], making our results well interpretable. **Supplementary Figure 2B** shows the network accuracy, again suggesting our results are acceptable and interpretable. The edge-weight accuracy indicated that most edges are not meaningfully different from each other because their confidence intervals overlap.

DISCUSSION

We analyzed the associations between psychotic experiences (PE), depressive symptoms (DS) and suicidal ideation (SI) in a large general population sample of adolescents using two complementary approaches: first, we investigated the associations between the three domains in general and second, at item level. The domains of PE, DS, and SI were associated with each other, in accordance with previous literature (61). Confirming previous findings of Sullivan et al. (62), our results suggest that depressive symptoms play an important mediating role in the relationship between SI and PE. Our findings of higher centrality indices for some DS in combination with the results yielded by the mediation analysis, show that the predictive role of PE for suicidal risk in adolescents is not only due to PE themselves. Specifically, our results suggest that these mediating effects may be due to associations between specific aspects of SI, depressive symptoms and psychotic experiences. We found that

TABLE 3 | Descriptive scores of psychotic experiences (raw and dichotomized scores).

Item	Domain	Mean scores (SD)		Median	%	
		Original responses	After recoding		Yes	No
Have you ever felt that you are being persecuted in anyway?	BE1	1.78 (0.95)	0.20 (0.399)	2	19.90	80.10
Have you ever felt as if there is a conspiracy against you?	BE2	1.63 (0.91)	0.15 (0.355)	1	14.87	85.13
Have you ever felt that people look at you oddly because of your appearance?	BE3	2.01 (1.08)	0.26 (0.439)	2	26.00	74.00
Have you ever felt as if the thoughts in your head are being taken away from you?	BE4	1.68 (0.93)	0.18 (0.381)	1	17.65	82.35
Have you ever felt as if the thoughts in your head are not your own?	BE5	1.54 (0.88)	0.13 (0.334)	1	12.70	87.30
Have your thoughts ever been so vivid that you were worried other people would hear them?	BE6	1.72 (1.05)	0.19 (0.396)	1	19.39	80.61
Have you ever heard voices when you are alone?	PA1	1.46 (0.86)	0.11 (0.312)	1	11.49	88.51
Have you ever seen objects, people or animals that other people can't see?	PA2	1.24 (0.68)	0.06 (0.243)	1	6.30	93.70
I feel I cannot get close to people	SA1	1.80 (1.03)	0.21 (0.404)	1	20.80	79.20
I am mostly quiet when with others	SA2	2.12 (1.09)	0.31 (0.462)	2	30.72	69.28
I feel nervous when giving a speech in front of a large group of people	SA3	2.79 (1.33)	0.53 (0.499)	3	52.80	47.20
I cannot focus on a task	NS1	2.70 (1.17)	0.51 (0.500)	3	51.70	48.30
I feel mentally insufficient and easily fatigued while thinking or reading	NS2	1.78 (0.98)	0.17 (0.382)	2	17.17	82.83
I need to take frequent breaks while working (studying)	NS3	2.69 (1.11)	0.51 (0.500)	3	50.90	49.10

BE, Bizarre experiences; PA, Perceptual anomalies; SA, Social anxiety; NS, Negative symptoms.

TABLE 4 | Descriptive scores of depressive symptoms (raw and dichotomized scores).

Item	Mean scores (SD)		Median	%	
	Original scores	After recoding		Yes	No
I couldn't seem to experience any positive feeling at all	1.80 (1.06)	0.21 (0.41)	1	21.47	78.53
It was difficult for me to motivate myself to do things	2.12 (1.15)	0.30 (0.46)	2	30.50	69.50
I felt that I had nothing to look forward to	1.45 (0.98)	0.12 (0.33)	1	12.20	87.80
I felt down-hearted and blue	2.14 (1.26)	0.32 (0.47)	2	32.59	67.41
I was unable to become enthusiastic about anything	1.62 (0.94)	0.14 (0.35)	1	14.74	85.26
I felt I wasn't worth much as a person	1.69 (1.14)	0.19 (0.39)	1	19.64	80.36
I felt that life was meaningless	1.58 (1.10)	0.16 (0.37)	1	16.30	83.70

TABLE 5 | Descriptive scores of suicidal ideation lifetime (dichotomized scores).

Item	Mean scores (SD)	Lifetime %	
		Yes	No
Have you wished you were dead or wished you could go to sleep and not wake up?	0.47 (0.499)	47.17	52.83
Have you actually had any thoughts about killing yourself?	0.15 (0.356)	14.93	85.07
Have you thought about how you might do this?	0.21 (0.406)	20.80	79.20
Have you had any intention of acting on these thoughts of killing yourself,	0.18 (0.386)	18.20	81.80
Have you started to work out or worked out the details of how to kill yourself?	0.06 (0.237)	6.00	94.00
Do you intend to carry out this plan?	0.05 (0.216)	4.90	95.10

DS mediated the association through the symptoms of avolition, pessimism, sadness, and feelings of worthlessness that had higher strength values.

These results are consistent with earlier evidence suggesting that some DS are more relevant than others in terms of their impact on impairments and relationships with risk factors (63), and that DS are differentially associated to specific impairments in children and adolescents (64).

In line with by Barragan et al. (65), we found specific associations between PE and DS. We observed links between paranoid ideation and anhedonia, sadness and self-depreciating feelings, and also specific connections between thought

TABLE 6 | Mediation analysis of psychotic experiences, depressive symptoms, and suicidal ideation.

Mediation steps	Outcome	Predictor	*B*	95% CI	R^2
1	Suicidal ideation	Psychotic experiences	0.092**	[0.082,0.101]	0.439
2	Depressive symptoms	Psychotic experiences	0.469**	[0.441,0.498]	0.627
3	Suicidal ideation	Depressive symptoms	0.101**	[0.067,0.106]	0.523
4		Psychotic experiences	0.044**	[0.033,0.055]	

***p < 0.001.*

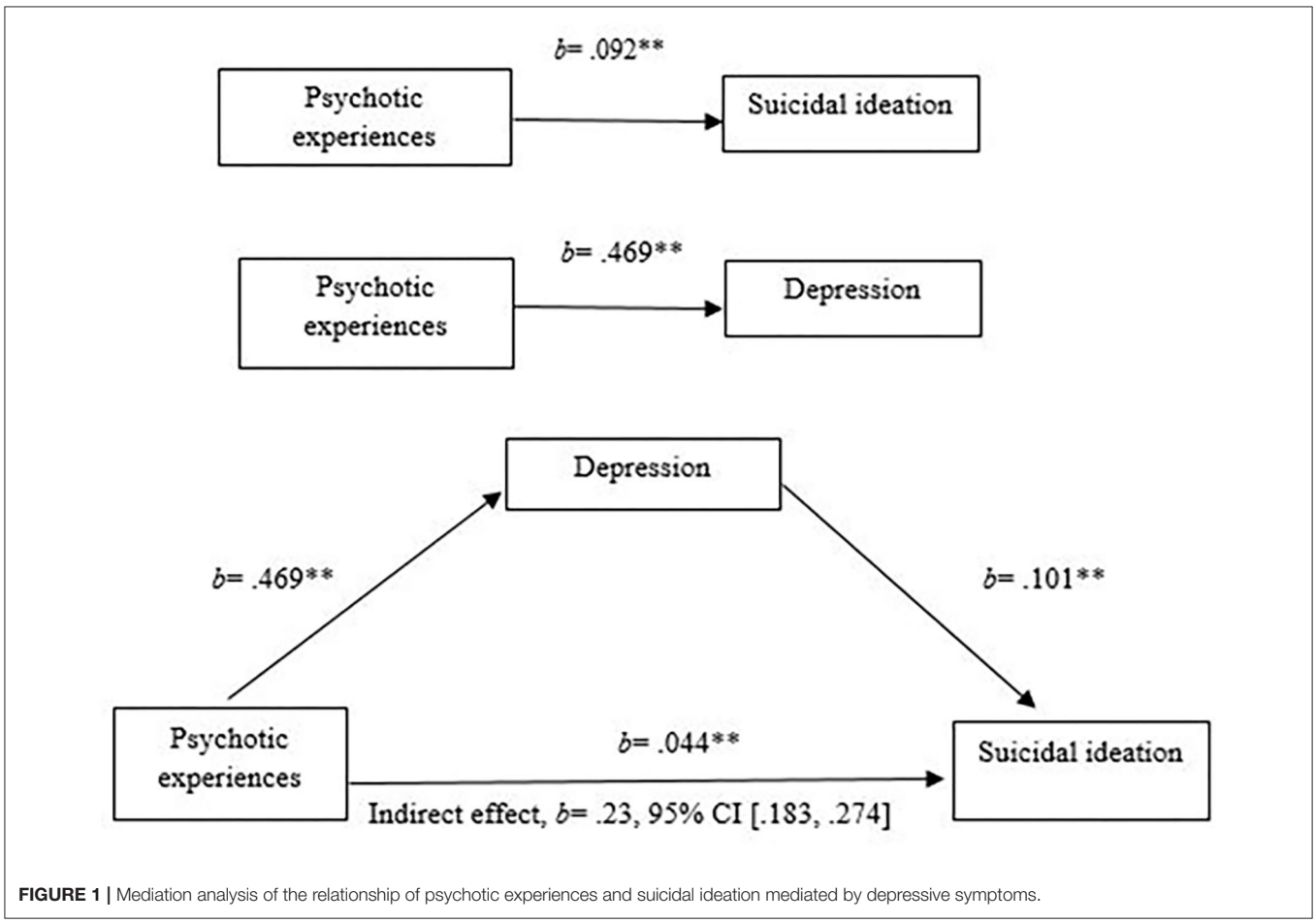

FIGURE 1 | Mediation analysis of the relationship of psychotic experiences and suicidal ideation mediated by depressive symptoms.

alienation/broadcasting symptoms and pessimism, avolition, anhedonia, and self-depreciating feelings. These results, and the specific link observed between auditory hallucinations and pessimism mirror those of another recent study showing that, in patients with mood disorders, only some types of PE (i.e., "hints and double meanings," "odd looks," and "being persecuted") are linked to some depressive symptoms (i.e., "self-criticalness" and "worthlessness") (30). However, because our cross-sectional design and different populations, we cannot test the directionality of the effects, which remains a critical research question (66).

Previous network analyses examining DS and SI have shown loss of interest, sadness, fatigue and feeling guilty as the most central symptoms for suicidality presentation in adult patients (43). These findings partially align with ours; however, given the differences observed between adult and adolescent depression (67), further specific comparisons using similar samples are needed. Mullarkey et al. (46) is the only study analyzing DS in non-clinical adolescent samples using network analyses. They found that self-hatred, loneliness, sadness, and pessimism were the most central symptoms. Our results are, again, partially in line with these findings, as the four DS that were the most central nodes in our network ("downhearted and blue"; "nothing to look forward to"; "life was meaningless"; and "not being worth much as a person") are similar to them. Although the age ranges of both samples are similar, direct comparisons must be interpreted with caution, considering we analyzed a narrower range of DS. Our results are also partially consistent

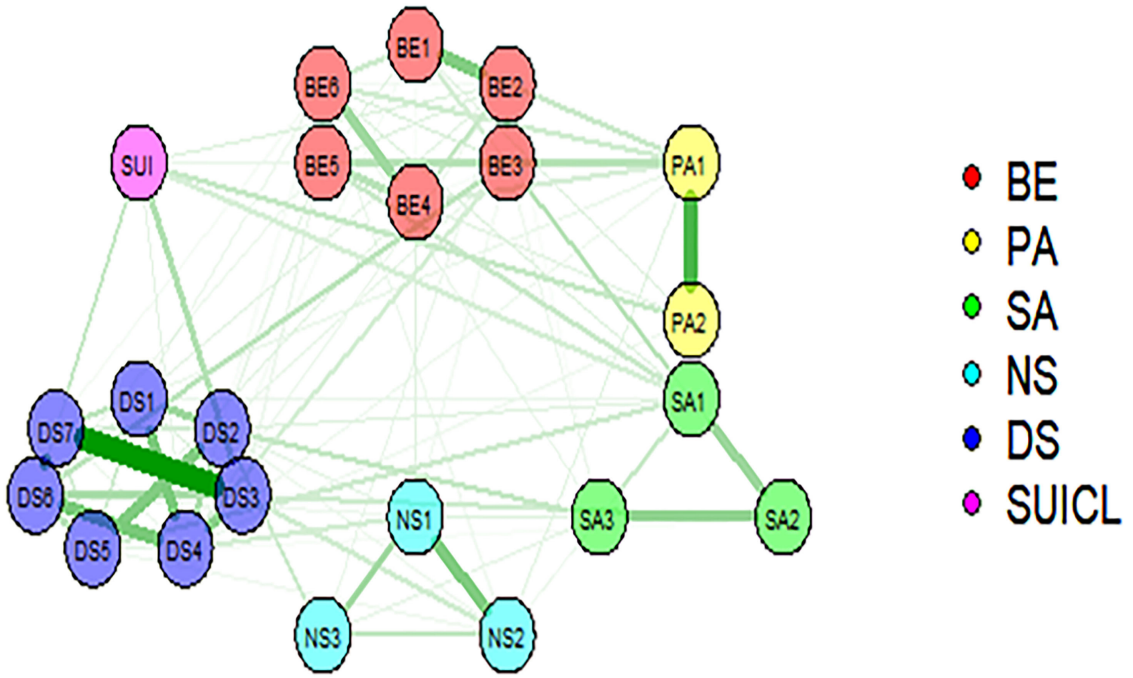

FIGURE 2 | Representation of network model of psychotic experiences, suicidal ideation, and depressive symptoms (BE, bizarre experiences; PA, perceptual anomalies; SA, social anxiety; NS, negative symptoms); DASS, depressive symptoms, SUICL, suicidal ideation (life time). Two main components are depicted: the symptoms or nodes (circles), and the edges (lines linking the symptoms). The edges represent the relationships between symptoms (green lines correspond to positive associations). The thickness of the edges represents the magnitude of the associate ion between nodes.

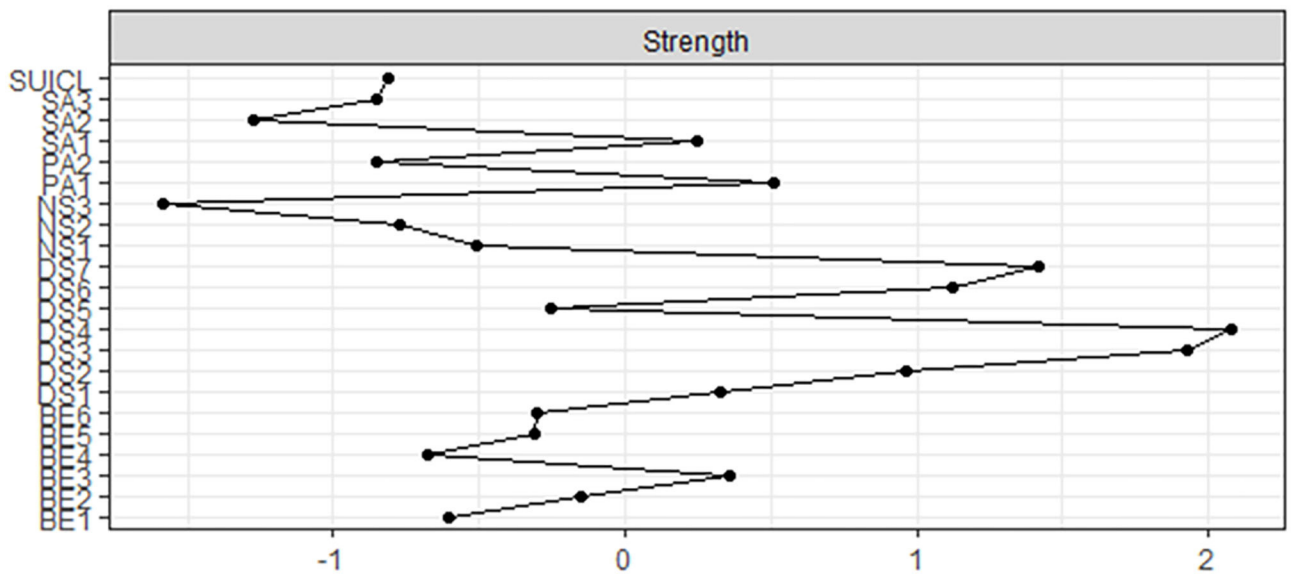

FIGURE 3 | Strength centrality values of nodes per subscale.

with other recent network analysis conducted with adolescent patients reporting that in patients with both major depressive disorder (MDD), social phobia and (SP) and MDD+SP, poor self-esteem and suicidal ideation were the most central, in addition to feelings of worthlessness and anhedonia in the MDD+SP subgroup (68), and with another study reporting

TABLE 7 | Strenght values of node-specific connections.

Connections	Strength value
SI-BE2	0.10
SI-BE3	0.16
Mean	0.13
SI-PA1	0.20
SI-PA2	0.51
Mean	0.35
SI-SA1	0.36
SI-DASS3	0.71
SI-DASS4	0.25
SI-DASS6	0.30
SI-DASS7	0.50
Mean	0.44

TABLE 8 | Mean strength of the 6 subscales.

Domain	Mean	Variance	Median
Depressive symptoms	5.71	1.13	5.76
Perceptual anomalies	4.11	1.51	4.11
Bizarre experiences	3.97	0.22	3.94
Social anxiety	3.53	0.99	3.25
Suicidal ideation, lifetime	3.29	NA	3.29
Negative symptoms	3.11	0.55	3.35

that fatigue and low mood as the most central nodes (69). Because the different sample characteristics (non-help seeking adolescents vs. clinical samples), direct comparisons must be cautionary done.

Regarding the associations between PE and SI, the PE domain of social anxiety was connected to SI through the node addressing difficulties to be close to people (SA1), which was clearly linked to the other two social anxiety symptoms, and to bizarre experiences reflecting both paranoid ideation and delusional experiences of thought alienation and thought broadcasting. SA1 was also connected to DS of anhedonia, and slightly associated with avolition. This fits with results from Jaya et al. (70), who found that DS mediated relationships between loneliness and positive symptoms in adults. In addition, they found that loneliness was uniquely associated with paranoid symptoms that were similar to the ones we found to be linked to sadness and feelings of life being meaningless.

Our findings also support previous research showing positive associations between odd beliefs and depressive symptoms relating to negative feelings and sadness in healthy young-adults and adults (29). Although we did not address either social functioning or social isolation, the connections we observed between social anxiety symptoms, bizarre experiences, depressive and negative symptoms are consistent with evidence demonstrating high co-morbidity and strong links between social isolation and loneliness and social anxiety in psychosis (71), between positive PE and perceived social isolation (72, 73) and between PE (delusional mood) and loneliness in a general population sample (20). As argued by Jang et al. (74), PE, and in particular beliefs that other people intend to harm and delusional experiences of thought control/broadcasting, could lead to an inaccurate interpretation of the world, especially in social situations. This potential reality distortion might make individuals less likely to seek out social company, which in turn could increase feelings of worthlessness, meaninglessness and existential void, which were the symptoms that were central in our network. Overall, our findings highlight the need of further research examining the prominent role of loneliness and its relationships with social anxiety and PE, which are regarded as potential predictors of suicidal behavior (75) in school-based sample of adolescents (76), early adolescent patients (77), and young adults with social anxiety disorder and high levels of PE (78).

There are some limitations that should be kept in mind regarding the interpretation of our results. First, regression-based mediation analyses do not explicitly control for measurement error, possibly hindering the adequate estimation of coefficients (79). Second, the meaning of centrality indices in psychology research is not undisputed (59). For instance, central nodes in cross-sectional data were not necessarily the most important symptoms, as found in subjects with social anxiety disorder (80). Finally, cross-sectional networks do not provide information on how symptoms trigger each other over time (81) and thus, causal relationships among symptoms cannot be inferred (96). Furthermore, cross-sectional data only allow examining mechanisms at group level but not at individual level (82). These issues are crucial to investigate further, e.g., through the "suicidal drive hypothesis for psychosis" framework, which states that psychosis could be consequential to suicidal behavior instead of causing higher suicidal risk (83). Finally, we addressed a narrow range of depressive symptoms and did not include some symptoms highlighted as relevant in adolescents when compared to adults (i.e., appetite and weight change and insomnia) (67). Strengths of our study include the large sample size, the use of two complementary analytic methods, and the high stability and moderate accuracy of our analyses. Working from the notion of psychosis existing as an extended phenotype (84), the exploration of subclinical expressions of psychosis offers opportunities to investigate mechanisms that, may explain a vulnerability for the development of psychosis along this continuum" (85). However, it should be kept in mind that this was a general (non-clinical) population sample and generalizability may be limited to more clinical expressions of psychosis.

In our sample, a relevant proportion of adolescents have experienced PE at least sometimes during their lifetime. Comparisons with previous research show different results. For instance, the endorsement rates of BE was lower when compared with Armando et al. (78) and Wüsten et al. (86), but similar when compared with Isaksson et al. (9). Additionally, the rates of PA were similar when compared to these studies and also with Issackson et al. (9), but slightly higher than Narita et al. (20). Because the different measures, sample sizes and age-ranges, clear conclusions on cultural differences cannot be drawn and further research is needed.

Some clinical implications can be drawn from our results. Aligning with other evidence revealing that relationships between PE and SI reflect a higher underlying risk of suicidal behavior as a function of psychiatric symptoms or mental distress (21, 22), our results suggest that youth clinical services should screen for a broad range of symptoms and suicide correlates when assessing suicidal risk. Moreover, our results corroborate the notion that PE play an important role already in early stages of mental health problems in young people (66), causing severe distress (86), higher use of mental health services (87) and reduced functioning, even when transient (88). Despite this evidence, strategies to both address and treat PE in mental health services are not commonly employed (89). Because these strategies may prevent PEs from becoming persistent PE (90) which increases the risk for later mental health problems (91), timely detection of PE should be routinely included in mental health services (10).

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Bioethics Committee of University of Talca. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

DN designed the study and directed its implementation, did the literature search, and wrote the manuscript. PM did the literature search and performed preliminary network analyses. SC performed the mediation analyses, edited, and reviewed the manuscript. JW reviewed the manuscript and revised it critically for intellectual content. All authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2020.552343/full#supplementary-material

REFERENCES

1. Mei C, Fitzsimons J, Allen N, Alvarez-Jimenez, M, Amminger GP, Browne V, et al. Global research priorities for youth mental health. *Early Interv Psychiatry.* (2020) 14:3–13. doi: 10.1111/eip.12878
2. Healy C, Brannigan R, Dooley N, Coughlan H, Clarke M, Kelleher I, et al. Childhood and adolescent psychotic experiences and risk of mental disorder: a systematic review and meta-analysis. *Psychol Med.* (2019) 49:1589–99. doi: 10.1017/S0033291719000485
3. Nishida, A, Sasaki T, Nishimura Y, Tanii H, Hara N, Inoue K, et al. Psychotic-like experiences are associated with suicidal feelings and deliberate self-harm behaviors in adolescents aged 12-15 years. *Acta Psychiatr Scand.* (2010) 121:301–7. doi: 10.1111/j.1600-0447.2009.01439.x
4. Kelleher I, Cederlöf M, Lichtenstein P. Psychotic experiences as a predictor of the natural course of suicidal ideation: a Swedish cohort study. *World Psychiatry.* (2014) 13:184–8. doi: 10.1002/wps.20131
5. Gill K, Quintero J, Poe L, Moreira A, Brucato G, Corcoran CM, et al. Assessing suicidal ideation in individuals at clinical high risk for psychosis. *Schizophr. Res.* (2015) 65:152–6. doi: 10.1016/j.schres.2015.04.022
6. Collip D, Wigman JT, Myin-Germeys I, Jacobs N, Derom C, Thiery E, et al. From epidemiology to daily life: linking daily life stress reactivity to persistence of psychotic experiences in a longitudinal general population study. *PLoS ONE.* (2013) 8:e62688. doi: 10.1371/journal.pone.0062688
7. Healy C, Gordon A, Coughlan H, Clarke M, Kelleher I, Cannon M. Do childhood psychotic experiences improve the prediction of adolescent psychopathology? A longitudinal population-based study. *Early Interv Psychiatry.* (2018) 13:1245–51. doi: 10.1111/eip.12762
8. McHugh C, Corderoy A, Ryan C, Hickie I, Large M. Association between suicidal ideation and suicide: meta-analyses of odds ratios, sensitivity, specificity and positive predictive value. *Bjpsych Open.* (2019) 5:e18. doi: 10.1192/bjo.2019.15
9. Issackson J, Vadlin S, Olofsdotte S, Aslund C, Nilsson K. Psychotic-like experiences during early adolescence predict symptoms of depression, anxiety, and conduct problems three years later: a community-based study. *Schizophr Res.* (2020) 215:190–6. doi: 10.1016/j.schres.2019.10.033
10. Yates K, Lång U, Cederlöf M, Boland F, Taylor P, Cannon M. Association of psychotic experiences with subsequent risk of suicidal ideation, suicide attempts, and suicide deaths. *JAMA Psychiatry*. (2019) 76:180. doi: 10.1001/jamapsychiatry.2018.3514
11. Kelleher I, Connor D, Clarke MC, Devlin N, Harley M, Cannon M. Prevalence of psychotic symptoms in childhood and adolescence: a systematic review and metaanalysis of population-based studies. *Psychol. Med.* (2012) 9:1–7. doi: 10.1017/S0033291711002960
12. Kelleher I, Corcoran P, Keeley H, Wigman JT, Devlin N, Ramsay H., et al. Psychotic symptoms and population risk for suicide attempt: a prospective cohort study. *JAMA Psychiatry.* (2013) 70:940–8. doi: 10.1001/jamapsychiatry.2013.140
13. D'Angelo E, Lincoln S, Morelli N, Graber K, Tembulkar S, Gonzalez-Heydrich J. Suicidal behaviors and their relationship with psychotic-like symptoms in children and adolescents at clinical high risk for psychosis. *Comprehens Psychiatry.* (2017) 78:31–7. doi: 10.1016/j.comppsych.2017.07.008
14. Fujita J, Takahashi Y, Nishida A, Okumura Y, Ando S, Kawano M. Auditory verbal hallucinations increase the risk for suicide attempts in adolescents with suicidal ideation. *Schizophr Res.* (2015) 168:209–12. doi: 10.1016/j.schres.2015.07.028
15. Connell M, Betts K, McGrath J, Alati R, Najman J, Clavarino A, et al. Hallucinations in adolescents and risk for mental disorders and suicidal behaviour in adulthood: prospective evidence from the MUSP birth cohort study. *Schizophr Res.* (2016) 176:546–51. doi: 10.1016/j.schres.2016.06.009
16. Kelleher I, Cederlöf M, Lichtenstein P. Psychotic experiences as a predictor of the natural course of, suicidal ideation: a Swedish cohort study. *Schizophr Res.* (2014) 153:S11. doi: 10.1016/S0920-9964(14)70034-9

17. Fredriksen K, Schoeyen H, Johannessen J, Walby F, Davidson L, Schaufel M. Psychotic depression and suicidal behavior. *Psychiatry*. (2017) 80:17–29. doi: 10.1080/00332747.2016.1208002
18. Hielscher E, DeVylder J, Saha S, Connell M, Scott J. Why are psychotic experiences associated with self-injurious thoughts and behaviours? A systematic review and critical appraisal of potential confounding and mediating factors. *Psychol Med*. (2017) 48:1410–26. doi: 10.1017/S0033291717002677
19. Bromet E, Nock M, Saha S, Lim C, Aguilar-Gaxiola S, Al-Hamzawi A, et al. Association between psychotic experiences and subsequent suicidal thoughts and behaviors. *JAMA Psychiatry*. (2017) 74:1136. doi: 10.1001/jamapsychiatry.2017.2647
20. Narita Z, Stickley A, DeVylder J. Loneliness and psychotic experiences in a general population sample. *Schizophr Res*. (2020) 218:146–50. doi: 10.1016/j.schres.2020.01.018
21. DeVylder J, Jahn D, Doherty T, Wilson C, Wilcox H, Schiffman J, et al. Social and psychological contributions to the co-occurrence of sub-threshold psychotic experiences and suicidal behavior. *Social Psychiatry Psychiatr Epidemiol*. (2015) 50:1819–30. doi: 10.1007/s00127-015-1139-6
22. Honings S, Drukker M, Groen R, van Os J. Psychotic experiences and risk of self-injurious behaviour in the general population: a systematic review and meta-analysis. *Psychol Med*. (2016) 46:237–51. doi: 10.1017/S0033291715001841
23. Balázs J, Miklósi M, Keresztény Á, Hoven C, Carli V, Wasserman C, et al. Adolescent subthreshold-depression and anxiety: psychopathology, functional impairment and increased suicide risk. *J Child Psychol Psychiatry*. (2013) 54:670–7. doi: 10.1111/jcpp.12016
24. Kessler RC, Amminger GP, Aguilar-Gaxiola S, Alonso J, Lee S, Ustün TB. Age of onset of mental disorders: a review of recent literature. *Curr Opin Psychiatry*. (2007) 20:359–64. doi: 10.1097/YCO.0b013e32816ebc8c
25. Jahn D, Bennett M, Park S, Gur R, Horan WP, Kring AM, et al. The interactive effects of negative symptoms and social role functioning on suicide ideation in individuals with schizophrenia. *Schizophr Res*. (2016) 170:271–7. doi: 10.1016/j.schres.2015.12.011
26. Verboom C, Sijtsema J, Verhulst F, Penninx B, Ormel J. Longitudinal associations between depressive problems, academic performance, and social functioning in adolescent boys and girls. *Dev Psychol*. (2014) 50:247–57. doi: 10.1037/a0032547
27. Thapar A, Collishaw S, Pine D, Thapar A. Depression in adolescence. *Lancet*. (2012) 379:1056–67. doi: 10.1016/S0140-6736(11)60871-4
28. Gili M, Castellví P, Vives M, de la Torre-Luque A, Almenara J, Blasco M, et al. Mental disorders as risk factors for suicidal behavior in young people: a meta-analysis and systematic review of longitudinal studies. *J Affect Disord*. (2019) 245:152–62. doi: 10.1016/j.jad.2018.10.115
29. Unterrassner L, Wyss T, Wotruba D, Haker H, Rössler W. The intricate relationship between psychotic-like experiences and associated subclinical symptoms in healthy individuals. *Front Psychol*. (2017) 8:1537. doi: 10.3389/fpsyg.2017.01537
30. Baryshnikov I, Suvisaari J, Aaltonen K, Koivisto M, Melartin T, Näätänen P, et al. Self-reported psychosis-like experiences in patients with mood disorders. *European Psychiatry*. (2018) 51:90–7. doi: 10.1016/j.eurpsy.2016.07.005
31. Klaassen R, Heins M, Luteij, L, van der Gaag M, van Beveren N. Depressive symptoms are associated with (sub) clinical psychotic symptoms in patients with non-affective psychotic disorder, siblings and healthy controls. *Psychol Med*. (2013) 43:747–56. doi: 10.1017/S0033291712001572
32. Granö N, Salmijärvi L, Karjalainen M, Kallionpää S, Roine M, Taylor P. Early signs of worry: psychosis risk symptom visual distortions are independently associated with suicidal ideation. *Psychiatry Res*. (2015) 225:263–7. doi: 10.1016/j.psychres.2014.12.031
33. Nishida A, Shimodera S, Sasaki T, Richards M, Hatch S, Yamasaki S, et al. Risk for suicidal problems in poor-help-seeking adolescents with psychotic-like experiences: findings from a cross-sectional survey of 16,131 adolescents. *Schizophr Res*. (2014) 159:257–62. doi: 10.1016/j.schres.2014.09.030
34. Sullivan S, Wiles N, Kounali D, Lewis G, Heron J, Cannon M, et al. Longitudinal associations between adolescent psychotic experiences and depressive symptoms. *PLoS ONE*. (2014) 9:e105758. doi: 10.1371/journal.pone.0105758
35. Hielscher E, Connell M, Lawrence D, Zubrick S, Hafekost J, Scott J. Association between psychotic experiences and non-accidental self-injury: results from a nationally representative survey of adolescents. *Social Psychiatry Psychiatric Epidemiol*. (2018) 54:321–30. doi: 10.1007/s00127-018-1629-4
36. Johnstone E, Ebmeier K, Miller P, Owens D, Lawrie S. Predicting schizophrenia: findings from the Edinburgh high-risk study. *Br J Psychiatry*. (2005) 186:18–25. doi: 10.1192/bjp.186.1.18
37. Hanssen M, Bak M, Bijl R, Vollebergh W, van Os, J. The incidence and outcome of subclinical psychotic experiences in the general population. *Br J Clin Psychol*. (2005) 44:181–91. doi: 10.1348/014466505X29611
38. Yung A, Stanford C, Cosgrave E, Killackey E, Phillips L, Nelson B, et al. Testing the Ultra High Risk (prodromal) criteria for the prediction of psychosis in a clinical sample of young people. *Schizophr Res*. (2006) 84:57–66. doi: 10.1016/j.schres.2006.03.014
39. Wigman J, van Os J, Abidi L, Huibers M, Roelofs J, Arntz A, et al. Subclinical psychotic experiences and bipolar spectrum features in depression: association with outcome of psychotherapy. *Psychol Med*. (2014) 44:325–36. doi: 10.1017/S0033291713000871
40. Narita Z, Wilcox H, DeVylder J. Psychotic experiences and suicidal outcomes in a general population sample. *Schizophr Res*. (2020) 215:223–8. doi: 10.1016/j.schres.2019.10.024
41. Baron RM, Kenny DA. The moderator-mediator variable distinction in social psychological research: conceptual, strategic and statistical considerations. *J Pers Soc Psychol*. (1986) 51:1173–82. doi: 10.1037/0022-3514.51.6.1173
42. Borsboom D. A network theory of mental disorders. *World Psychiatry*. (2017) 16:5–13. doi: 10.1002/wps.20375
43. Wanders RB, Wardenaar KJ, Kessler RC, Penninx BW, Meijer RR, de Jonge P. Differential reporting of depressive symptoms across distinct clinical subpopulations: what difference does it make? *J Psychosom Res*. (2015) 78:130–6. doi: 10.1016/j.jpsychores.2014.08.014
44. Melhem N, Porta G, Oquendo M, Zelazny J, Keilp J, Iyengar S, et al. Severity and variability of depression symptoms predicting suicide attempt in high-risk individuals. *JAMA Psychiatry*. (2019) 76:603–12. doi: 10.1001/jamapsychiatry.2018.4513
45. Beard C, Millner A, Forgeard M, Fried E, Hsu K, Treadway M, et al. Network analysis of depression and anxiety symptom relationships in a psychiatric sample. *Psychol Med*. (2016) 46:3359–69. doi: 10.1017/S0033291716002300
46. Mullarkey M, Marchetti I, Beevers C. Using network analysis to identify central symptoms of adolescent depression. *J Clin Child Adolesc Psychol*. (2018) 48:656–68. doi: 10.1080/15374416.2018.1437735
47. Núñez D, Fresno A, van Borkulo C, Courtet P, Arias V, Garrido V, et al. Examining relationships between psychotic experiences and suicidal ideation in adolescents using a network approach. *Schizophr Bull*. (2018) 44(Suppl. 1):S96. doi: 10.1093/schbul/sby015.237
48. Hinkin T. A review of scale development practices in the study of organizations. *J Manag*. (1995) 21:967–88. doi: 10.1177/014920639502100509
49. Capra C, Kavanagh D, Hides L, Scott J. Brief screening for psychosis-like Little R. A Test of Missing Completely at random for multivariate data with missing values. *J Am Stat Assoc*. (1988) 83:1198–202. doi: 10.1080/01621459.1988.10478722
50. Liu C, Tien Y, Chen, C, Chiu Y, Chien Y, Hsieh MH, et al. Development of a brief self-report questionnaire for screening putative pre-psychotic states. *Schizophr Res*. (2013) 143:32–7. doi: 10.1016/j.schres.2012.10.042
51. Antúnez Z, Vinet E. Depression anxiety stress scales (DASS – 21): validation of the abbreviated version in Chilean university students. *Terapia Psicol*. (2012) 30:49–55. doi: 10.4067/S0718-48082012000300005
52. Posner K, Brown G, Stanley B, Brent D, Yershova K, Oquendo M, et al. The Columbia–suicide severity rating scale: initial validity and internal consistency findings from three multisite studies with adolescents and adults. *Am J Psychiatry*. (2011) 168:1266–77. doi: 10.1176/appi.ajp.2011.10111704
53. Núñez D, Arias V, Méndez-Bustos P, Fresno A. Is a brief self-report version of the Columbia severity scale useful for screening suicidal ideation in Chilean adolescents? *Comprehens Psychiatry*. (2019) 88:39–48. doi: 10.1016/j.comppsych.2018.11.002
54. Hayes AF. *Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach*. New York, NY: Guilford Publications (2013).
55. Preacher K, Hayes A. Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behav Res Methods*. (2008) 40:879–91. doi: 10.3758/BRM.40.3.879

56. Hayes A, Scharkow M. The relative trustworthiness of inferential tests of the indirect effect in statistical mediation analysis: does method really matter? *Psychol Sci.* (2013) 24:1918–27. doi: 10.1177/0956797613480187
57. Preacher K, Hayes A. SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behav Res Methods Instruments Comput.* (2004) 36:717–31. doi: 10.3758/BF03206553
58. van Borkulo C, Borsboom D, Epskamp S, Blanken T, Boschloo L, Schoevers R, et al. A new method for constructing networks from binary data. *Sci Rep.* (2014) 4:5918. doi: 10.1038/srep05918
59. Bringmann L, Elmer T, Epskamp S, Krause R, Schoch D, Wichers M, et al. What do centrality measures measure in psychological networks? *J Abnormal Psychol.* (2019) 128:892–903. doi: 10.1037/abn0000446
60. Epskamp S, Borsboom D, Fried E. Estimating psychological networks and their accuracy: a tutorial paper. *Behav Res.* (2018) 50:195–212. doi: 10.3758/s13428-017-0862-1
61. Zavos H, Eley T, McGuire P, Plomin R, Cardno A, Freeman D, et al. Shared etiology of psychotic experiences and depressive symptoms in adolescence: a longitudinal twin study. *Schizophr Bull.* (2016) 42:1197–206. doi: 10.1093/schbul/sbw021
62. Sullivan S, Lewis G, Gunnell D, Cannon M, Mars B, Zammit S. The longitudinal association between psychotic experiences, depression and suicidal behaviour in a population sample of adolescents. *Social Psychiatry Psychiatr Epidemiol.* (2015) 50:1809–17. doi: 10.1007/s00127-015-1086-2
63. Fried E, Nesse R. Depression sum-scores don't add up: why analyzing specific depression symptoms is essential. *BMC Med.* (2015) 13:72. doi: 10.1186/s12916-015-0325-4
64. Maasalo K, Wessman J, Aronen E. Low mood in a sample of 5–12 year-old child psychiatric patients: a cross-sectional study. *Child Adolesc Psychiatry Mental Health.* (2017) 11:50. doi: 10.1186/s13034-017-0183-2
65. Barragan M, Laurens K, Navarro J, Obiols J. Psychotic-like experiences and depressive symptoms in a community sample of adolescents. *Eur Psychiatry.* (2011) 26:396–401. doi: 10.1016/j.eurpsy.2010.12.007
66. Heinze K, Lin A, Nelson B, Reniers R, Upthegrove R, Clarke L, et al. The impact of psychotic experiences in the early stages of mental health problems in young people. *BMC Psychiatry.* (2018) 18:214. doi: 10.1186/s12888-018-1767-y
67. Rice F, Riglin L, Lomax T, Souter E, Potter R, Smith D, et al. Adolescent and adult differences in major depression symptom profiles. *J Affect Disord.* (2019) 243:175–81. doi: 10.1016/j.jad.2018.09.015
68. Torre-Luque A, Essaub C. Symptom network connectivity in adolescents with comorbid major depressive disorder and social phobia. *J Affect Disord.* (2019) 255:60–68. doi: 10.1016/j.jad.2019.05.015
69. McElroy E, Napoleone E, Wolpert M, Patalay P. Structure and connectivity of depressive symptom networks corresponding to early treatment response. *Eclinicalmedicine.* (2019) 8:29–36. doi: 10.1016/j.eclinm.2019.02.009
70. Jaya E, Hillmann T, Reininger K, Gollwitzer A, Lincoln T. Loneliness and psychotic symptoms: the mediating role of depression. *Cogn Ther Res.* (2017) 41:106–16. doi: 10.1007/s10608-016-9799-4
71. Lim M, Rodebaugh T, Zyphur M, Gleeson J. Loneliness over time: the crucial role of social anxiety. *J Abnorm Psychol.* (2016) 125:620–30. doi: 10.1037/abn0000162
72. Chau A, Zhu C, So S. Loneliness and the psychosis continuum: a meta-analysis on positive psychotic experiences and a meta-analysis on negative psychotic experiences. *Int Rev Psychiatry.* (2019) 31:471–90. doi: 10.1080/09540261.2019.1636005
73. Wickham S, Taylor P, Shevlin M, Bentall R. The impact of social deprivation on paranoia, hallucinations, mania and depression: the role of discrimination social support, stress and trust. *PloS ONE.* (2014) 9:e105140. doi: 10.1371/journal.pone.0105140
74. Jang J, Lee Y, Cho S, Cho I, Shin N, Kim S. Psychotic-like experiences and their relationship to suicidal ideation in adolescents. *Psychiatry Res.* (2014) 215:641–5. doi: 10.1016/j.psychres.2013.12.046
75. Calati R, Ferrari C, Brittner M, Oasi O, Olié E, Carvalho A, et al. Suicidal thoughts and behaviors and social isolation: a narrative review of the literature. *J Affect Disord.* (2019) 245:653–67. doi: 10.1016/j.jad.2018.11.022
76. Endo K, Ando S, Shimodera S, Yamasaki S, Usami S, Okazaki Y, et al. Preference for solitude, social isolation, suicidal ideation, and self-harm in adolescents. *J Adolesc Health.* (2017) 61:187–91. doi: 10.1016/j.jadohealth.2017.02.018
77. Gallagher M, Prinstein M, Simon V, Spirito A. Social anxiety symptoms and suicidal ideation in a clinical sample of early adolescents: Examining loneliness and social support as longitudinal mediators. *J Abnorm Child Psychol.* (2014) 42:871–83. doi: 10.1007/s10802-013-9844-7
78. Armando M, Lin A, Girardi P, Righetti V, Dario C, Saba R, et al. Prevalence of psychotic-like experiences in young adults with social anxiety disorder and correlation with affective dysregulation. *J Nerv Ment Dis.* (2013) 201:1053–9. doi: 10.1097/NMD.0000000000000050
79. Pardo A, Román M. Reflexiones sobre el modelo de mediación estadística de Baron y Kenny. *Anal Psicol.* (2013) 29:614–23. doi: 10.6018/analesps.29.2.139241
80. Rodebaugh T, Tonge N, Piccirillo M, Fried E, Horenstein A, Morrison A, et al. Does centrality in a cross-sectional network suggest intervention targets for social anxiety disorder? *J Consult Clin Psychol.* (2018) 86:831–44. doi: 10.1037/ccp0000336
81. Bos F, Snippe E, de Vos S, Hartmann J, Simons C, van der Krieke L, et al. Can we jump from cross-sectional to dynamic interpretations of networks? Implications for the network perspective in psychiatry. *Psychother Psychosomat.* (2017) 86:175–7. doi: 10.1159/000453583
82. Fisher A, Medaglia J, Jeronimus B. Lack of group-to-individual generalizability is a threat to human subjects research. *PNAS.* (2018) 115:E6106–15. doi: 10.1073/pnas.1711978115
83. Murphy J, Shevlin M, Hyland P, Christoffersen M, Elklit A, Bentall R. Reconsidering the association between psychosis and suicide: a suicidal drive hypothesis. *Psychosis.* (2018) 10:286–97. doi: 10.1080/17522439.2018.1522541
84. van Os J, Linscott R. Introduction: the extended psychosis phenotype. Relationship with schizophrenia and with ultrahigh risk status for psychosis. *Schizophr Bull.* (2012) 38:227–30. doi: 10.1093/schbul/sbr188
85. Unterrasnert L. Subtypes of psychotic-like experiences and their significance for mental health. In: Irtelli F, editor. *Psychosis. Biopsychosocial and Relational Perspectives*. IntechOpen (2018). p. 3–19.
86. Wüsten C, Schlier B, Jaya E, Alizadeh B, Bartels-Velthuis A, van Beveren N, et al. Psychotic experiences and related distress: a cross-national comparison and network analysis based on 7141 participants from 13 countries. *Schizophr Bull.* (2018) 44:1185–94. doi: 10.1093/schbul/sby087
87. Bhavsar V, Maccabe J, Hatch S, Hotopf M, Boydell J, McGuire P. Subclinical psychotic experiences and subsequent contact with mental health services. *Bjpsych Open.* (2017) 3:64–70. doi: 10.1192/bjpo.bp.117.004689
88. Maijer K, Hayward M, Fernyhough C, Calkins M, Debbané M, Jardri R, et al. Hallucinations in children and adolescents: An updated review and practical recommendations for clinicians. *Schizophr Bull.* (2019) 45:S5–23. doi: 10.1093/schbul/sby119
89. Bukenaite A, Stochl J, Mossaheb N, Schäfer M, Klier, CM, et al. Usefulness of the CAPE-P15 for detecting people at ultra-high risk for psychosis: Psychometric properties and cut-off values. *Schizophr Res.* (2017) 189:69–74. doi: 10.1016/j.schres.2017.02.017
90. Peters E, Ward T, Jackson M, Woodruff P, Morgan C, McGuire P, et al. Clinical relevance of appraisals of persistent psychotic experiences in people with and without a need for care: an experimental study. *Lancet Psychiatry.* (2017) 4:927–36. doi: 10.1016/S2215-0366(17)30409-1
91. Kalman J, Bresnahan M, Schulze T, Susser E, Predictors of persisting psychotic like experiences in children and adolescents: a scoping review. *Schizophr Res.* (2019) 209:32–9. doi: 10.1016/j.schres.2019.05.012

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