KU Leuven

Groep Biomedische Wetenschappen

Faculteit Geneeskunde

Departement Neurowetenschappen

KU LEUVEN

DOCTORAL SCHOOL
BIOMEDICAL SCIENCES

DE KRACHT VAN HECHTING

DE ROL VAN HECHTINGSRELATIES BIJ ZELFVERWONDINGSGEDACHTEN EN -GEDRAGINGEN IN ADOLESCENTEN

Julie JANSSENS

Jury:

Promotoren:

Prof. Inez Myin-Germeys
Prof. Olivia Kirtley

Voorzitter leescommissie: Prof. Patrick Callaerts

Voorzitter openbare verdediging: Prof. Patrick Dupont

Juryleden:

Prof. Ellen Townsend (University of Nottingham, United Kingdom)
Prof. Gwendolyn Portzky (Ghent University, Ghent, Belgium)
Prof. Peter Kuppens (KU Leuven, Leuven, Belgium)
Prof. Laurence Claes (KU Leuven, Leuven, Belgium)

Proefschrift voorgedragen tot het behalen van de graad van Doctor in de Biomedische Wetenschappen

September 2024

KU Leuven

Biomedical Sciences Group

Faculty of Medicine

Department of Neurosciences

KU LEUVEN

DOCTORAL SCHOOL
BIOMEDICAL SCIENCES

THE POWER OF ATTACHMENT

THE ROLE OF ATTACHMENT RELATIONSHIPS IN ADOLESCENT' SELF-HARM THOUGHTS AND BEHAVIOURS

Julie JANSSENS

Jury:

Supervisors:

Prof. Inez Myin-Germeys
Prof. Olivia Kirtley

Chair examining committee: Prof. Patrick Callaerts

Chair public defence: Prof. Patrick Dupont

Jury members:

Prof. Ellen Townsend (University of Nottingham, United Kingdom)
Prof. Gwendolyn Portzky (Ghent University, Ghent, Belgium)
Prof. Peter Kuppens (KU Leuven, Leuven, Belgium)
Prof. Laurence Claes (KU Leuven, Leuven, Belgium)

Dissertation presented in partial fulfilment of the requirements for the degree of Doctor in Biomedical Sciences

September 2024

Table of Contents

Summary

Self-harm, here conceptualized as both suicidal and non-suicidal self-harm thoughts and behaviours, is a leading cause of death and injury worldwide and, especially adolescents are vulnerable. This creates a need to investigate risk and protective factors for adolescent self-harm to better understand *who* is at risk, *when* momentary risk is increased and *how* risk for self-harm may be reduced.

In this thesis, I used Experience Sampling data from a large study on adolescent mental health in Flanders to investigate specific risk factors for self-harm in adolescents, the extent to which attachment relationship quality is associated with these risk factors, and whether it attenuates these associations. During the writing of this doctoral thesis, I specifically focused on identifying best methodological practices for Experience Sampling research on self-harm.

Findings presented in **Chapter 3** and **4** show that adolescents with lower-quality attachment relationships with their father and mother, and adolescents who have experienced a higher number of adverse childhood experiences are at increased risk for self-harm thoughts and behaviours. In **Chapter 6**, we reveal that momentary risk for (more intense) self-harm thoughts is increased when adolescents feel (more) lonely. Additionally, in **Chapter 6**, evidence revealed that adolescents engaging in self-harm behaviours experience a decrease in loneliness – suggesting an immediate relief effect of self-harm, thereby further increasing our understanding of *why* adolescents may engage in self-harm. **Chapters 4, 5** and **6** provide evidence for parental attachment relationship quality as a potential protective factor attenuating the negative effect of important risk factors for self-harm, i.e., adverse childhood experiences and loneliness.

In **Chapter 7**, we revealed that the current ESM literature on interpersonal processes (e.g., loneliness and attachment) and self-harm is fragmented due to a proliferation of investigated constructs that are operationalized in highly diverse ways. Moreover, we show that this literature lacks measurement transparency, thereby undermining replicability. In addition to this, we noticed a

limited use of high-sampling frequencies that can help unravel specific timescales of associations, as well as appropriate temporal models that control for autoregressive effects needed to reliably identify what incrementally predicts self-harm. We offer suggestions for future researchers to increase consistency in construct definitions and their operationalizations, measurement transparency and the ability to reliably identify when in time specific risk factors predict self-harm. In **Chapter 8**, we have provided examples of ours and other's work to demonstrate the opportunities and solutions to challenges of implementing open science practices in self-harm research.

Overall, the research included in this thesis shows that adolescents are at risk for self-harm, especially those with low-quality parental attachment bonds and more childhood adversity, and that feelings of loneliness may predict self-harm. In addition, whilst self-harm behaviours may be used to alleviate distress associated with loneliness, strengthening attachment relationships with both parents may have significant value in our attempt to prevent and manage adolescent mental health problems, e.g., loneliness and self-harm. Future research can build on these findings and provide answers to how specific types of attachment bonds can be maintained throughout adolescence and what their unique and incremental contribution is, when in time risk factors predict self-harm thoughts or its transition to behaviours and whether specific subgroups are more vulnerable requiring targeted intervention. Throughout, we encourage other ESM researchers to use standardized assessment methods, increasingly implement open science practices and employ appropriate statistical models.

Samenvatting

Zelfverwonding, in deze thesis gedefinieerd als zowel suïcidale als niet-suïcidale zelfverwondingsgedachten en -gedragingen, veroorzaakt veel overlijden en letsels wereldwijd, waarbij vooral adolescenten kwetsbaar zijn. Dit creëert de noodzaak om risico- en beschermende factoren voor zelfverwonding bij adolescenten te onderzoeken zodanig dat we beter begrijpen *wie* risico loopt, *wanneer* het risico op een bepaald moment toeneemt en *hoe* het risico op zelfverwonding kan worden verminderd.

In deze doctoraatsthesis heb ik gebruikgemaakt van data afkomstig van een grootschalig onderzoek naar de geestelijke gezondheid van adolescenten in Vlaanderen, verzameld met de Experience Sampling methode. Ik heb deze data gebruikt om specifieke risicofactoren voor zelfverwonding bij adolescenten te onderzoeken, in hoeverre de kwaliteit van hechtingsrelaties geassocieerd is met deze risicofactoren, en of de kwaliteit van hechtingsrelaties deze associaties afzwakt.

De bevindingen gepresenteerd in **Hoofdstuk 3** en **4** tonen aan dat adolescenten met lagere kwaliteit van hechtingsrelaties met hun vader en moeder, en adolescenten die meer negatieve kindervaringen hebben meegemaakt, een verhoogd risico lopen op zelfverwondingsgedachten en -gedragingen. In **Hoofdstuk 6** tonen we dat het acute risico op (intensere) zelfverwondingsgedachten toeneemt wanneer adolescenten zich (meer) eenzaam voelen. Daarnaast blijkt uit **Hoofdstuk 6** dat adolescenten die aan zelfverwonding doen, een afname in eenzaamheid ervaren – wat wijst op een onmiddellijk verlichtend, emotieregulerend, effect van zelfverwonding en zo ons begrip van *waarom* adolescenten aan zelfverwonding doen, vergroot. **Hoofdstukken 4, 5** en **6** leveren bewijs voor de kwaliteit van ouderlijke hechtingsrelaties als een potentiële beschermende factor die het negatieve effect van belangrijke risicofactoren voor zelfverwonding, namelijk negatieve kindervaringen en eenzaamheid, kan verminderen.

In **Hoofdstuk 7** laten we zien dat de huidige ESM-literatuur over interpersoonlijke processen (zoals eenzaamheid en hechting) en zelfverwonding gefragmenteerd is door een wildgroei aan

onderzochte constructen die op zeer uiteenlopende manieren zijn geoperationaliseerd. Bovendien constateerden we dat deze literatuur een gebrek aan meettransparantie vertoont, wat repliceerbaarheid ondermijnt. Daarnaast merkten we een beperkt gebruik van hoogfrequente metingen op die kunnen helpen specifieke tijdschalen van associaties te ontrafelen, evenals een gebrek aan geschikte temporele modellen die nodig zijn om autoregressieve effecten te controleren en betrouwbaar te identificeren wat zelfverwonding uniek en incrementeel voorspelt. We doen suggesties voor toekomstige onderzoekers om consistentie in constructdefinities en hun operationalisaties te vergroten, meettransparantie te verbeteren en het vermogen om betrouwbaar vast te stellen wanneer specifieke risicofactoren zelfverwonding voorspellen, te versterken. In **Hoofdstuk 8** hebben we voorbeelden van ons eigen werk en dat van anderen gegeven om de kansen en oplossingen voor de uitdagingen van het implementeren van open science praktijken in zelfverwondingsonderzoek te demonstreren.

Samenvattend toont het onderzoek in deze doctoraatsthesis aan dat adolescenten risico lopen op zelfverwonding, en dan vooral jongeren met weinig kwaliteit in hun ouderlijke hechtingsbanden en meer negatieve kindervaringen, en dat gevoelens van eenzaamheid zelfverwonding kunnen voorspellen. Terwijl zelfbeschadigend gedrag kan worden gebruikt om de stress geassocieerd met eenzaamheid te reguleren, kan het versterken van hechtingsrelaties met ouders waardevol zijn in onze poging om zelfverwonding bij adolescenten te voorkomen en te behandelen. Toekomstig onderzoek kan voortbouwen op deze bevindingen en antwoorden bieden op hoe hechtingsbanden gedurende de adolescentie kunnen worden behouden, en wat hun specifieke, unieke en incrementele bijdrage is, wanneer in de tijd risicofactoren zelfverwondingsgedachten of de overgang naar gedrag voorspellen, en of specifieke subgroepen kwetsbaarder zijn en gerichte interventie nodig hebben. Terwijl moedigen we ESM-onderzoekers aan om gestandaardiseerde meetmethoden te gebruiken, open science praktijken steeds meer te implementeren en de meest geschikte statistische modellen te gebruiken.

Chapter 1: General Introduction

1.1 The urgency of self-harm research

Self-harm is a leading cause of death and injury worldwide (Kiekens et al. 2023; WHO, 2021) and, therefore, a major public health concern. Self-harm is defined by the National Institute for Health and Care Excellence as "any act of self-poisoning or self-injury carried out by an individual, irrespective of motivation" (NICE, 2023). Individuals may use this behaviour to escape unbearable mental pain or regulate emotions (Edmondson et al., 2016; O'Connor et al., 2009; Madge et al., 2008; Rasmussen et al., 2016), and self-harm also occurs in non-human primates (Novak, 2003). More than 700,000 individuals die by suicide every year (WHO, 2021) and the number of individuals who think about harming themselves, whether that is with or without suicidal intent, is even larger (Gillies et al., 2018; Kiekens et al., 2018; Mortier et al., 2018). Specifically, in Flanders, 25 individuals per day engage in self-harm behaviours adding up to 8,943 self-harm incidents in 2022, which is an increase of 3.9% compared to 2021 (Vancayseele et al., 2022).

1.2 Self-harm vs. NSSI

The distinction between self-harm and non-suicidal self-injury (NSSI) is controversial (Kapur et al., 2013). However, differentiating between suicidal and non-suicidal self-harm can be important as this advances research and individualizes help. In 2015, non-suicidal self-injury (NSSI) was proposed as a separate new diagnostic category for further study in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) with the purpose of providing more appropriate help to individuals who were otherwise mislabelled as borderline personality or psychiatric disorder (Zetterqvist, 2015). Notwithstanding, suicidal and non-suicidal self-harm are strongly related and highly dynamic in nature, meaning the underlying intent of the behaviour or method can vary greatly over time within individuals. Indeed, the same individual may engage in non-suicidal self-harm but switch to other methods of self-harm or change intention over time (Kapur et al., 2013). Throughout

this PhD thesis, we consider both suicidal and non-suicidal self-harm thoughts and behaviours when we refer to “self-harm”.

1.3 Adolescents at risk

Adolescents are especially vulnerable for self-harm (Hawton et al., 2012), with a peak around the age of 14-15 years (Gandhi et al., 2018; Kidger et al., 2012). In community adolescent samples, lifetime prevalence rates go up to 23% for non-suicidal self-harm behaviour (Gillies et al., 2018), 22.6% for suicidal ideation and 15.8% for suicide attempts (Van Meter et al., 2023). Moreover, individuals who engage in non-suicidal self-harm behaviours are at high risk for future episodes of self-harm and suicide (Kiekens et al., 2018). Unfortunately, self-harm remains largely under the radar as most do not reach clinical services (see Figure 1; "The iceberg model of self-harm", Geulayov et al., 2018). Together, these findings highlight the importance and timeliness of investigating risk and protective factors for self-harm in a non-clinical adolescent population to identify *who* is at risk (i.e., between-person level) and *when* momentary risk for self-harm is increased among vulnerable individuals (i.e., within-person level).

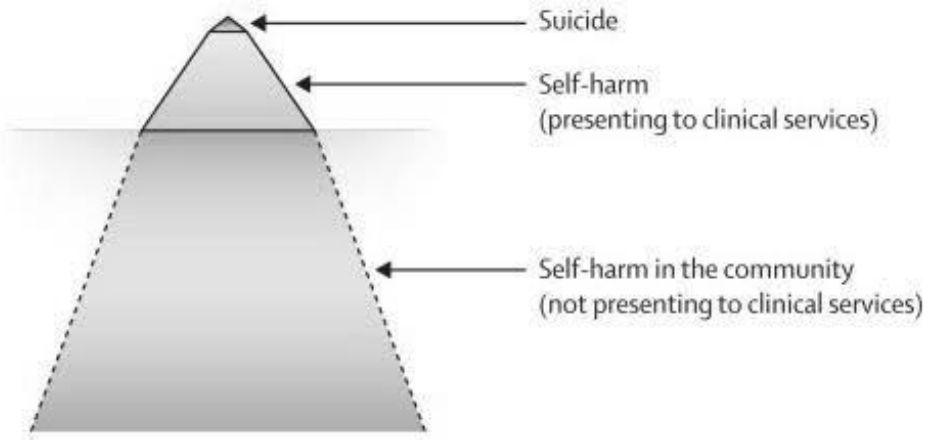


Figure 1. *The iceberg model of self-harm (Geulayov et al. 2018)*

1.4 Increased vulnerability during COVID-19

In the midst of writing this PhD thesis, the spread of the COVID-19 virus threatened both our physical and mental health (WHO, 2020). Although there was much media speculation about the adverse impact of this crisis on mental health and family life, there was actually little empirical investigation of this. Moreover, the emerging research on the impact of COVID-19 on mental health was mostly limited to adult studies (Moccia et al., 2020; Veer et al., 2020), whilst adolescents are a population group who may be especially vulnerable to the mental health impacts of COVID-19. There are two main reasons for this. First, adolescence is a vulnerable period for the onset of psychopathology in general (Solmi et al., 2021) as research suggests that 75% of adults who report ever having a mental health condition indicate they experienced their first symptoms during adolescence (Kessler et al., 2012). Second, and potentially most crucial here, the drastic changes in daily social life due to the pandemic and associated lockdown measures may have particularly affected adolescents, as they are at a critical stage of social development (Andrews et al., 2020; Orben et al., 2020). Adolescents' enforced proximity to their families and the limitation of face-to-face contact with peers may not allow their developmental needs to be met (Andrews et al., 2020; Grusec & Davidov, 2021; Orben et al., 2020; Steinberg & Morris, 2001). This highlights the importance of investigating the mental health of adolescents during the pandemic as they are at increased risk for developing self-harm thoughts and behaviours.

1.5 Differentiating between self-harm thoughts and behaviours

A prominent contemporary theoretical framework that provides a comprehensive, although not exhaustive, overview of key risk and protective factors for self-harm, is the Integrated Motivational-Volitional (IMV) model[1] (O'Connor, 2011; O'Connor & Kirtley, 2018). This model, presented in Figure 2, draws on earlier theories of suicide, e.g., the Interpersonal Theory of Suicide (IPT; Joiner, 2005;

[1] While the IMV model was initially developed in the context of suicidal thoughts and behaviours, it can also be applied to self-harm thoughts and behaviours more broadly (O'Connor & Kirtley, 2018).

Van Orden et al., 2010) and the Cry of Pain model (Williams, 2014), and differentiates between risk and protective factors that provide the biopsychosocial context (i.e., pre-motivational phase) in which self-harm thoughts and behaviours may emerge, those that lead individuals to think about self-harm (i.e., motivational phase), and those that govern the transition from self-harm thoughts to behaviours (i.e., volitional phase). This distinction is vital as these require different clinical approaches (Branley-Bell et al., 2019). Whilst other ideation-to-action theories exist, i.e., the Interpersonal Theory of Suicide (IPT; Joiner, 2005; Van Orden et al., 2010) and the Three Step Theory of Suicide (3ST; Klonsky & May, 2015), the IMV model is by nature the most comprehensive and, therefore, the main theoretical framework throughout this PhD thesis.

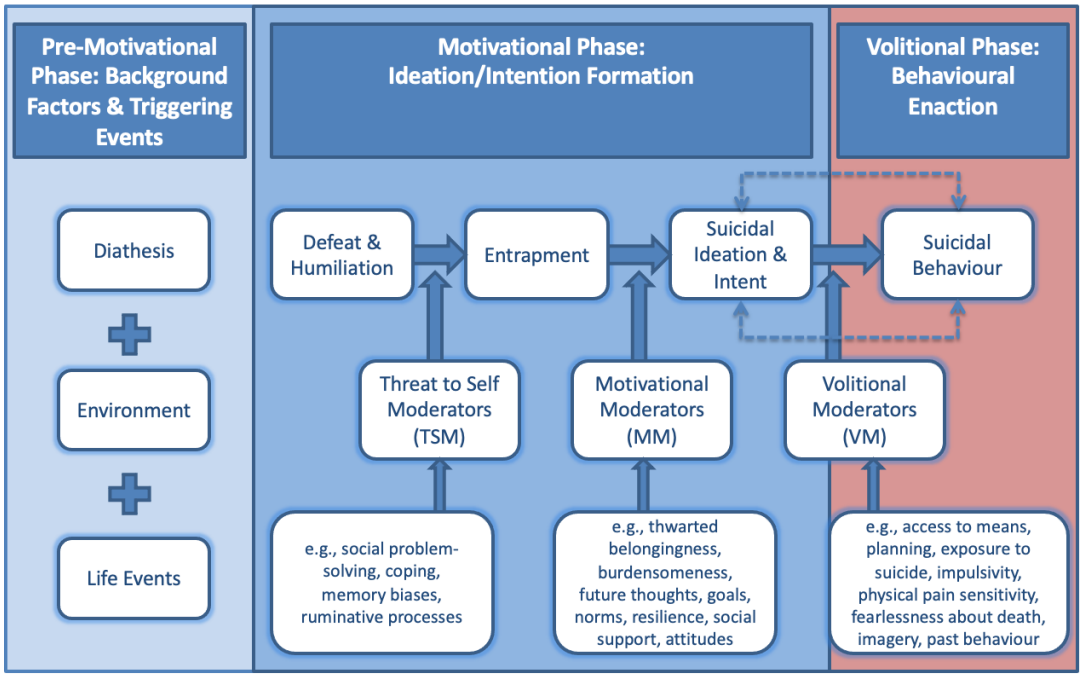


Figure 2. *The Integrated Motivational-Volitional (IMV) model (O'Connor, 2011; O'Connor & Kirtley, 2018)*

1.6 Risk factors for self-harm

Despite the comprehensiveness of the IMV model, there are two potential new risk factors that could be integrated into it, namely adverse childhood experiences (ACEs) and loneliness. These two factors have been highlighted in previous research as crucial in understanding self-harm risk (Calati et al., 2019; Gandhi et al., 2018; Hughes et al., 2017; Kalmakis & Chandler, 2015; McClelland et

al., 2020; Sahle et al., 2021). However, it remains unclear to what extent these experiences carry over into the daily lives of adolescents.

1.6.1 Adverse Childhood Experiences (ACEs)

Many studies have confirmed an association between adverse childhood experiences (ACEs) and a range of negative physical and psychological outcomes including self-harm (Hughes et al., 2017; Kalmakis & Chandler, 2015; Sahle et al., 2021). Within the pre-motivational phase of the IMV model (O'Connor, 2011; O'Connor & Kirtley, 2018), ACEs can be described under the term "Life Events" as distal predisposing factors for self-harm (O'Connor & Kirtley, 2018). ACEs include distressing and traumatic childhood events that are uncontrollable by the child, including physical, sexual, and emotional abuse, emotional and physical neglect, and caregiver risk factors such as parental psychopathology, substance misuse, incarceration, parental loss, separation or divorce, and family/domestic violence (Corcoran & McNulty, 2018; Sachs-Ericsson et al., 2016; Saul et al., 2014).

Exposure to one ACE is not uncommon and has been experienced by more than 20% of adolescents (Moore & Ramirez, 2016) and almost half (46.4%) of adults (Hughes et al. 2017). Moreover, studies suggest that the occurrence of one ACE increases the likelihood of the occurrence of other ACEs by 80% and that cumulative exposure to multiple ACEs has greater negative implications (Björkenstam et al., 2013; Bunting et al., 2023; Felitti et al., 1998; Moore & Ramirez, 2016), including increased risk of suicidal thoughts and behaviours (Felitti et al., 1998).

A framework that describes the association between multiple or prolonged exposure to ACEs and how we deal with intense negative emotions and stress, is the Window of Tolerance model (see Figure 3; Corrigan et al., 2011; Siegel, 1999). This model provides a framework for understanding of how individuals regulate emotions and stress by recognizing that individuals experience a continuum of arousal states ranging from hypoarousal (low arousal), e.g., dissociation, to hyperarousal (high arousal), e.g., self-harm. Within this continuum lies the *window of tolerance* representing the optimal zone within which a person can adaptively deal with stressors and regulate emotions. Individuals

who have experienced multiple or prolonged exposure to ACEs may have a narrowed window of tolerance, causing them to oscillate between hyperarousal and hypoarousal states (Corrigan et al., 2011).

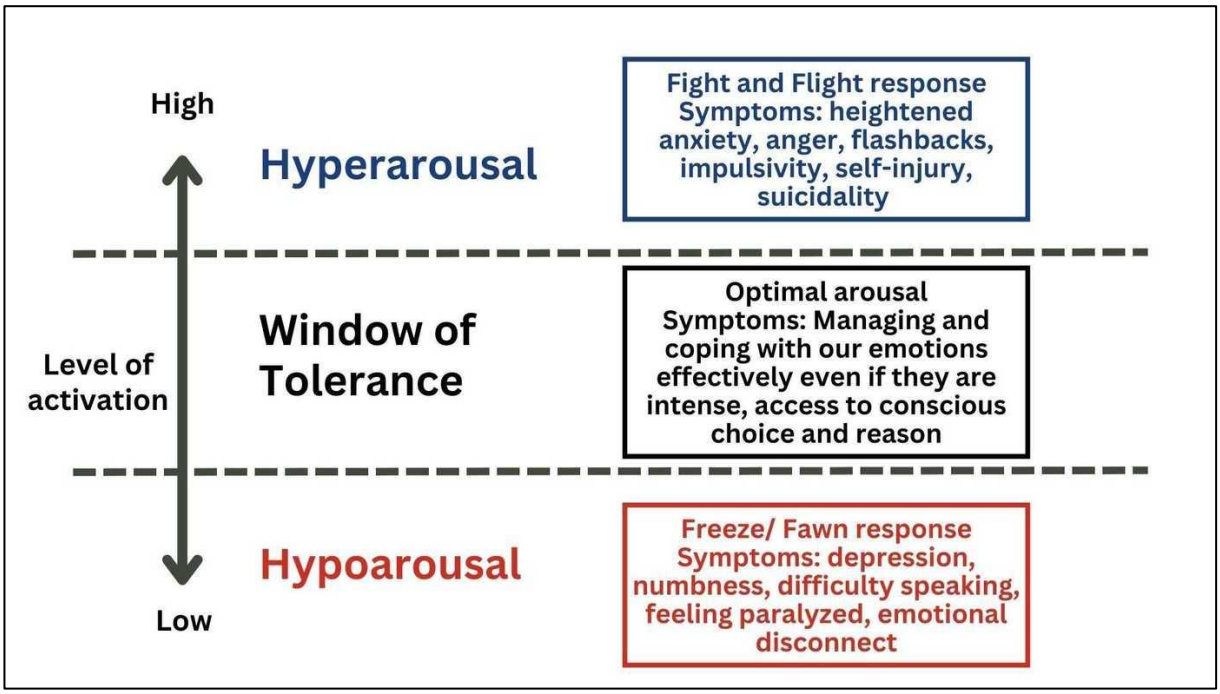


Figure 3. *Window of Tolerance model (Siegel, 1999)*

Within the IMV model, ACEs can be understood as stressful life events that, combined with vulnerability factors, provide the biopsychosocial context in which self-harm thoughts and behaviours may emerge (O'Connor & Kirtley, 2018; Souza et al., 2024). Determining whether and in what way the number and type of ACEs are differentially associated with self-harm thoughts or behaviours is, therefore, valuable for research and clinical practice. This would enable prevention and intervention resources to be tailored to the needs of adolescents *who* are most at risk. Whereas ACEs are suggested to be associated with self-harm (Angelakis et al., 2020), the role of ACEs as a pre-motivational factor within the context of the IMV model has not yet been sufficiently investigated to draw firm conclusions (Souza et al., 2024).

1.6.2 Loneliness

Another crucial risk factor that has received attention in recent years (Lee et al., 2021; HM Government, 2018), particularly during the COVID-19 pandemic, is loneliness (Calati et al., 2019;

Gandhi et al., 2018; McClelland et al., 2020) — the 'deficiency of a person's network of social relations in some important way, either quantitatively or qualitatively' (Perlman & Peplau, 1981, p. 31). Within the IMV model, loneliness may act as a motivational moderator that may influence the emergence of self-harm thoughts (O'Connor & Kirtley, 2018; Souza et al., 2024). Indeed, loneliness is subsumed within the broader suicide research literature under the key concept of thwarted belongingness, which refers to the fundamental unmet "need to belong" (Baumeister & Leary, 1995, p.1; Van Orden et al., 2010). Thwarted belongingness is a central tenet of the Interpersonal Psychological Theory of Suicide (IPT; Joiner, 2005; Van Orden et al., 2010), and features within the Integrated Motivational-Volitional model (IMV; O'Connor, 2011; O'Connor & Kirtley, 2018) as a risk factor implicated in the development of self-harm thoughts. Individuals with a history of self-harm thoughts or behaviours experience loneliness more intensely than those without (McClelland et al., 2021), and loneliness is prospectively associated with suicidal ideation (McClelland et al., 2020).

Loneliness may play a particularly important role in adolescents' risk for self-harm due to the profound relational shifts that normatively occur during this developmental period (Sawyer et al., 2018). Specifically, adolescence is characterized by crucial changes in social relationships, including an increase in peer orientation and a shift in the need for physical proximity to parents to a need for their emotional availability (Bosmans & Kerns, 2015). These transitions increase the risk of relationship needs being unmet (Achterhof et al., 2022; Bamps et al., 2022), which results in the experience of loneliness (Goossens, 2018; Lasgaard et al., 2011). In fact, about 80% of adolescents experience loneliness at least sometimes (Hawkley & Cacioppo, 2010). These feelings of loneliness may hinder reliance on adaptive strategies (e.g., seeking support from others) to deal with intense stress during adolescence, thereby increasing the risk for self-harm. Thus, adolescence is a critical period for both loneliness and self-harm (Lasgaard et al., 2011). Accordingly, prior research revealed that adolescents who report self-harm thoughts and behaviours experience significantly more loneliness (Gandhi et al., 2018; Lasgaard et al., 2011). However, we lack vital knowledge about temporal associations between loneliness and self-harm thoughts and behaviours (i.e., how

loneliness is related to self-harm risk over minutes/hours) in adolescents that could be used to inform and improve interventions as it may answer our question *when* adolescents are at increased risk.

1.7 The power of attachment

Whilst the profound relational shifts during adolescence may create vulnerability for adverse mental health outcomes (Lasgaard et al., 2011), they also offer great opportunities to establish supportive relationships that can help mitigate the impact of childhood adversity (Gajos et al., 2022; Narayan et al., 2021; Venta, 2020). Indeed, one key factor that could act as a potential protective factor, and pre-motivational factor within the IMV model, against loneliness and the negative consequences of ACEs are positive attachment relationships with parents and peers.

In the 1960s, John Bowlby developed the Attachment Theory (1969, 1973) that now ranks among the most influential theories in developmental psychology (Dixon, 2015) and clinical practice. Researchers observed how children responded to their caregiver leaving and returning which led to the creation of four categories of attachment: secure (i.e., child sought interaction/proximity and was effectively comforted), avoidant (i.e., child ignores caregiver), ambivalent/anxious (i.e., child cannot find comfort in caregivers arms nor return to play) and disorganized (i.e., child shows chaotic behaviour towards caregiver) (Ainsworth et al., 1987, 2015). In contrast to the three insecure attachment orientations, securely attached children use their attachment figure as a safe haven when comfort, care or guidance is needed and as a secure base that fosters confidence in themselves and trust in others – which is needed to explore the world and develop the strategies and skills they need in life. Of the general population, research shows that 42% is insecurely attached and that this increases up to 73% in clinical samples (Bakermans-Kranenburg & van IJzerdoorn, 2009).

Whilst this categorical structure of attachment has dominated attachment research, emerging evidence in both children and adults shows that attachment can be structured along two dimensions (i.e., anxiety and avoidance), on which an individual is positioned, which translates into a specific set

of beliefs and behaviours (Brennan et al., 1998; Crowell et al., 1999). Attachment orientation is determined by the extent to which a child experiences the parent as responsive, sensitive and attuned to their needs, i.e., the quality of the attachment relationship. These experiences are internalized and define how an individual views the world and responds to stress and intense negative emotions. More anxiously attached individuals are more likely to engage in hyperactivating strategies (e.g., preoccupation with support and hypervigilant to rejection and abandonment), whilst more avoidantly attached individuals are more likely to engage in deactivating strategies (e.g., suppressing emotions and keeping others at a distance) (Davila & Kashy, 2009; Mikulincer & Shaver, 2003). Although attachment was mainly conceptualized as a stable and fixed trait that was developed during early parent-child interactions, more recent research reveals a dynamic nature of attachment. Indeed, individuals can shift in their position on these two attachment dimensions (i.e., anxiety and avoidance) over time, and depending on the person someone is with and context someone is in (Gillath et al., 2009). This offers a golden opportunity for researchers and clinical practice, as this suggests attachment is a changeable process with a clear and tangible causal factor, i.e., parent-child attachment relationship (De Wolff & Van IJzerdoorn, 1997), which could allow for the design of interventions aimed at fostering secure attachment.

Despite Attachment Theory being well substantiated over time and the fact that attachment relationship quality can be posited as a pre-motivational factor within the IMV model (O'Connor & Kirtley, 2018; Zortea et al. 2021), existing studies on attachment and self-harm report conflicting results (Gandhi et al., 2016; Glazebrook et al., 2016; Koenig et al., 2021; Santangelo et al., 2017; Santens et al., 2018; Zortea et al., 2021) and consensus is limited on how attachment relationships are related to self-harm thoughts and behaviours in a non-clinical population of adolescents. Indeed, previous studies have rarely directly investigated whether attachment relationship quality is differentially associated with thinking (ideating) about self-harm versus engaging in self-harm behaviours. Moreover, understanding to what extent high-quality attachment relationships can

modify or reduce the negative effect of childhood adversity and loneliness on self-harm, can optimize prevention and treatment substantially.

1.8 Experience Sampling Methodology to the rescue

Investigating dynamic daily-life processes such as loneliness and self-harm that fluctuate over hours and days, during individuals' everyday lives (Czyz et al., 2019; Kaurin et al., 2022; Kiekens et al., 2021; Kleiman et al., 2017) requires that we assess these in an ecologically valid manner by targeting them in the context where they naturally occur: daily life. Moreover, to elucidate *when* self-harm thoughts develop, we need to investigate temporal associations between short-term risk factors (i.e., loneliness) and self-harm thoughts and behaviours. For this, we need to move beyond traditional retrospective self-report methods that introduce recall bias and low ecological validity (Sedano-Capdevilla et al., 2021). Experience Sampling Methodology (ESM) provides a powerful solution to this as it allows for investigating current experiences, e.g., loneliness and self-harm thoughts and behaviours in adolescents' daily life. ESM requires an individual to complete brief questionnaires on a smartphone device during their everyday life, multiple times a day for several days (Csikszentmihalyi & Larson, 1987; Myin-Germeys et al., 2018).

Moreover, using ESM to assess temporal associations between loneliness and self-harm behaviours could help us refine our understanding of *why* individuals engage in self-harm. Indeed, ESM can allow us to empirically test the most frequently reported emotional regulation function of self-harm, i.e., immediate emotional relief (Kleindienst et al., 2008) in an ecologically valid manner. According to the functional model of self-harm (Nock & Prinstein, 2004; Nock, 2009), self-harm behaviour is reinforced when the behaviour produces desired outcomes, e.g., a decrease in feelings of loneliness. Previous studies have provided empirical support for the functional model of self-harm (Izadi-Mazidi et al., 2019; Rasmussen et al., 2016), including that adolescents reported reduced feelings of loneliness both during and after self-harm behaviour (Laye-Gindhu & Schonert-Reichl, 2005). However, these studies are limited in their accuracy and reliability, as participants were

reflecting on past behaviours, rather than reporting current behaviours. Therefore, an ESM study that investigates within-person, temporal associations between loneliness and self-harm thoughts and behaviours in adolescents' daily life is timely and could significantly advance our understanding of the micro process at play during self-harm.

1.9 Measurement challenges in ESM research

As discussed in the previous section, ESM creates many opportunities for studying dynamic processes involved in self-harm thoughts and behaviours. However, ESM also presents multiple challenges. First, there is considerable and understandable concern about the possible reactive/iatrogenic effects associated with the repeated assessments in the ESM research on self-harm thoughts and behaviours. However, empirical evidence suggests there is no harm in assessing self-harm using ESM. Indeed, asking about self-harm had no effect on increasing its severity or frequency (Coppersmith et al., 2022; Husky et al., 2014). This holds huge promise for capturing rare phenomena, such as self-harm, with an ESM approach.

Second, the value of using ESM to capture interpersonal processes (IPs), such as loneliness, and self-harm thoughts and behaviours in daily life largely depends on our ability to accurately assess these constructs. Emerging literature reveals discussions around measurement issues in ESM (Eisele et al., 2024; Kirtley et al., 2021; Mestdagh & Dejonckheere, 2021) because of a lack of measurement transparency (Flake & Fried, 2020) and the common use of unvalidated measures (Horstmann & Ziegler, 2020). This hinders scientific communication and cumulative evidence-building. Therefore, and particularly against the backdrop of the replication crisis, a thorough investigation of current methods used to assess IPs, e.g., loneliness, and self-harm thoughts and behaviours in ESM studies is warranted to tackle threats to transparency and validity in this literature. Moreover, to build a cumulative science of IPs, such as loneliness and attachment, in the context of self-harm, it is relevant to create a systematic overview of the relationships between IPs and self-harm at both the between- and within-person levels.

Third, assessing daily-life self-harm thoughts and behaviours in a general adolescent sample entails statistically dealing with zero-inflated longitudinal data (i.e., we expect most adolescents to indicate “no self-harm thoughts” at most timepoints). Moreover, it is necessary to account for the mixture of zeros and continuously distributed non-zero values (i.e., self-harm thoughts, if present, may vary in intensity resulting in a range of positive values). However, evidence on which model is appropriate when dealing with zero-inflated and semi-continuous longitudinal data is lacking (Alfo & Maruotti, 2010).

1.10 Open Science practices

A first step towards improved scientific communication and cumulative evidence building in ESM research on self-harm may be the implementation of open science practices. These include registering hypotheses and detailed analysis plans before data collection or analysis (i.e., pre-registration) — and even having these plans peer-reviewed as a Registered Report — and sharing codes and materials to advance transparency, reproducibility and replicability in research (Munafo et al., 2017). Given that ESM brings several decisions on design, i.e. forking paths (Gelman & Loken, 2013), and analytic challenges (Kirtley et al., 2021), the use of open science practices may be perceived as challenging by researchers within this field. Nevertheless, both theory and practice would benefit from the implementation of these open science practices because it facilitates replication and increases the credibility of study findings (Ammerman & Law, 2022; Kirtley, 2021; Flake & Fried, 2020). Especially in the self-harm research field, replication is needed because sample sizes are often small to increase the generalizability of findings and build cumulative theory. However, a lack of knowledge and training opportunities for clinical psychology researchers hinders the use of open science practices (Carpenter & Law, 2021). Therefore, a guide describing open science practices may be necessary and useful to help strengthen the foundations of our evidence base for the future.

1.11 Main model of this PhD thesis

This brings us to the main model of this PhD thesis (see Figure 4). Taken together, I will focus on specific risk factors for self-harm in adolescents, the extent to which attachment relationship quality is associated with these risk factors, and whether it moderates these associations. During the writing of this doctoral thesis, I specifically focused on identifying best methodological practices for ESM research on self-harm.

Figure 4. *Main model of this PhD project, investigating risk factors for self-harm and the extent to which attachment is associated with these risk factors and may moderate these associations, whilst identifying the best methodological practices within this literature.*

Chapter 2: Objectives

2.1 Investigation of associations between specific risk factors (i.e., ACEs and loneliness) and self-harm and the extent to which attachment is associated with these risk factors and moderates these associations

This objective is divided into four steps. First, in **Chapter 3**, we investigate how mother, father and peer attachment relationship quality are associated with lifetime and current self-harm thoughts and behaviours. Additionally, we examined how mother, father and peer attachment relationship quality interact with each other in relation to lifetime and current self-harm thoughts and behaviours. In **Chapter 4**, we extend Chapter 3 by investigating how and to what extent specific types of ACEs are associated with lifetime and current self-harm thoughts and behaviours, and attachment, and to what extent attachment moderates associations between ACEs and self-harm thoughts and behaviours.

In **Chapter 5**, we investigate to what extent attachment relationship quality is associated with changes in adolescents' levels of irritability, stress, and loneliness in daily life from before to during the COVID-19 pandemic. We also examine whether attachment relationship quality is associated with adolescents' experiences of COVID-19-related family conflict and its perceived burden. **Chapter 6** concludes the empirical work of this PhD thesis by investigating to what extent loneliness is associated with self-harm thoughts in the next minutes/hours at the within-person level and to what extent the change in loneliness from one timepoint to the next timepoint is moderated by self-harm behaviours within that same time interval at the within-person level. In addition, we examine to what extent low levels of paternal and maternal attachment relationship quality are associated with higher levels of loneliness at the between-person level and whether parental attachment relationship quality moderates the moment-to-moment associations between loneliness and self-harm at the between- and within-person level.

2.2 Evaluation and advancement of methodological approaches and open science aspects within this literature

This objective consists of two parts. In **Chapter 7**, we synthesise the literature on IPs and self-harm in daily life and addresses four critical questions: (1) Which IPs have been assessed in ESM studies of self-harm and how have they been assessed, (2) Who is more at risk for self-harm, (3) When is risk for self-harm increased among individuals who report self-harm and (4) Do IPs in daily life differentially relate to self-harm thoughts rather than behaviours? In **Chapter 8**, we provide the current literature with examples from our and others' work to demonstrate opportunities for future-proofing research by implementing open science practices, and we discuss some of the challenges and their potential solutions.

Chapter 3: Lifetime and current self-harm thoughts and behaviours and their relationship to parent and peer attachment (Registered Report)

Published (with open access) as:

Janssens, J. J., Myin-Germeys, I., Lafit, G., Achterhof, R., Hagemann, N., Hermans, K. S., ... & Kirtley, O. J. (2022). Lifetime and current self-harm thoughts and behaviors and their relationship to parent and peer attachment. *Crisis: The Journal of Crisis Intervention and Suicide Prevention.* https://doi.org/10.1027/0227-5910/a000878

Supplementary materials for this chapter are available online: https://osf.io/8eu9y/

Abstract

Background: Previous research suggests attachment is a vulnerability factor for self-harm thoughts and behaviours in adults. Yet, few studies have investigated this relationship during adolescence, even though adolescence is a critical period for changes in attachment relationships, and self-harm onset. Whether and how attachment relates to self-harm thoughts and behaviours as measured in daily life is also unknown.

Aims*:* To investigate whether and how paternal, maternal, and peer attachment are associated with lifetime and current adolescent self-harm thoughts and behaviours. Additionally, to examine how different attachment bonds interact in relation to lifetime and current adolescent self-harm thoughts and behaviours.

Method*:* Pre-existing data from N=1913 adolescents of the SIGMA study were used. Attachment and lifetime history of self-harm thoughts and behaviours were measured via retrospective questionnaires. Current self-harm thoughts and behaviours were assessed ten times per day for six days using the Experience Sampling Method (ESM).

Results*:* Paternal and maternal attachment were associated with lifetime self-harm thoughts and behaviours and current self-harm thoughts. No significant associations were found between peer attachment and self-harm outcomes.

Limitations*:* Some analyses were underpowered.

Conclusion*:* Our results highlight the importance of parent-child attachment relationships, which may be intervention targets for prevention and treatment of adolescent self-harm.

Introduction

Self-harm refers to any act of self-poisoning or self-injury carried out by an individual, irrespective of motivation (NICE, 2011). It is among the leading causes of death and injury worldwide (WHO, 2008) and engaging in self-harm significantly increases suicide risk (Hawton et al., 2020). Approximately 90% of people who self-harm began during adolescence (Nock & Prinstein, 2004), with the typical age of onset being around 14 years old (Gandhi et al., 2018). To enable early intervention and prevention of self-harm thoughts and behaviours, it is crucial to understand the psychological factors that underpin them.

Previous studies have investigated the role of family functioning in self-harm. Results demonstrated that adolescents reporting reduced family support and excessive behavioural parental control were more likely to report self-harm (Baetens et al., 2015; Palmer et al., 2016). Despite the indication that family functioning may play an important role in self-harm, few studies have substantively examined self-harm in relation to what is potentially the most important aspect of family functioning: attachment.

Bowlby's Attachment Theory (1969) contends that secure attachment bonds develop when children generally experience their parents as available, responsive and attuned. These secure attachment bonds promote the development of stress buffering intra- and interpersonal skills (Bowlby, 1973). Conversely, children with predominantly negative past attachment experiences will develop an insecure parental attachment bond (i.e., lack of trust, poor communication quality and high interpersonal alienation). Consequently, these children may adopt other, possibly maladaptive, strategies to cope with intense negative emotions, such as self-harm.

Existing studies on attachment and self-harm report conflicting results and one study found only indirect effects between parental attachment and self-harm via coping strategies (Glazebrook et al., 2016). While some support the importance of maternal and peer bonds (Gandhi et al., 2016), others emphasize the paternal bond (Santens et al., 2018). One potential explanation for these

conflicting results is that secure attachment in one domain could protect against insecure attachment in another (Buyse et al., 2011; Mota et al., 2016). Likewise, double-insecure children (i.e., insecurely attached to both parents), may do worse than those with a secure relationship to at least one parent (Kochanska & Kim, 2013). To our knowledge, no published research has investigated the relative and buffering effects of different types of attachment bonds on self-harm within a large, general population sample. Further, most research has focused on individuals from clinical or adult populations (Claes et al., 2016; Glazebrook et al., 2015). As most young people do not present to health services for self-harm (Geulayov et al., 2018; McMahon et al., 2014), research with a general population adolescent sample could increase generalisability and open up new directions for interventions to prevent self-harm in this underserved population.

A further limitation of previous research on attachment and self-harm is that studies have rarely directly investigated whether attachment is differentially associated with thinking (ideating) about self-harm versus engaging in self-harm behaviours. However, contemporary 'ideation-to-action' theoretical models of suicidal behaviour distinguish between the psychosocial processes associated with self-harm thoughts, and those associated with self-harm behaviours (Klonsky & May, 2015; O'Connor, 2011; O'Connor & Kirtley, 2018). To this end, the current study builds upon recent research (Zortea et al., 2019) highlighting the utility of the Integrated Motivational-Volitional model (IMV; O'Connor & Kirtley, 2018) for understanding how attachment is related to self-harm thoughts and behaviours. Within the IMV, attachment is posited as a pre-motivational factor, associated with both thoughts and behaviours (Zortea et al., 2019). To date, however, the relationship between attachment and self-harm in the context of the IMV model has been investigated only in adult samples. Determining whether attachment is differentially related to self-harm thoughts and behaviours in adolescence is of practical importance for early intervention efforts, as most self-harm thoughts and behaviours begin during adolescence.

In addition to investigating whether attachment may differentially relate to self-harm thoughts or behaviours, it is also crucial to measure these thoughts and behaviours where they naturally occur: in daily life. Previous research on self-harm in adolescence has relied on retrospective, self-report questionnaires that do not assess the dynamic nature of self-harm. Yet, research assessing self-harm thoughts and behaviours repeatedly within short periods (i.e. hours) is critical to meaningfully capture fluctuations as they occur (Czyz et al., 2019; Glenn et al., 2020). ESM is an intensive longitudinal technique assessing self-reports of behaviours and experiences during daily life (Csikszentmihalyi & Larson, 1987). Participants complete questionnaires on a smartphone, several times a day for multiple days, during their normal everyday life. This technique offers a powerful solution to issues of recall bias and ecological validity, by providing us with reliable information about individuals' self-harm thoughts and behaviours within their real-world context (Myin-Germeys et al., 2018).

In the current study, we aimed to investigate the association between different attachment relationships and self-harm thoughts and behaviours in adolescents. Using pre-existing data from a large, adolescent cohort study (Kirtley et al., 2021) we investigated attachment in relation to both lifetime history, and current daily-life experiences of self-harm thoughts and behaviours. Specifically, we investigated how mother, father and peer attachment are associated with lifetime and current self-harm thoughts and behaviours. Additionally, we examined how mother, father and peer attachment interact with each other in relation to lifetime and current self-harm thoughts and behaviours. We hypothesised that adolescents with higher levels of paternal, maternal and peer attachment insecurity would be more likely to report lifetime and current self-harm thoughts and behaviours. Further, we predicted that the negative effect of an insecure attachment bond on lifetime and current self-harm thoughts and behaviours would be reduced by security in other attachment bonds.

Method

Participants and recruitment

The data used in this study were drawn from Wave I of the SIGMA study (Kirtley et al., 2021), a large-scale longitudinal study investigating mental health in Flemish adolescents. The original dataset includes cross-sectional data from 1913 adolescents, recruited from the general population via 22 schools across Flanders (Belgium). Schools distributed information letters to potential participants and their caregivers inviting them to participate. Participants were included if they were in their first, third or fifth year of mainstream secondary education, had an adequate command of the Dutch language and provided informed consent (from themselves and a caregiver). Most participants within the sample were female (n = 1207; 63%). The age range was 11 to 20 years (M = 13.76 years, SD = 1.86 years), with n = 1048 (55%) in their first year, n = 424 (22%) in their third year, and n = 441 (23%) in their fifth year of mainstream secondary education.

From the full sample (N = 1913), n = 1507 have valid lifetime self-harm data and n = 1788 have valid daily life self-harm data. We used a 10% subsample from both datasets to calculate power and conduct a confirmatory factor analysis (CFA). For the main analyses, samples comprised n = 1272 with valid lifetime self-harm data and at least one observation in the attachment variable and n = 1450 with valid daily life self-harm data and at least one observation in the attachment variable. For more details on this selection procedure, see supplementary material: https://osf.io/8eu9y/.

Procedure

The full procedure for the SIGMA project is detailed elsewhere (Kirtley et al., 2021). Data were collected via self-report questionnaires completed during a 100-minute in-class testing session, and in daily life using the experience sampling method (ESM), between January 2018 and June 2019. Participants completed a battery of self-report questionnaires via tablets during the testing session. Afterwards, participants received a smartphone to complete the ESM questionnaires via the MobileQ application (Meers et al., 2020). Participants were asked to complete 10 ESM questionnaires during a

six-day period. Each day, notifications were randomly distributed in 90-minute blocks. The questionnaire consisted of 39 to 46 items with an estimated completion time of 2-4 minutes. Participants had 90 seconds to complete each item. As reimbursement, all participants received a 10-euro shopping voucher. Participants received no feedback on their compliance or other data during or after the ESM week. Various steps were taken to ensure participant safety and wellbeing, including provision of support information. For details, see the supplementary material: https://osf.io/8eu9y/. The study received ethical approval from the UZ/KU Leuven Medical Ethics Committee (S61395).

Measures

The full list of items and details on scoring and construction are included in the supplementary material: https://osf.io/8eu9y/.

Attachment

The Dutch version of the Inventory of Parent and Peer Attachment (IPPA; Armsden & Greenberg, 1987; Dutch translation by Noom et al., 1999) is a self-report questionnaire developed to assess quality of parental and peer attachment. Three dimensions of attachment security are measured: trust, communication and alienation. A CFA on two subsamples stratified according to the prevalence of lifetime (n = 149) and current (n = 178) self-harm thoughts and behaviours confirmed a three-factor structure.

Lifetime self-harm thoughts and behaviours

Four items were used to assess lifetime non-suicidal and suicidal self-harm thoughts and behaviours, adapted from the Child and Adolescent Self-harm in Europe study (CASE; Madge et al., 2008) questionnaire. All items were translated and back-translated from English to Dutch. Based on these items, three groups were created: 0 = “No self-harm thoughts/behaviours”, 1 = “Thoughts only” and 2 = “(Thoughts and) behaviours”.

Depression

Depressive symptoms were assessed using the six-item Depression subscale of the Brief Symptom Inventory (BSI) (Derogatis & Spencer, 1993), and a sum-score calculated.

Self-harm thoughts and behaviours during daily life

In the ESM questionnaire, three self-constructed items were used to assess current self-harm thoughts and behaviours. The three items were branched and presented in a fixed order. The first item was presented at every notification in order to assess self-harm thoughts. If self-harm thoughts were indicated, one item on self-harm behaviour and one item on suicidal intent followed.

Missing data

Due to completely missing data on the self-harm and attachment variable, our final sample sizes were n = 1272 to investigate hypotheses regarding lifetime self-harm and n = 1450 to investigate hypotheses regarding daily life self-harm. Missing attachment data were imputed using multiple imputation using chained equations (MICE). For details on missing data analyses, see the supplementary material: https://osf.io/8eu9y/.

Data analyses

A model selection procedure was conducted for all models. For further details of the analyses, including power calculations, see https://osf.io/8eu9y/.

Attachment and lifetime self-harm thoughts and behaviours

To investigate the relationship between attachment (paternal, maternal and peer) and lifetime self-harm thoughts and behaviours, we first conducted an ordinal logistic regression with self-harm history (0 = “No thoughts – no behaviours group”, 2 = “Only thoughts group”, 3 = “(Thoughts and) behaviours group”) as the outcome to test main effects. Paternal, maternal and peer attachment insecurity were all set simultaneously as the predictor variables in the model. We then investigated each combination of the following interaction terms: paternal x maternal x peer attachment. Given

convergence issues during analysis of the stratified subsample (10%; n = 149), interaction analyses were exploratory.

Attachment and current self-harm thoughts

The relationship between attachment (paternal, maternal and peer) and self-harm thoughts in daily life were analysed using a two-part mixed effects model for semi-continuous data (Tom et al., 2016). The model specified a logistic regression for the dichotomous indicator that the outcome is zero or not (0 = “Having no thoughts” or 1 = “Having thoughts”). Then, a standard linear mixed model was estimated for the logarithmic transformation of the non-zero responses (“Having thoughts” with a strength from 1 to 6), allowing for varying intercepts. This model was estimated by specifying a joint distribution that links separate mixed-effects models (i.e. logistic and a linear mixed effects model for the log-transformed non-zero responses). The two models were linked by covariance between their respective random effects with the results that the two parts of the model were estimated simultaneously (Tooze et al., 2002). Given the general population sample, we expected an excess of zero observations, e.g. (0 = “No self-harm thoughts”), and therefore the two-part mixed-effects model was especially suitable to analyse these intensive longitudinal data (Blozis et al., 2020; Farewell et al., 2017).

Attachment and current self-harm behaviours

To investigate the relationship between attachment and self-harm behaviours in daily life (measured using ESM), we conducted a binary logistic mixed-effects regression with the presence of self-harm behaviour (0 = “No self-harm behaviour”, 1 = “Self-harm behaviour”) as the outcome. We included random intercepts for persons.

In all models, we simultaneously entered paternal, maternal and peer attachment as predictor variables and controlled for age, gender and depression assessed at baseline, given their associations with self-harm thoughts and behaviours. To investigate the interaction effect of

attachment on current self-harm thoughts and behaviours, we included each combination of the following interaction terms: paternal x maternal x peer attachment.

Power analysis

A two-step Monte Carlo simulation approach for power calculation was used, as distributions for the variables of interest could not be found within the existing literature. See supplementary materials for further information: https://osf.io/8eu9y/.

For the hypotheses regarding lifetime self-harm, the results showed that the model performed with sufficient power (.78 - 1) when investigating the probability of reporting no thoughts vs. thoughts. Analysis on the probability of reporting thoughts vs. thoughts and behaviours was underpowered (.22 - .69).

For analyses on current self-harm, the model was sufficiently powered (1), except for analysis of the relationship between paternal attachment insecurity and self-harm thoughts (the zero part of the model), which was underpowered (.10).

Deviations from Stage 1

During data analysis, it became clear that we had to deviate slightly from the Stage 1 manuscript. See the supplementary materials: https://osf.io/8eu9y/ for a transparent changes document.

Results

Descriptive statistics are provided in Table 1. Imputed values were plausible (see supplementary materials: https://osf.io/8eu9y/).

Table 1

Descriptive statistics for lifetime (N=1235) and current (ESM; N=1210) self-harm sample

Variables		*n(%)*	*M(SD)*	*Mdn*	*Range*
Lifetime sample					
Demographics	Age (years)		13.86(1.86)	13	11-19
	Gender, % Females		48		
Attachment insecurity	Paternal		-17.49(7.39)	-19	-28-8
	Maternal		-20.46(6.04)	-22	-28-5
	Peer		-18.15(6.11)	-19	-28-4
Depressive symptoms			4.60(4.56)	3	0-20
Lifetime self-harm	No thoughts/behaviours	726(59%)			
	Thoughts only	248(20%)			
	(Thoughts and) behaviours	261(21%)			
Current (ESM) sample					
Demographics	Age (years)		13.77(1.84)	13	11-19
	Gender, % Females		66		
Attachment insecurity	Paternal		-17.6(7.24)	-19	-28-8
	Maternal		-20.44(6.13)	-22	-28-5
	Peer		-18.11(6.05)	-19	-28-4
Depressive symptoms			4.61(4.54)	3	0-20
Current self-harm	No thoughts/behaviours	522(43%)			
	Thoughts only	390(32%)			
	Thoughts and behaviours	298(25%)			
	Intensity of thoughts[1]	1210(100%)	1.25(0.95)	1	1-7
	Intensity of thoughts[2]	688(57%)	4(2.16)	4	1-7
Overall compliance	Number of completed beeps		25.88(12.41)	25	1-59

[1]For full sample on a scale from 1 to 7; [2]For 'thoughts only', and 'thoughts and behaviours' groups on a scale from 1 to 7.

Confirmatory analyses

Attachment and lifetime self-harm thoughts and behaviours

Higher paternal and maternal attachment insecurity were significantly associated with a greater likelihood of reporting lifetime self-harm thoughts and behaviours, β = 0.03, *SE* = 0.01, *OR (0|1) = 4.11, OR (1|2) = 15.85*, p = .002 and β = 0.04, *SE* = 0.01, *OR (0|1) = 4.12, OR (1|2) = 15.86*, p <

.001, respectively. The association between peer attachment and lifetime self-harm thoughts and behaviours was non-significant, *β* = 0.006*, SE* = 0.01, *OR (0|1) = 4.09, OR (1|2) = 15.83*, *p* = .06. See Table 2 (supplementary materials) for further results.

Attachment and current self-harm thoughts and behaviours

Higher paternal and maternal attachment insecurity were significantly associated with the presence of current self-harm thoughts, *β* = 0.03*, SE* = 0.01, *OR (0|1) = 0.98, p* = .02, *β* = 0.04*, SE* = 0.01, *OR (0|1) = 0.96*, *p* < .001, respectively, whilst peer attachment insecurity was not, *β* = 0.02*, SE* = 0.01, *OR (0|1) = 0.99, p* = .16. Associations between attachment (paternal, maternal and peer) and the intensity of current self-harm thoughts were all non-significant, *β* = -0.002*, SE* = 0.003, *p* = .52, *β* = 0.002*, SE* = 0.003, *p* = .59, *β* = -0.006*, SE* = 0.004, *p* = .10, respectively.

Paternal, maternal, or peer attachment insecurity were not significantly associated with the absence/presence of self-harm behaviours, *Log-Odds* = -0.001, *SE* = 0.01, *p* = .92, *Log-Odds* = 0.03, *SE* = 0.02, *p* = .09, *Log-Odds* = -0.02, *SE* = 0.02, *p* = .27, respectively. For further results, see Table 3 and 4 (supplementary materials).

Exploratory analyses

Due to space constraints, all exploratory analyses are reported in the supplementary materials: https://osf.io/8eu9y/.

Discussion

Confirmatory analyses

Consistent with previous literature (Gandhi et al., 2016; Santens et al., 2018) and attachment theory (Bowlby, 1969, 1973), we found that adolescents with higher levels of paternal and maternal attachment insecurity were more likely to report lifetime and current self-harm thoughts, and lifetime self-harm behaviours. Given the association between attachment insecurity and both lifetime self-harm thoughts and behaviours, and current self-harm thoughts, our findings also offer partial support for attachment insecurity as a pre-motivational variable within the IMV model (O'Connor & Kirtley,

2018), where parent-child attachment relationships may increase vulnerability for self-harm thoughts and behaviours (Zortea et al., 2019). Conversely, self-harm may influence attachment relationships (Ferrey et al., 2015), and this should be investigated in future studies. Findings support prevention and treatment initiatives for adolescent self-harm that restore trust and communication in parent-child relationships, e.g. Attachment-Based Family Therapy (Diamond et al., 2010). However, we found no significant associations between paternal or maternal attachment insecurity and the intensity of current self-harm thoughts, or presence of current self-harm behaviours. Since our models of the association between attachment insecurity and lifetime self-harm behaviours, and paternal attachment insecurity and the presence of current self-harm thoughts were underpowered, results should be interpreted with caution and require replication in larger samples.

Despite the equivocal empirical evidence to date, the lack of an association between peer attachment and self-harm was unexpected (Gandhi et al., 2016). A possible explanation for these results could be the younger average age of the current sample (13.8 yrs) relative to those of previous studies ($\geq$ 15.6 yrs) that found an association between peer attachment insecurity and self-harm (Claes et al., 2010; Jarvi et al., 2013). The effect of peer relationships on psychological outcomes increases with age in the transition to adulthood, where peers become increasingly important (Moretti & Peled, 2004; Wilkinson, 2004), therefore this relationship may only emerge in older adolescents. Moreover, research has often found only an indirect effect of peer attachment on self-harm, via parental attachment or self-esteem (Gandhi et al., 2016; Wilkinson & Walford, 2001).

Strengths and limitations

To our knowledge, this is the first study investigating whether adolescents' attachment insecurity with both parents and peers is associated with self-harm. Given that the current study provides evidence from both retrospective questionnaires as well as ESM for the relationship between attachment and self-harm, we believe this study contributes to research and practice. Finally, we consider the use of open science practices (the Registered Report article format, open

materials, and open code) – still the exception rather than the rule in clinical psychology research (Tackett et al., 2019) – a major strength.

However, several limitations should be discussed. First, researchers have argued that the IPPA assesses parent and peer *relationship quality* rather than attachment (Gandhi et al., 2019), therefore our study may be more appropriately characterised as investigating relationship quality. Second, some analyses were underpowered. However, the high degree of transparency in our methodology and analysis facilitates future direct replication in higher-powered studies.

Conclusions

The current study provides evidence for the association of both paternal and maternal attachment with lifetime and current self-harm thoughts and lifetime self-harm behaviours, during adolescence, and provides support for attachment as a pre-motivational variable within the IMV model. Parent-child attachment relationships may be promising intervention targets for the prevention and treatment of adolescent self-harm. Future research should further investigate the buffering effects of different types of attachment bonds on self-harm.

Chapter 4: Associations between adverse childhood experiences, parent-child and peer attachment relationships, and daily-life self-harm in adolescents

Article submitted and under review

Available as a preprint online:

Janssens, J. J., Lafit, G., De Corte, E., Achterhof, R., Hagemann, N., Hermans K. S. F. M., Hiekkaranta, A. P., Lecei, A., Myin-Germeys, I., & Kirtley, O. J. (2023). Associations between adverse childhood experiences, parent-child and peer attachment relationships, and daily life self-harm in adolescents. https://osf.io/preprints/psyarxiv/bt58k

Supplementary materials for chapter are available online: https://osf.io/uq5ba/

Abstract

Background: Self-harm is a leading cause of death and injury worldwide and is especially common amongst adolescents. Adverse childhood experiences (ACEs) are a risk factor for self-harm within the Integrated-Motivational Volitional (IMV) model. However, it remains unclear whether ACEs are associated with lifetime self-harm thoughts, behaviours, or both, and whether these are prospectively associated with current self-harm thoughts and behaviours. Moreover, research that investigates potential protective factors in the association between ACEs and self-harm is scarce. Here, we investigated whether ACEs were associated with lifetime and current self-harm thoughts and behaviours, and whether parent-child or peer attachment relationship quality influenced this association. Additionally, we explored whether specific types of ACEs were differentially associated with self-harm.

Methods: *N*=1014 adolescents were recruited across 22 Flemish schools (Belgium). Retrospective questionnaires were used to assess ACEs, lifetime self-harm thoughts and behaviours, and paternal, maternal, and peer attachment relationship quality. Experience Sampling Methodology (ESM) was used to assess current self-harm thoughts and behaviours, 10x/day for 6 days.

Results: Multilevel analyses demonstrated associations between ACEs and lifetime and current self-harm thoughts and behaviours, that were attenuated by a high-quality maternal attachment relationship. Specific types of ACEs (e.g., sexual victimization) were more strongly associated with lifetime and current self-harm thoughts and behaviours.

Limitations: Subjective experience of ACEs has not been investigated and some analyses were underpowered.

Conclusions: The study provides evidence for ACEs as a risk factor for both self-harm thoughts and behaviours, and maternal relationship quality may buffer the impact of ACEs on self-harm.

Introduction

Both suicidal and non-suicidal self-harm are a leading cause of death and injury worldwide (Kiekens et al. 2023; WHO, 2021) and, therefore, a major public health concern. Self-harm is defined by the National Institute for Health and Care Excellence as "any act of self-poisoning or self-injury carried out by an individual, irrespective of motivation" (NICE, 2023) and is especially common amongst adolescents (Hawton et al., 2012). Although previous studies have identified a range of general risk factors for self-harm in adolescents, e.g., depression (O'Connor & Nock, 2014) and social disadvantage (Hawton et al., 2012), it remains challenging to identify *who* specifically is most at risk for self-harm. Addressing this challenge would enable prevention and intervention resources to be tailored to the needs of adolescents who are most at risk.

Many studies have confirmed an association between adverse childhood experiences (ACEs) and a range of negative physical and psychological outcomes including self-harm (Hughes et al., 2017; Kalmakis & Chandler, 2015; Sahle et al., 2021). ACEs include distressing and traumatic childhood events that are uncontrollable by the child, including physical, sexual, and emotional abuse, emotional and physical neglect, and caregiver risk factors such as parental psychopathology, substance misuse, incarceration, parental loss, separation or divorce, and family/domestic violence (Corcoran & McNulty, 2018; Sachs-Ericsson et al., 2016; Saul et al., 2014). Exposure to one ACE is not uncommon and has been experienced by more than 20% of adolescents (Moore et al., 2016) and almost half (46.4%) of adults (Hughes et al. 2017). Moreover, studies suggest that the occurrence of one ACE increases the likelihood of the occurrence of other ACEs by 80% and that cumulative exposure to multiple ACEs has greater negative implications (Björkenstam et al., 2013; Bunting et al., 2023; Felitti et al., 1998; Moore et al., 2016), including increased risk of suicidal thoughts and behaviours (Felitti et al., 1998). Despite this extensive research, there are four main gaps within the literature on ACEs and self-harm.

First, studies have often not differentiated between thinking about (ideating) versus engaging in self-harm behaviours (action), whilst factors associated with self-harm thoughts might be

different from those associated with the behaviour (Klonsky & May, 2015; O'Connor & Kirtley, 2018), and require different clinical approaches (Jameson, 2020). Ideation-to-action models of self-harm, such as the Integrated Motivational-Volitional (IMV) model (O'Connor, 2011; O'Connor & Kirtley, 2018), can provide a useful framework for investigating how factors such as ACEs may relate uniquely to self-harm thoughts or behaviours, or to both. This model builds on earlier ideation-to-action theories of suicide, e.g., the Interpersonal Theory of Suicide (Joiner, 2005; Van Orden et al., 2010) and the Cry of Pain model (Williams, 2014), by providing a comprehensive overview of risk and protective factors involved in the emergence of self-harm thoughts, and the transition to self-harm behaviours. Within the IMV model, ACEs can be understood as "stressful life events" that, combined with vulnerability factors, provide the biopsychosocial context in which self-harm thoughts and behaviours may emerge (O'Connor & Kirtley, 2018).

Second, traditional retrospective questionnaires assessing self-harm thoughts and behaviours are limited by being unable to take into account the dynamic nature of these phenomena (Czyz, Horwitz, et al., 2019; Kaurin et al., 2022; Kiekens et al., 2020; Kleiman et al., 2017). An ideal solution to this issue, is to use Experience Sampling Methodology (ESM), where intensive longitudinal data are collected about individuals' current experiences, thoughts, behaviours, and contexts via brief smartphone questionnaires, completed multiple times a day for days or weeks (Csikszentmihalyi & Larson, 1987; Myin-Germeys et al., 2018). This methodology reduces recall bias and increases ecological validity because individuals respond to these questionnaires where these experiences, thoughts and behaviours naturally occur: in their daily life (Myin-Germeys et al., 2018). Investigating how adolescents' previous experiences of ACEs relate to their current self-harm thoughts and behaviours in daily life can generate more reliable insights into the prospective relationship between ACEs and self-harm. In fact, this also provides opportunities to understand factors that may buffer against the negative impact of ACEs on self-harm.

This brings us to a third notable shortcoming —research to date has paid little attention to the role of protective factors in the association between ACEs and self-harm (Edwards et al., 2019; Narayan et al., 2021), although necessary to refine intervention and prevention strategies.

One key factor that could protect adolescents from the negative consequences of ACEs are positive attachment relationships with parents and peers. Indeed, whilst profound relational shifts during this age period may create vulnerability for adverse mental health outcomes (Lasgaard et al., 2011), they also offer great opportunities to establish supportive relationships that can help mitigate the impact of childhood adversity (Gajos et al., 2022; Narayan et al., 2021; Venta, 2020). For example, Attachment Theory (Bowlby, 1696/1973) argues that positive attachment relationships are built through a child experiencing the parent —and later peers — as responsive, sensitive and attuned to their needs. These experiences are internalized and define how an individual views the world and responds to stress and intense negative emotions. Adolescents with lower-quality attachment bonds are more likely to respond to distress with avoidance (i.e., preference for emotional distance and not depending on others) or anxiety (i.e., intensely worrying about the availabilty of their attachment figure) resulting in not finding the support they need when stressed. Conversely, adolescents with higher-quality attachment bonds are strengthened in their ability to find the appropriate support, guidance, and care needed to deal with life adversities (Brenning et al., 2012). However, empirical research investigating the association between attachment relationship quality and ACEs is limited and varying in adolescents (Kim, 2021; Walker & Venta, 2023; Wang et al., 2021). More research is needed to further explore the extent to which paternal, maternal and peer attachment relationship quality may buffer against the negative impact of ACEs on adolescent self-harm, and as such, provide potential intervention targets for mitigating the deleterious effects of adversity on adolescents.

A fourth and final gap that this study aims to fill is that, whilst specific types of ACEs seem to be more strongly related to self-harm than others, relatively few studies have compared differential associations between specific ACEs and self-harm outcomes. For example, research shows that

physical and sexual abuse are more strongly related to future suicide attempts compared to other types of ACEs (Joiner et al., 2007). However, more research is required to extend our knowledge of which types of ACEs are more strongly associated with self-harm in adolescents, so that clinical interventions can be tailored accordingly.

In order to address the identified gaps within the literature, the current study extends our previous work in the same sample (Janssens et al., 2022; Janssens et al., 2023, preprint) — in which we investigated the association between parent and peer attachment, and lifetime and current self-harm thoughts and behaviours — to answer the following research questions:

(1) How are ACEs associated with lifetime and current self-harm thoughts and/or behaviours, and paternal, maternal, and peer attachment relationship quality?
(2) To what extent does paternal, maternal and peer attachment relationship quality moderate the associations between ACEs and lifetime and current self-harm thoughts and/or behaviours?
(3) Are specific types of ACEs more strongly associated with lifetime and current self-harm thoughts and/or behaviours?

First, we hypothesized that adolescents who report more ACEs, are more likely to report lifetime and current self-harm thoughts and behaviours. Second, we predicted that the more ACEs reported by adolescents, the greater the intensity of the current self-harm thoughts reported by adolescents. Third, we hypothesized that adolescents who report more ACEs, are more likely to report lower levels of paternal, maternal and peer attachment relationship quality. Fourth, we expect that the positive association between ACEs and self-harm thoughts and behaviours (lifetime and current) is mitigated by higher levels of paternal, maternal and peer attachment relationship quality. Finally, as an exploratory aim of our study, we investigate which types of ACEs (maltreatment; peer and sibling victimization; sexual victimization; witnessing and other exposure to violence) are more strongly associated with lifetime and current self-harm thoughts and behaviours.

Method

Participants

We used data from Wave I of the SIGMA study, which is a large-scale longitudinal study on adolescent mental health (Kirtley et al., 2021). In total, 1913 adolescents across 22 schools participated, of which 1207 identified as female (63%). The total sample's age ranged from 11 to 20 years (M=13.76, SD=1.86 years). Due to missing data and a two-step power calculation, *N*=619 participants were not included. Our final sample consists of *N*=1014 adolescents. For more details, see the supplementary materials: https://osf.io/uq5ba/.

Recruitment

Participants were recruited in school. Inclusion criteria for participants were attending the first, third, or fifth year of mainstream secondary school, fluency in Dutch, being available on the in-school testing session, availability to complete the six-day ESM period, and providing informed consent, both from themselves and their caregiver. Participants received a 10-euro shopping voucher in return for their participation. The research team ensured anonymity of the participants and confidentiality of the data. Full ethical approval was received from the UZ/KU Leuven Medical Ethics Committee (S61395).

Procedure

Participants completed a large battery of retrospective questionnaires on a tablet, using REDCap (Harris et al., 2009). After, they were guided through an ESM demo questionnaire and provided with a smartphone (i.e., Motorola Moto E4) and received a sheet with contact details for support services, such as Zelfmoordlijn (1813).

The sampling scheme was semi-random signal-contingent and participants had to fill out 10 ESM questionnaires a day for six consecutive days, via the Mobile Q application (Meers et al., 2020). Beeps were randomly distributed in 90-minute blocks, with beeps at least 15 minutes apart. Each ESM questionnaire included 39 to 46 items depending on the branching. Participants received no feedback on their compliance. For more details on the procedure for the SIGMA project, see Kirtley et al. (2021).

Measures

Retrospective measures

Lifetime self-harm thoughts and behaviours

Lifetime self-harm thoughts and behaviours were measured using four items (CASE; Madge et al., 2008): (1) “Have you ever thought about ending your life?”, (2) “Have you ever tried to end your own life?”, (3) “Have you ever thought about harming yourself, but without wanting to die?” and (4) “Have you ever actually harmed yourself, but without wanting to die?”. Individuals could respond with: yes, multiple times; yes, once; and no, never. Subsequently, each participant was assigned to a group: (1) no thoughts/behaviours, (2) only thoughts and (3) behaviours. Items showed good internal consistency (ω = .88).

Adverse childhood experiences (ACEs)

The number and type of ACEs were assessed using the Juvenile Victimization Questionnaire (JVQ) (Hamby et al., 2011). The JVQ assesses 5 types: (1) Conventional crime, (2) Maltreatment, (3) Peer and sibling victimization, (4) Sexual victimization, and (5) Witnessing and other exposure to violence. Since the "Conventional crime" subscale was less relevant for this age group, it was omitted during Wave I testing. All items are summed to create a total score for the number of ACEs they were exposed to and higher scores indicate greater exposure to ACEs. The JVQ showed adequate reliability in children and adolescents (Finkelhor et al., 2005), and good internal consistency within this sample (ω = .80).

Attachment relationship quality

Quality in the relationships with mother, father and peers was assessed with the Inventory for Parent and Peer Attachment (IPPA; Armsden & Greenberg, 1987; Dutch translation by Noom et al., 1999). This inventory consisted of 12 items for each relationship (father, mother and peers) and were divided over 3 subscales: (1) Communication, (2) Trust and (3) Alienation. A total score for each relationship was calculated. Given that previous research suggested that a dimensional approach is more precise and robust (Gandhi et al., 2019), continuous scores were used instead of cut-off scores.

Previous confirmatory factor analysis within the same sample revealed that it is not appropriate to merge the paternal and maternal score into a composite parental score (Janssens et al., 2022). The IPPA was shown to be a reliable and valid measure in adolescents (Gullone & Robinson, 2005). The father, mother and peer attachment items showed all good internal consistency (ω = .93, ω = .90, ω =.89, respectively).

Age, gender and depressive symptoms

Age was reported in years and participants reported whether they identified themselves as: (0) male, (1) female or (2) other. To assess depressive symptoms, adolescents filled out the Depression subscale of the Brief Symptom Inventory (BSI; Derogatis & Spencer, 1993) and a sum score was calculated. The Depression subscale showed good internal consistency (ω = .91).

Daily-life measures (ESM)

Current self-harm thoughts and behaviours

Current self-harm thoughts and behaviours were assessed using two ESM items. The first item assessed the presence/absence and the intensity of self-harm thoughts: "Since the last beep, have you considered harming yourself?". This item was rated on a 7-point Likert scale: (1) not at all – (7) very much. If a score of 2 or higher was reported, the second item that assessed current self-harm behaviours was presented: "Since the last beep, have you actually harmed yourself on purpose?". Participants responded to this second item with yes or no and were assigned to a group (0) no thoughts/behaviours, (1) only thoughts or (2) thoughts and behaviours. The full ESM questionnaire is publicly available online in the ESM Item Repository (Kirtley et al., 2020): www.esmitemrepository.com.

Missing data

A multiple imputation model by chained equations (MICE; van Buuren & Groothuis-Oudshoorn, 2011) was used to impute missing data in the depressive symptoms and paternal, maternal and peer attachment relationship quality variable. The quality of the imputed datasets was checked using density plots. For more details: https://osf.io/uq5ba/.

Open Science practices

All hypotheses and the analysis plan were post-registered (Benning et al., 2019): https://osf.io/b2mnk.

Data analyses

R version 4.3.1 was used for all analyses. The following packages were used: ggplot2 (Wickham, 2016), MICE (van Buuren & Groothuis-Oudshoorn, 2011), GLMMadaptive version 0.6-8 (Rizopoulos, 2023), Hmisc (Harrell, 2023), reshape2 (Wickham, 2007), dplyr (Wickham et al., 2023), lme4 (Bates et al., 2015), lmerTest (Kuznetsova, Brockhoff & Christensen, 2017), parameters (Lüdecke et al., 2020), psych (Revelle, 2023), mitools (Lumley, 2019) and ordinal (Christensen, 2022).

Power analysis

All analyses were sufficiently powered, except for the moderation effect of maternal and peer attachment relationship quality in the association between ACEs and current self-harm behaviours. For more details: https://osf.io/uq5ba/.

Main analyses

Confirmatory analyses

An ordinal logistic regression estimated whether adolescents who reported more ACEs were more likely to report lifetime self-harm thoughts and/or behaviours. The outcome variable was the lifetime self-harm categories to which participants were assigned to: (1) no thoughts/behaviours, (2) thoughts and (3) behaviours. The time-invariant, continuous predictor variable was the total number of ACEs reported and we controlled for age, gender, and depressive symptoms. For this analysis, we had valid data from *N*=805 adolescents.

A two-part mixed-effects model for semi-continuous data (Tom et al., 2016) estimated whether adolescents who report more ACEs were more likely to report current self-harm thoughts and whether the number of ACEs was related to the intensity of the current self-harm thoughts. The model included random intercepts for persons and we controlled for age, gender, and depressive symptoms. Data were valid from *N*=803 adolescents for this analysis.

A binary logistic mixed-effects regression estimated whether adolescents who report more ACEs were more likely to report current self-harm behaviours. The outcome variable was the presence of current self-harm behaviours (i.e., (0) no or (1) yes). The time-invariant, continuous, predictor variable was the number of total ACEs and we controlled for age, gender, and depressive symptoms. We used data from *N*=803 adolescents for this analysis.

A linear regression model estimated whether adolescents with lower levels of paternal, maternal and peer attachment relationship quality (i.e., time-invariant predictor variable) were more likely to report a higher number of ACEs (i.e., time-invariant, continuous outcome variable). Here, we controlled for age and gender. Data were valid from *N*=803 adolescents.

To investigate whether these associations were moderated by levels of paternal, maternal and peer attachment relationship quality, the appropriate interaction terms were included in each model. Data were valid from *N*=922 adolescents.

Exploratory analyses

To investigate whether some types of ACEs were more strongly associated with lifetime and current self-harm thoughts and behaviours, the continuous predictor variable, ACEs, was converted to a categorical predictor variable.

Results

Table 1 provides an overview of the descriptive statistics.

Table 1

Descriptive statistics for all three subgroups

Variables	Subgroup 1 (N=805)				Subgroup 2 (N=803)				Subgroup 3 (N=922)			
	n (%)	M (SD)	Mdn	Range	n (%)	M (SD)	Mdn	Range	n (%)	M (SD)	Mdn	Range
					Demographics							
Age		14.13 (1.92)	14	11-19		13.98 (1.88)	14	11-19		14.04 (1.92)	14	11-19
Gender (% females)	67.08				67.61				65.29			
					Retrospective measures							
Lifetime self-harm thoughts and behaviours												
No thoughts/behaviours	483											
Thoughts only	156											
(Thoughts and) behaviours	166											
Attachment relationship quality												
Paternal		17.35 (7.49)	19	-8-28		17.49 (7.41)	19	-8-28		17.47	19	-8-28

Maternal	20.45 (5.94)	22	-5-28	20.67 (5.81)	22	-5-28	20.49	22	-5-28
Peer	18.43 (5.98)	-19	-4-28	18.55 (5.98)	19	-4-28	18.3	19	-4-28
ACEs	3.81 (3.23)	3	0-25	3.57 (2.98)	3	0-25	3.74 (3.29)	3	0-25
Depressive symptoms	4.54 (4.58)	3	0-20	4.65 (4.53)	3	0-20			
				Daily-life measures					
Current self-harm thoughts									
No thoughts/behaviours				369 (45.95%)					
Thoughts only				255 (31.76%)					
Thoughts and behaviours				179 (22.29%)					
Intensity of thoughts[a]				3 (2.16)	3	0-6[c]			
Intensity of thoughts[b]				3 (2.16)	3	0-6 [c]			
				Overall compliance					
Number of completed beeps				26.20 (12.20)	26	1-59			

Note. [a] For thoughts only. [b]For thoughts and behaviours groups. [c]Rescaled from 1-7 to 0-6. These three subgroups were drawn from the full sample of *N*=1014 unique participants and, therefore, largely overlapping (for more details on the selection of these subgroups, see the supplementary materials on the OSF page of this project: https://osf.io/uq5ba/). Of these *N*=1014, *N*=898 adolescents (89%) reported at least one ACE.

Confirmatory analyses

ACEs and self-harm thoughts and behaviours

Adolescents who report more ACEs, were more likely to report lifetime self-harm thoughts and/or behaviours (Table 2). For every one unit increase in ACEs, the odds of moving from group 0 (i.e., having no self-harm thoughts) to group 1 (i.e., having self-harm thoughts) and from group 1 to group 2 (i.e., engaging in self-harm behaviour) increased by 1.23.

The number of ACEs was significantly associated with a greater likelihood of reporting current self-harm thoughts and behaviours (see Table 3 and 4). The association between ACEs and the intensity of current self-harm thoughts was non-significant.

ACEs and attachment relationship quality

Adolescents who report more ACEs, report significantly lower levels of paternal, maternal and peer attachment relationship quality (Table 5).

Attachment relationship quality as a moderator

Maternal attachment relationship quality moderated the positive association between ACEs and lifetime self-harm thoughts and behaviours (Table 2); the association was weaker for adolescents with lower maternal attachment relationship quality. No significant moderation effects were found with paternal or peer attachment relationship quality in the association between ACEs and lifetime self-harm thoughts and behaviours.

No significant moderation effects by attachment relationship quality were found in the association between ACEs and the presence of current self-harm thoughts. Higher levels of maternal attachment relationship quality had a mitigating effect on the positive association between ACEs and the intensity of current self-harm thoughts (Table 3). Moderation effects by paternal and peer attachment relationship quality and the intensity of current self-harm thoughts were non-significant.

In the associations between ACEs and current self-harm behaviours, no significant moderation effects by attachment relationship quality were found (Table 4).

Table 2

Ordinal logistic regression, estimating lifetime self-harm thoughts and behaviours from number of ACEs, with and without attachment relationship quality as moderator

	Lifetime self-harm thoughts and behaviours			
	β (SE)	95% CI	OR (0|1|2)	*p*
Model without attachment relationship quality				
ACEs	**0.21 (0.03)**	**[0.16;0.27]**	**1.23**	**<.001**
Age	**0.12 (0.04)**	**[0.03;0.20]**	**1.13**	**.01**
Gender (female)	**0.37 (0.18)**	**[0.02;0.72]**	**1.45**	**.04**
Depressive symptoms	**0.21 (0.02)**	**[0.17;0.24]**	**1.23**	**<.001**
Model with attachment relationship quality				
ACEs	-0.04 (0.08)	[-0.20;0.11]	0.96	.59
Age	**0.09 (0.05)**	**[0.01;0.18]**	**1.09**	**.03**
Gender (female)	**0.55 (0.19)**	**[0.18;0.92]**	**1.73**	**.004**
Depressive symptoms	**0.18 (0.02)**	**[0.13;0.22]**	**1.19**	**<.001**
ACEs*Attachment relationship quality				
Paternal	0.003 (0.004)	[-0.00;0.01]		.46

Maternal	**0.01 (0.004)**	**[0.00;0.02]**	**.009**
Peer	-0.0003 (0.004)	[-0.01;0.01]	.93

Note. P-values <.05 are displayed in bold.

Table 3

Two-part mixed-effects model, predicting the presence/absence and intensity of current self-harm thoughts from ACEs, with and without attachment relationship quality as moderator

	Current self-harm thoughts						
	Binary part (presence/absence)				Continuous part (intensity)		
	β (SE)	95% CI	OR (0|1)	*p*	β (SE)	95% CI	*p*
Model without attachment relationship quality							
ACEs	**0.12 (0.03)**	**[0.07;0.18]**	**1.13**	**<.001**	0.01 (0.01)	[0.00;0.03]	.06
Age	-0.09 (0.05)	[-0.19;0.01]	1.09	.08	-0.01 (0.01)	[-0.04;0.02]	.41
Gender (female)	**-0.52 (0.18)**	**[-0.88;-0.17]**	**0.59**	**.004**	-0.02 (0.05)	[-0.12;0.09]	.72
Depressive symptoms	**0.09 (0.02)**	**[0.05-0.13]**	**1.10**	**<.001**	-0.01 (0.01)	[-0.02;0.01]	.36
Model with attachment relationship quality							
ACEs	0.06 (0.08)	[-0.09;0.21]	1.06	.44	**0.05 (0.02)**	**[0.01;0.09]**	**.01**

Age	**-0.10 (0.05)**	**[-0.19;0.00]**	**0.91**	**.05**	-0.01 (0.01)	[-0.04;0.02]	.42
Gender (female)	-0.34 (0.19)	[-0.71;0.03]	0.71	.07	-0.04 (0.05)	[-0.15;0.07]	.46
Depressive symptoms	**0.06 (0.02)**	**[0.01;0.10]**	**0.94**	**.01**	-0.002 (0.01)	[-0.01;0.01]	.81
ACEs*Attachment relationship quality							
Paternal	-0.002 (0.004)	[-0.01;0.01]		.58	0.0005 (0.001)	[0.00;0.00]	.62
Maternal	-0.007 (0.004)	[-0.00;0.02]		.13	**-0.003 (0.001)**	[0.00;0.00]	**.03**
Peer	-0.003 (0.004)	[-0.01;0.01]		.50	-0.00005 (0.001)	[0.00;0.00]	.97

Note. P-values <.05 are displayed in bold. For easier interpretation, estimates of the binary part are multiplied by -1 as the model estimates the probability that the outcome is zero (absence of self-harm thoughts).

Table 4

Binary logistic mixed-effects regression, predicting the presence/absence of current self-harm behaviours from ACEs, with and without attachment relationship quality as moderator

	Presence/absence of current self-harm behaviours		
	Log-Odds (SE)	95% CI	*p*
Model without attachment relationship quality			
ACEs	**0.10 (0.04)**	**[0.03;0.17]**	**.005**

Age	-0.02 (0.07)	[-0.15;0.11]	.74
Gender (female)	-0.29 (0.25)	[-0.77;0.20]	.25
Depressive symptoms	-0.05 (0.03)	[-0.10;0.00]	.07
Model with attachment relationship quality			
ACEs	-0.001 (0.09)	[-0.18;0.17]	.99
Age	-0.02 (0.07)	[-0.16;0.11]	.73
Gender (female)	-0.23 (0.25)	[-0.73;0.27]	.37
Depressive symptoms	-0.05 (0.03)	[-0.11;0.01]	.08
ACEs*Attachment relationship quality			
Paternal	0.003 (0.01)	[-0.01;0.01]	.51
Maternal	-0.001 (0.01)	[-0.01;0.01]	.89
Peer	0.01 (0.01)	[-0.01;0.02]	.39

Note. P-values <.05 are displayed in bold.

Table 5

Linear regressions, predicting paternal, maternal and peer attachment relationship quality from the number of ACEs

		Attachment relationship quality							
		Paternal			Maternal			Peer	
	β (SE)	95% CI	*p*	β (SE)	95% CI	*p*	β (SE)	95% CI	*p*
ACEs	**-0.68 (0.07)**	**[-0.82;-0.53]**	**<.001**	**-0.49 (0.06)**	**[-0.61;-0.37]**	**<.001**	**-0.48 (0.06)**	**[-0.61;-0.36]]**	**<.001**
Age	**0.88 (0.12)**	**[0.63;1.12]**	**<.001**	0.65 (0.12)	[0.44;0.85]	<.001	0.10 (0.11)	[-0.11;0.32]	.34
Gender (female)	**1.09 (0.48)**	**[0.15;2.02]**	**.02**	-0.05 (0.39)	[-0.81;0.71]	.89	**-1.46 (0.42)**	**[-2.28;-0.65]**	**<.001**

Note. P-values <.05 are displayed in bold.

Exploratory analyses

Types of ACEs and self-harm thoughts and behaviours

Maltreatment, peer and sibling victimization, and sexual victimization were positively associated with a greater likelihood of reporting lifetime self-harm thoughts and behaviours. Peer and sibling victimization was found to be most strongly associated with lifetime self-harm thoughts and behaviours, followed by maltreatment. No significant association was found between witnessing or other exposure to violence, and lifetime self-harm thoughts and behaviours.

Maltreatment and sexual victimization were significantly associated with a greater likelihood of reporting current self-harm thoughts. Maltreatment was found to be more strongly associated with the presence of current self-harm thoughts than sexual victimization. No significant associations were found between peer and sibling victimization, witnessing or other exposure to violence, and the presence of current self-harm thoughts.

Only sexual victimization was found to be significantly associated with higher levels (i.e., greater intensity) of current self-harm thoughts. Sexual victimization was the only type of ACE that was significantly associated with a greater likelihood of reporting current self-harm behaviours.

Discussion

General summary of the results

Adolescents who report a higher number of ACEs were more likely to report both lifetime and current self-harm thoughts and behaviours. The association between ACEs and the intensity of current self-harm thoughts was non-significant. In line with our hypotheses, adolescents who reported more ACEs reported lower levels of paternal, maternal and peer attachment relationship quality. Higher levels of maternal, but not paternal or peer, attachment relationship quality buffered the association between ACEs and lifetime self-harm thoughts and behaviours, and between ACEs and the intensity of current self-harm thoughts. No significant moderation effects by maternal, paternal or peer attachment relationship quality were found in the association between ACEs and current self-harm behaviours. However, analyses regarding maternal and peer attachment

relationship quality in the association between ACEs and current self-harm behaviours were underpowered and, therefore, should be interpreted with caution.

Of the four different types of ACEs we assessed, peer and sibling victimization was most strongly associated with lifetime self-harm thoughts and behaviours, followed by maltreatment, then sexual victimization, with the latter two ACEs also being associated with increased likelihood of reporting self-harm thoughts in daily life. Peer and sibling victimization and witnessing or other exposure to violence were both not significantly associated with the presence of current self-harm thoughts. Finally, adolescents who reported sexual victimization were more likely to report higher levels of current self-harm thoughts, and current self-harm behaviours. Maltreatment, peer and sibling victimization, and witnessing or other exposure to violence were not significantly associated with the intensity of current self-harm thoughts or the presence of current self-harm behaviours.

Confirmatory analyses

ACEs and self-harm thoughts and behaviours

Consistent with our hypotheses, results revealed that adolescents who report a higher number of ACEs were more likely to report both lifetime and current self-harm thoughts and behaviours. However, inconsistent with our hypothesis, no significant association was found between ACEs and the intensity of self-harm thoughts. These findings add to earlier literature (Bruffaerts et al., 2010; Cleare et al., 2018; Glassman et al., 2007; Madge et al., 2011; Sahle et al., 2021) by extending previous retrospective research to prospective associations in daily life. Moreover, these findings fit within a diathesis-stress framework (Rubinstein, 1986; van Heeringen, 2012) — the backdrop to the IMV model (O'Connor & Kirtley, 2018) — by suggesting that a certain amount of ACEs ("stress") can precipitate self-harm. However, not all adolescents exposed to the same amount of ACEs will develop self-harm; it will depend on the presence and influence of other distal vulnerability factors ("diatheses") (van Heeringen, 2012), e.g., attachment relationship quality (O'Connor & Kirtley, 2018). This suggests that ACEs are an important target in the prevention of self-harm thoughts and behaviours, and that a broader focus on factors that may protect against or

exacerbate the deleterious impact of ACEs may also be meaningful. Moreover, our findings suggest that ACEs may not be involved in the escalation (i.e., increasing intensity) of self-harm thoughts and did not differentiate between individuals with self-harm thoughts and those with behaviours. This encourages further investigation into factors specifically involved in the emergence of thoughts and the transition to behaviours such that treatment can be tailored accordingly.

ACEs and attachment relationship quality

As predicted, we found that adolescents who reported a higher number of ACEs, have lower-quality relationships with their father, mother, and peers. This is in line with previous literature that found that maltreated children are significantly more likely to have insecure attachment relationships. In fact, some researchers indicate that 80% of children that have experienced maltreatment have low-quality attachment bonds (see Baer & Martinez,2006, for a literature review). Moreover, findings from the current study extend this earlier literature by suggesting associations broader than just maltreatment within the family and the bonds that develop within it, as associations were found between ACEs and paternal, maternal, but also peer attachment relationship quality. However, our research is unable to disentangle any direction or causality of these associations, and therefore, it remains unclear whether it is the socioemotional environment (e.g., parent-child and peer relationships) that serves as a risk factor for ACEs (Zielinsky & Bradshaw, 2006) or whether ACEs inhibit the formation of strong social bonds (Allwood & Widom, 2013; Barboza & Siller, 2021; Craig et al., 2022; Kharsati & Bhola, 2016; Stagaki et al., 2022), or both. Future studies are needed to unravel the direction of this association, and whether other factors may mediate this association.

Attachment relationship quality as a moderator

One key aim of this study was to investigate whether paternal, maternal and/or peer attachment relationship quality influences the association between ACEs and self-harm thoughts and behaviours in adolescents. Although replication is needed, as the available data in Western adolescent samples is limited, the current study provides evidence for maternal relationship quality

influencing the association between ACEs on both lifetime self-harm thoughts and behaviours. These findings align with the results from a previous study in a sample of Central American adolescents (Walker & Venta, 2023) that found that maternal, and not paternal, attachment security mitigates the association between ACEs and lifetime self-harm behaviours. Moreover, this adds to our understanding of the great variation in effects of ACEs identified in numerous studies, as these findings suggest that the effect of ACEs on adolescent self-harm can be influenced by the context in which children develop, including the familial context (Zielinski & Bradshaw, 2006). Additionally, maternal attachment relationship quality was shown to influence the association between past ACEs and the intensity of current self-harm thoughts. This provides us with specific knowledge about the importance of the maternal relationship in the de-escalation of self-harm thoughts experienced during everyday life; which may be especially informative for the treatment of self-harm thoughts and prevention of self-harm.

Interestingly, no significant moderating effect by paternal or peer attachment relationship quality was observed. The apparent importance of a high-quality maternal relationship in the association between ACEs and self-harm may, therefore, reflect a unique contributing role of mothers relative to fathers (e.g., Van IJzendoorn & De Wolff, 1997). In fact, prior work suggests that maternal bonds may be more focused on protection and comfort (i.e., safe-haven function in times of distress), which may be specifically important in the context of ACEs. Paternal relationships, in turn, are characterized by an emphasis on supporting exploration (i.e., a secure base function when a child feels safe) (Grossman & Grossman, 2020; Keijsers et al., 2010; Venta et al., 2020).

Exploratory analyses

The current study is one of the few studies that included and compared different types of ACEs and their specific associations with lifetime and current self-harm thoughts and behaviours. In line with earlier work (Cleare et al., 2018; Holt et al., 2015; John et al., 2018; Myklestad & Straiton, 2021), results suggest that three types of ACEs are associated with lifetime and current self-harm thoughts and behaviours: childhood maltreatment, peer and sibling victimization and sexual

victimization. In fact, adolescents reporting any of these three types of ACEs were significantly more likely to report lifetime self-harm thoughts and behaviours, with maltreatment posing the strongest risk, followed by peer and sibling victimization. These findings support one of the key aspects of Joiner's (2005) theory – that various painful experiences such as physical and sexual abuse confer elevated risk of suicidal behaviour (Joiner, 2007; Van Orden et al., 2010).

Strengths and limitations

Our study has a number of strengths. First, studies have rarely differentiated between self-harm thoughts and behaviours whilst associations may differ and have different implications for theory and practice (Klonsky & May, 2015; O'Connor & Kirtley, 2018; Jameson, 2020). Therefore, we consider it a strength of our study that we were able to provide unique insights into the associations between ACEs and self-harm thoughts and ACEs and self-harm behaviours. Second, by using ESM to assess self-harm, we reduced the risk of recall bias and increased ecological validity, which allowed for a more reliable picture of adolescents' daily reality (Myin-Germeys et al., 2018). Third, most research on this topic has been conducted in the US (Kalmakis & Chandler, 2015), which hampers the generalizability of findings to adolescents in Europe and other geographical areas. For this reason, using a non-clinical Belgian sample of adolescents was especially valuable. Fourth, research has often only investigated the effect of one type of ACE (e.g., Holt et al., 2015) or the total number of ACEs on self-harm, when including multiple types of ACEs in one study (e.g., Russell et al., 2019). This hinders the reliability of comparisons across studies and limits our knowledge of the unique contribution of a particular type of ACE to self-harm. Including different types of ACEs in our study is, therefore, of great value to reveal the relative magnitude of associations between different types of ACEs and self-harm.

Despite these strengths, our study also has limitations. First, the JVQ does not take into account the subjective experience of ACEs and is limited in the types of events it covers. We encourage future researchers to include a wider range of events, such that a broader representation of the impact of ACEs on self-harm becomes possible. For example, the Juvenile Victimization

Questionnaire in interview format is a more comprehensive measure that does take frequency, but also severity of ACEs into account. Second, some analyses were underpowered and, therefore, future studies are needed to replicate these findings. However, given that power analyses are still uncommon in ESM research (Trull & Ebner-Priemer, 2020), we consider our power calculation valuable, as it provides transparency and opens the way for other researchers to conduct similar power analyses.

Clinical implications

Our research revealed that 89% of adolescents report at least one ACE and prior studies revealed that the occurrence of one ACE increases the probability of occurrence of another ACE by 80% (Björkenstam et al., 2013; Bunting et al., 2023; Felitti et al., 1998; Moore et al., 2016). Moreover, results from our study showed that adolescents report on average 3 to 4 ACEs and that a higher amount is associated with a higher likelihood of reporting lifetime and current self-harm thoughts and behaviours. This highlights the importance of clinicians specifically assessing exposure to ACEs in adolescents that are vulnerable for developing self-harm. Given the evidence indicating the positive influence of a high-quality maternal relationship in adolescents experiencing ACEs, it may be worthwhile for clinicians to focus on strengthening this bond. Moreover, our exploratory investigations suggest that specific types of ACEs (i.e., childhood maltreatment, peer and sibling victimization, and sexual victimization) are differentially associated with lifetime and current self-harm thoughts and behaviours.

Conclusions

The current study shows that ACEs are associated with lifetime and current self-harm thoughts and behaviours, and supports ACEs as a pre-motivational phase variable within the IMV model. Moreover, our study highlights the importance of high-quality maternal relationships, as these may attenuate the effect of ACEs on self-harm. Exploratory analyses revealed that specific types of ACEs are more strongly associated with lifetime and current self-harm thoughts and behaviours (i.e., childhood maltreatment, peer and sibling victimization and sexual victimization). As

such, the amount and type of ACEs and the maternal relationship, may be promising targets in prevention and management of adolescent self-harm thoughts and behaviours.

Chapter 5: The impact of COVID-19 on adolescents' daily lives – the role of parent-child relationship quality

Published as:

Janssens, J. J., Achterhof, R., Lafit, G., Bamps, E., Hagemann, N., Hiekkaranta, A. P., ... & Kirtley, O. J. (2021). The impact of COVID-19 on adolescents' daily lives: The role of parent–child relationship quality. *Journal of Research on Adolescence, 31*(3), 623-644. https://doi.org/10.1111/jora.12657

Supplementary materials for this chapter are available online: https://osf.io/wdkxz/

Abstract

COVID-19 lockdown measures have profoundly impacted adolescent' daily life, with research suggesting an increase in irritability, stress, loneliness and family conflict. A potential protective factor is parent-child relationship quality, however, no studies have investigated this. We used data from SIGMA, a longitudinal, experience sampling cohort study, in which N = 173 adolescents aged 11 to 20 were tested before and during COVID-19. Multilevel analyses showed decreased daily-life irritability and increased loneliness from pre- to mid-pandemic. Daily-life stress levels were unchanged. Relationship quality was negatively associated with irritability and loneliness and buffered against the increase in loneliness. Effect sizes were small and do not support a strong effect of the first lockdown on irritability, stress, loneliness, and family conflict in adolescents.

Introduction

The current spread of the novel SARS-CoV-2 (COVID-19) virus is a major threat to physical and, along with the national lockdown measures imposed, also to mental health (WHO, 2020). Although there has been much media speculation about the adverse impact of this crisis on mental health and family life, there has been little empirical investigation of this. Moreover, emerging research on the impact of COVID-19 on mental health (Moccia et al., 2020; Veer et al., 2020) is limited to adult studies, with a few notable exceptions (Green et al., 2021; Janssen et al., 2020; Magson et al., 2021; Widnall et al., 2020). However, adolescents are a population group who may be especially vulnerable to any mental health impacts of COVID-19.

Adolescence is a developmental period where the vast majority of mental health conditions have their onset (Solmi et al., 2021). Large-scale US research suggests that 75% of adults who report ever having a mental health condition indicate they experienced their first symptoms during adolescence (Kessler et al., 2012). Along with significant physical and psychological changes, adolescence is a period of profound social transformation, where both peer and parent interactions are crucial for the development of adolescents into independent adults (Andrews et al., 2020; Blakemore & Mills, 2014; Steinberg & Morris, 2001). During this period, adolescents strive to become independent and focus more on socializing and spending time with friends rather than with their families. Consequently, the drastic changes in daily social life due to the pandemic and associated lockdown measures may have particularly affected adolescents, as they are at a a critical stage of social development (Andrews et al., 2020; Orben et al., 2020). Adolescents' enforced proximity to their families and the limitation of face-to-face contacts with peers may not allow their developmental needs to be met (Andrews et al., 2020; Grusec & Davidov, 2021; Orben et al., 2020; Steinberg & Morris, 2001). Findings from emerging research during the pandemic suggest an increased vulnerability for mental health problems in adolescents as compared to adults (Magson et al., 2021), however some studies suggest a decrease in psychopathology symptoms (Widnall et al.,

2020). To learn more about these conflicting findings on the impact of COVID-19 on adolescent mental health, we may need to focus more on mental health symptoms at a subclinical level.

Several studies and viewpoint papers have suggested an increase in irritability, stress and loneliness in adolescents due to the sudden global virus outbreak and government-imposed lockdown regulations, which may be precursors to later mental health problems (Hasking et al., 2021; Loades et al., 2020; Panda et al., 2021). For example, previous studies found that irritability was fairly common among quarantined adolescents (Panda et al., 2021), possibly due to the increased parental involvement, reducing adolescents' privacy and time alone (Hasking et al., 2021; Wang, 2020). An increase in stress may also be expected, as adolescents worry about their own and loved ones' safety during the pandemic, as well as their school education, given the swift transition to online learning from home (Ellis et al., 2020; Hasking et al., 2021). Additionally, limitation of face-to-face contact with peers potentially increased concerns about maintaining close social connections during a period where these are crucial for adequate development and mental well-being (Andrews et al., 2020; Grusec & Davidov, 2021; Smetana et al., 2015). Therefore, enforced physical distancing may have led adolescents to feel lonely during the COVID-19 pandemic (Ellis et al., 2020; Loades et al., 2020). The broader literature emphasizes how these daily-life outcomes, i.e irritability, stress and loneliness, are related to negative physical and mental health outcomes, e.g. anxiety disorders, depression, and suicidal behaviour and mortality (Brotman et al., 2017; Hawkley & Cacioppo, 2010; McClelland et al., 2020; Romeo, 2017; Stringaris et al., 2018). As such, investigating proximal vulnerability and protective factors for irritability, stress and loneliness could inform efforts to mitigate or prevent mental health problems in adolescents.

In addition to the potential impact of the COVID-19 pandemic on adolescents' levels of irritability, stress, and loneliness, several review papers suggest an impact on the family system as a whole (Campbell, 2020; Prime et al., 2020). To understand this, we can draw upon the Family Resilience Model (FRM; Henry et al., 2015): a theoretical framework describing how families as

systems navigate unexpected adversity, such as the COVID-19 pandemic, given certain pre-existing protective and vulnerability factors. The FRM includes four basic elements that play a role in family resilience: family risk, protection, vulnerability, and adaptation. Families each have their own set of vulnerabilities and protective factors, which combine with certain risks (i.e. stressors) to produce a unique response to adversity. Both protection and adaptation occur within the Family Adaptive Systems (FAS) that are described in the FRM as arising from family interactions, which develop and regulate key domains of everyday family life. The five FAS within the FRM include, but are not limited to, meaning, emotion, control, maintenance, and stress response systems. For example, from the perspective of the FRM, the Stress Response System regulates the level of change and stability in the family equilibrium on a meta-level. The other FAS influence how a family develops what is necessary to regulate family goals, structures and interaction patterns, and adapt to the incoming adversity. For example, when the quality of parent-child relationships (an aspect of the Family Emotion Adaptative System) is poor before a new incoming challenge, this can limit family resilience and the adversity may further worsen the relationship. At the same time, when there is already a high level of conflict (an aspect of the Family Control Adaptative System), this may increase the distress during adversity and heighten the level of conflict in the family (Henry et al., 2015).

Emerging research suggests COVID-19-related stress, fear, uncertainty, limited support networks and social isolation are risk factors for family conflict during the pandemic (Campbell, 2020; Guessoum et al., 2020). Another conceptual framework, recently proposed by Prime et al. (2020), posits that the social disruptions caused by the pandemic may heighten stress in parents, which in turn negatively affects parental, parent-child and sibling relationships. Parents' stress increases during the pandemic because they are searching for a new work-family balance (e.g. shift in routines and structures), dealing with job insecurity/loss, as well as concerns about their safety and that of their loved ones. When parents' mental and emotional resources are exhausted, ensuring the positive functioning of the family is difficult (Prime et al., 2020). This proposed cascading process suggests that family conflict is a particularly relevant risk factor for adolescent adjustment and well-being

(Browne et al., 2015). Therefore, it is of utmost importance to understand the consequences of the COVID-19 pandemic on adolescents and their families. High-quality parent-child relationships, may buffer against the risk of negative outcomes in the context of COVID-19 by promoting resilience (Prime et al., 2020), whereas poor parent-child relationships within families may create vulnerability to the negative effects of the pandemic on family life, e.g. family conflict (Henry et al., 2015).

Previous research has shown that high-quality parent-child relationships can protect adolescents against the impact of stressors (Dimitry, 2012; Kronenberg et al., 2010; Wickrama & Kaspar, 2007) as this can provide them with the opportunity to more easily identify, describe and share feelings with others (Cerutti, 2018; Gandhi, 2019). Conversely, adolescents with lower quality parent-child relationships might lack the skills to find support from others and share difficulties, meaning their strategies for dealing with adversity fall short (Brumariu & Kerns, 2010; Shpigel et al., 2012). During adolescence, the need for (physical) proximity from the parental figure changes to the need for (emotional) availability, as self-regulatory skills grow with age. Nevertheless, adolescents still need their parents to be available in times of need, because peer relationships are still developing and the intense emotions - inherent to adolescence – may be overwhelming (Bosmans et al., 2015).

The broader literature has shown that low-quality parent-child relationships are associated with more frequent and burdensome family conflict, whereas high-quality parent-child relationships are associated with less frequent and less burdensome family conflict (Shpigel et al., 2012; Hannum & Dvorak, 2004). Therefore, children with poor parent-child relationships and their families are potentially more strongly impacted by stressors such as the pandemic. However, no published research in adolescents so far has investigated the presumed impact on irritability, stress, loneliness and family conflict during this pandemic, and how the quality of paternal and maternal relationships may be associated with these outcomes. More specifically, how and to what extent the quality of paternal and maternal relationships can mitigate or exacerbate the pandemic's potential impact on these daily-life outcomes, and family conflict. Insights into these associations may help us to identify

adolescents and families at risk of adverse mental health outcomes or experiencing heightened conflict and to develop effective strategies to support them.

Research on mental health and family dynamics during COVID-19 faces two major challenges. First, in order to investigate dynamic processes such as irritability, stress and loneliness in adolescents, it is necessary to look at these outcomes in an ecologically valid manner by targeting them in the context where they naturally occur: daily life. The Experience Sampling Method (ESM; Csikszentmihalyi & Larson, 1987; Myin-Germeys et al., 2018) enables data on adolescents' activities, thoughts and experiences to be captured within the context of their natural daily life, by completing multiple brief questionnaires on a smartphone over a period of several days. The use of ESM to assess feelings of irritability, stress and loneliness is expected to improve the accuracy of measurements by reducing recall bias and increasing ecological validity. Second, the vast majority of studies examining psychological and social effects of COVID-19 are cross-sectional. Consequently, we lack data on key predictors (and outcomes) from before the pandemic. Considering that pre-pandemic vulnerability factors may heighten risk of negative psychological outcomes and family conflict (Prime et al., 2020), longitudinal data which enables comparison of predictors and outcomes pre- and during-pandemic is essential. To this end, the current study leverages pre-COVID-19 data from an ongoing adolescent cohort study including ESM (SIGMA; Kirtley et al., 2021) in combination with data collected from a subgroup of these adolescents during the first COVID-19 lockdown (Achterhof et al., 2021).

Our study aims to investigate to what extent the quality of a parent-child relationship is associated with changes in adolescents' levels of irritability, stress and loneliness in daily life from before to during the COVID-19 pandemic. We also examine whether the quality of the parent-child relationship is associated with adolescents' experiences of COVID-19-related family conflict and its perceived burden. First, we hypothesize that there will be an increase in adolescents' levels of irritability, stress and loneliness in daily life from before to during the pandemic. Second, we predict

that adolescents who report a lower quality of paternal and maternal relationships will be more likely to report higher levels of irritability, stress and loneliness in daily life before and during the pandemic. Third, we expect that changes in adolescents' daily life levels of irritability, stress and loneliness from before to during the pandemic will be moderated by the quality of the paternal and maternal relationship, such that adolescents with a lower quality of relationships exhibit a larger increase of irritability, stress, and loneliness. Fourth, we hypothesize that adolescents who report a lower quality of paternal and maternal relationships will be more likely to experience more frequent and burdensome family conflict during the pandemic.

Method

Socio-cultural context

For the current study, we used data from two waves of the SIGMA study: Wave I and Wave COVID-19. SIGMA is a large-scale, accelerated longitudinal study that investigates the mental health and development of adolescents. Wave I of the SIGMA study included data from 1913 adolescents from 22 schools in Flanders, the Northern, Dutch-speaking region of Belgium and took place between January 2018 and June 2019. Flanders counts approximately 6.6 million people (Statbel, 2020) of which 457,000 are in secondary education (Statistiek Vlaanderen, 2019). The sample was representative in terms of sex, education level, and geographical spread.

Wave COVID-19 of the SIGMA study occurred during the first national lockdown from the 27th of April until the 10th of May. On the 18th of March 2020, the Belgian government decided to impose restrictive measures to prevent the spread of COVID-19. There was a stay-at-home order and, schools and non-essential shops were closed. In the week of the 4th of May, some measures were lifted (e.g. outdoor activities with a friend) and it was announced that other regulations (e.g. schools) would be lifted in the near future (Belgische Federale Overheidsdiensten, 2020).

Participants and recruitment

For a detailed description of the measures and sample from the full SIGMA study, see Kirtley et al. (2021). For an overview of the complete COVID-19 Wave of SIGMA, see Achterhof et al. (2021b). See supplementary file 1 for a full overview of the self-report measures used for the full Wave I of the SIGMA study and Wave COVID-19.

Wave I took place between January 2018 and June 2019 and includes data from 1913 adolescents, recruited via 22 mainstream secondary schools. The majority of the schools were recruited via their existing relationship with Te Gek!?, a Flemish non-governmental organization that aims to break taboos surrounding discussion of mental health, and a partner organization of the SIGMA study. After the board of the secondary school had agreed with participation, the research team visited the school to explain the study and recruit potential participants. The parents/caregivers and potential participants were sent an information letter with further details. The majority of the sample were female (n = 1207; 63%), n = 695 were male (36%) and 11 participants indicated 'Other' (< 1%). Within Wave I, age ranged from 11 to 20 years (M = 13.76 years, SD = 1.86 years). Inclusion criteria were being in the first, third or fifth year of mainstream secondary education, having an adequate command of Dutch and having provided informed consent, both from themselves and their parent/caregiver. Within the current study, we only included adolescents that have participated in both Wave I and Wave COVID-19.

Wave COVID-19 occurred during the first national lockdown in Belgium due to COVID-19 from the 27th of April until the 10th of May. From the full Wave I sample, it was possible to contact 1581 of 1913 adolescents via email (for n = 239 there was no contact information available and for n = 93 the contact information was erroneous). Of those, n = 173 took part in this second follow-up wave, and n = 110 participated in the ESM part of the study. Regarding the family situation of this group, n = 146 indicated having both a father and a mother in their lives, n = 2 indicated having two fathers, whilst 2 other participants indicated having only one father or one mother. The other n = 17 indicated 'Other' (if none of the other options were relevant to them) or did not answer the question about their

family situation. Inclusion criteria for the COVID-19 measurement were having participated in Wave I of SIGMA, providing contact information for follow-up contact at Wave I, being able to complete baseline questionnaires in REDCap (Harris et al., 2009), having provided informed consent and if younger than 18 years of age, providing informed consent from a parent/caregiver as well. Both SIGMA Wave I and COVID-19 received full approval from the UZ/KU Leuven Medical Ethics Committee (S61395).

Procedure

Wave I

The full procedure for Wave I of the SIGMA study is described in detail in Kirtley et al. (2021). During school hours (100 minutes), instructions were given to the participants by the research team where they received an explanation about the purpose of the study, as well as where they had the opportunity to ask questions and were guided through a demo of the full ESM questionnaire. Participants completed self-report questionnaires in school on a tablet using the REDCap application (Harris et al., 2009). At the end of the testing session, all participants received a support sheet with contact details for relevant support services, including local and national crisis and advice phone lines.

Daily-life data was collected using the Experience Sampling Method (ESM). To complete the ESM questionnaires via the MobileQ app (Meers et al., 2020), participants received a smartphone device (Motorola Moto E4) from the research team. The sampling scheme was semi-random signal-contingent with an ESM questionnaire 10 times a day, for six consecutive days. The questionnaire consisted of a minimum of 39 items and a maximum of 46 items with an average completion time of 162.8 seconds. The notification would buzz or beep for 90 seconds or until the participants opened the notification. To complete each item, they had 90 seconds. Participants were instructed to answer these items with the moment right before the notification in mind (e.g. 'I feel irritated'). Compensation for participation was a 10-euro gift voucher for a physical or online store. In addition,

schools received mental health-themed psychoeducation sessions, workshops or educational materials, delivered in cooperation with Te Gek!?. Participants received no feedback on their ESM compliance and were included irrespective of their rate. The average compliance during Wave I was 39.5% across all participants (N = 1913) and notifications. The MobileQ app did not allow partial responses to be saved until 25th of October 2018.

Wave COVID-19

The data collection procedure for Wave COVID-19 was kept as similar as possible to that of Wave I, but was conducted completely remotely. Participants were invited to take part via email and received instructions via a pre-recorded video made by the research team. The self-report questionnaire battery was slightly adapted for this follow-up (e.g. inclusion of a questionnaire assessing experiences of COVID-19-related stressors, such as family conflict).

As the MobileQ application used in Wave I, was not suited for remote data collection, participants installed another experience sampling application, SEMA3 (Koval et al., 2019) on their own smartphone device. The sampling scheme for Wave COVID-19 was the same for Wave COVID-19, but the momentary questionnaire consisted of 40 to 45 items (depending on conditional branching), as well as once-a-day morning (10 items) and evening questionnaires (21 items). The questionnaire expired after 10 minutes, even if participants were still completing items. All data until the moment of expiry was saved on the phone. If participants had not opened the questionnaire, a reminder was sent to the participants after five minutes. Compensation for participation in this wave was a 10-euro gift voucher for an online store. For the group of 110 participants with ESM data in the COVID-19 measurement, the compliance rate was 43.6%.

Measures

Self-report questionnaires

Relationship quality (Wave I)

The quality of the parental relationship was assessed with a Dutch version of the Inventory of Parent and Peer Attachment (IPPA; Armsden & Greenberg, 1987; translated into Dutch by Noom, Dekovic, & Meeus, 1999), a 36-item self-report questionnaire at baseline in Wave I of the SIGMA study. Both paternal and maternal relationship quality was assessed on three dimensions: trust, communication and alienation. To assess relationship quality, a sum score was used that added the Trust and Communication item scores and subtracted the Alienation item scores. Items were rated on a 4-point Likert-type scale (from 1 = "Almost never" to 4 = "Almost always"). For example, "My mother respects my feelings" and "I feel angry with my mother". As both one- and two-factor models have been suggested for the IPPA (Gandhi et al., 2016; Murphy et al., 2017), we conducted a confirmatory factor analysis to test whether a two-factor (separate father and mother relationship quality scores) or a one-factor (composite parental relationship quality score) was most appropriate. The CFA in the present study showed that a two-factor model ($\chi 2$ = 1404.3, AIC = 6479.7, BIC = 6597.0) was a better fit than the one-factor model ($\chi 2$ = 1559.3, AIC = 6632.7, BIC = 6747.6). Paternal and maternal relationship quality were weakly correlated (r = .17). Internal consistency was high (Cronbach's α = 0.90) for both the paternal and maternal relationship quality scales.

Family conflict (Wave COVID-19)

The experience and burden of family conflict during COVID-19 was investigated with 3 items from the 22-item COVID-19-related stressors questionnaire adapted from the DynaCORE survey on resilience, conducted as part of the DynaMORE project (https://dynamore-project.eu/). Parental, parent-child and sibling conflict were assessed using the following 3 items: "In the following, some situations are listed that people may experience due to the current COVID-19 pandemic. Please indicate if you are currently experiencing the following situations or have experienced these during the past two weeks in connection to the COVID-19 pandemic, and how burdensome these are/were to you: (1) conflict between your parents, (2) conflict between you and your parents and (3) conflict between you and your siblings." Presence vs. absence of family conflict in each of the three domains

was measured using a binary 'Yes'/'No' item. If participants indicated 'Yes' when asked about presence of family conflict, the follow-up item was administered to assess the burden of the family conflict, with five response options ranging from 'Not at all burdensome' to 'Very burdensome'. Cronbach's α for the family conflict scale was 0.54.

Age and sex (Wave I and Wave COVID-19)

Given that previous research has highlighted differences in irritability, loneliness, and stress as a function of age (Friberg et al., 2012; Van Roekel et al., 2010) and sex (Friberg et al., 2012), we included these as covariates in the analysis.

Experience Sampling

Irritability, stress and loneliness (Wave I and COVID-19)

To investigate momentary irritability, stress and loneliness, the following items were used: 'I feel irritated', 'I feel stressed' and 'I feel lonely'. These three items were rated on a 7-point Likert scale ranging from 1 (Not at all) to 7 (Very much). All ESM items were presented in a fixed order.

Missing data

From the 173 participants who took part in both waves, 22 were excluded due to completely missing data on their relationship quality scales and 75 had incomplete data for parental relationship quality (at least one item filled out for paternal or maternal relationship quality) assessed with the Inventory of Parent and Peer Attachment at baseline in Wave I of the SIGMA study. Therefore, these incomplete data (for n = 75) were imputed using multiple imputation by chained equations (MICE). This particular multiple imputation technique operates under the assumption that the missing data are Missing At Random (MAR) and is recommended to address larger numbers of missing data in psychiatric research (Azur et al., 2011). Within the current study, 20 imputed datasets were used to perform the analyses, and parameter estimates were pooled using Rubin's rule (Heymans & Eekhout, 2019). All participants were asked to indicate whether they had: 1. 'One father and one mother', 2.

'Two mothers', 3. 'Two fathers', 4. 'One father', 5. 'One mother' or 6. 'Other'. This provided us with information about the family situation of those who had incomplete data for parental relationship quality. Supplementary analyses showed that 63 of the 75 participants with incomplete data indicated to have both a mother and a father in their lives, 3 of them indicated 'Other' and 1 of them indicated having 2 fathers. These 67 participants received both questionnaires for paternal and maternal relationship quality. The other 8 participants (of the 75 with incomplete data) indicated having only one mother or one father, meaning they received only one questionnaire regarding relationship quality with their available parent. We only imputed data for paternal relationship quality if participants had completed at least one item for paternal relationship quality, and similarly for the imputation of maternal relationship quality data. Imputation was carried out in R studio (RStudio Team, 2020) with R version 4.0.3 (R Core Team, 2020) using the mice package (van Buuren & Groothuis-Oudshoorn, 2011).

Open science practices

Hypotheses and planned analyses were post-registered on the Open Science Framework (OSF) after data collection but before data were accessed and analyses were conducted (Benning et al., 2019), using the registration template for ESM research (Kirtley et al., 2021). The post-registration is available at: https://osf.io/wdkxz/. Please see supplementary file 2 for changes that were made to the registration along with the full description of CFA results, list of ESM items, missing data procedure, R codes for all main and power analyses at: https://osf.io/wdkxz/. ESM items used in Wave I of the SIGMA study are also publicly available in the ESM Item Repository (Kirtley et al., 2020).

Data analyses

For the research questions on the associations between relationship quality at Wave I and daily-life irritability, stress and loneliness at Wave I and Wave COVID-19, we estimated linear mixed effects models, as these data have a multilevel structure with repeated measurements (i.e. observations) nested within persons. Multilevel models, i.e. linear mixed effects models, enable us to

analyse data that are organized at more than one level (i.e. nested data) by taking into account that observations within any given cluster at any level (e.g. observations nested within a person) can be expected to be more similar to each other than to observations within other clusters. In all multilevel models, we accounted for autocorrelation with the corAR1() component. For the analyses on relationship quality and family conflict, we used logistic regressions as the variables included were all time-invariant. All analyses were carried out in R Studio (RStudio Team, 2020) with R version 4.0.3 (R Core Team, 2020).

Sensitivity power analysis

As there was no data available from a pilot study nor information in the literature on effect sizes, we conducted a sensitivity power analysis to calculate the effect size that could be detected within the COVID-19 sample (N = 173). For full details on the sensitivity power analysis, see: https://osf.io/wdkxz/. For the sensitivity power analysis the following packages were used: future.apply (Bengtsson, 2020), r2glmm (Jaeger, 2017) and nlme (Pinheiro et al., 2020).

For the hypotheses regarding the increase in irritability, stress and loneliness, the results show that the standard linear mixed models are sufficiently powered (> .99). For the hypotheses regarding relationship quality and irritability, stress and loneliness at T0, the results show that the standard linear mixed models are sufficiently powered (≥ .88) in the case of partial R2 > .02. For the hypotheses relationship quality and irritability, stress and loneliness at T1, the results show that the standard linear mixed models have sufficient power (≥ .82) in the case of an effect size of partial R2 > .03. For the moderation hypotheses regarding the change in irritability, stress and loneliness from T0 to T1 and how this is associated with parent-child relationship quality, the standard linear mixed models perform with sufficient power (≥ .80) in the case of partial R2 > .06. For the hypotheses regarding the experience of family conflict, the results show that the binary logistic regression is underpowered (.07 - .77). For the hypotheses regarding the burden of family conflict, power could not be calculated because of convergence issues arising due to the small sample size.

Relationship quality and irritability, stress and loneliness

To estimate the change in levels of irritability, stress and loneliness in daily life from Wave I to Wave COVID-19, a standard linear mixed model was performed on each outcome variable (irritability; stress and loneliness), allowing for varying intercepts. The timepoint (0 = "Wave I", 1 = "Wave COVID-19") was set as the predictor, whilst age and sex were included as covariates in separate models for each outcome variable. Of the N = 173 participants, N = 110 had ESM data during Wave I and Wave COVID-19 and were therefore included in these three standard linear mixed models.

The associations between the relationship quality (paternal and maternal) and the levels of irritability, stress and loneliness at Wave I were estimated with standard linear mixed models with the levels of irritability, stress and loneliness at Wave I all set as a separate outcome variable, allowing for varying intercepts. Paternal and maternal relationship quality were both simultaneously set as the predictor variables in each of the three standard linear mixed models, whilst age and sex were included as covariates. N = 151 participants had both relationship quality and ESM data during Wave I, and were therefore included in this analysis.

The same analyses with relationship quality (paternal and maternal) as predictors simultaneously in each model, were conducted for Wave COVID-19 data for each of the three outcome variables (irritability at Wave COVID-19; stress at Wave COVID-19 and loneliness at Wave COVID-19). Age and sex were included as covariates in all three standard linear mixed models and intercepts were allowed to vary. For these three standard linear mixed models, N = 88 participants were included because they had relationship quality data at Wave I and ESM data during Wave COVID-19.

The moderation of relationship quality (paternal and maternal) in the change in irritability, stress and loneliness from Wave I to Wave COVID-19 was estimated with three standard linear mixed models with the levels of irritability, stress and loneliness all set as the outcome in separate models. The timepoint (0 = "Wave I", 1 = "Wave COVID-19"), paternal and maternal relationship quality and

the interaction terms (timepoint x paternal relationship quality; timepoint x maternal relationship quality) were entered simultaneously as the predictor variables with random intercepts for persons. In all three models, we included age and sex as covariates. For these moderation analyses, N = 88 participants were included. For these ESM-based analyses, the following packages were used: r2glmm (Jaeger, 2017), readxl (Wickham & Bryan, 2019), mice (van Buuren & Groothuis-Oudshoorn, 2011), mitml (Grund et al., 2019) and nlme (Pinheiro et al., 2020). For more details on how the models are expressed, see the post-registration: https://osf.io/wdkxz/.

Relationship quality and family conflict

To investigate the association between relationship quality (paternal and maternal) and the experience of family conflict, a binary logistic regression with the presence/absence of family conflict (0 = "Absence of family conflict", 1 = "Presence of family conflict") was performed for each outcome variable (parental conflict; parent-child and sibling). Paternal and maternal relationship quality were both set simultaneously as the predictor variables in each of the three models. In all three binary logistic regressions, N = 151 adolescents were included, and age and sex were included as covariates.

Finally, an ordinal logistic regression with the burden of family conflict (0 = "No burden at all", 1 = "Hardly burdensome", 2 = "Somewhat burdensome", 3 = "Quite burdensome" and 4 = "Very burdensome") was performed for each outcome variable (parental conflict burden; parent-child conflict burden and sibling conflict burden) to investigate the association between relationship quality (paternal and maternal) and the burden of each type of family conflict. Paternal and maternal relationship quality were both set as the predictor variables simultaneously in each of the three models. In all three ordinal logistic regressions, N = 151 adolescents were included, and age and sex were included as covariates. Analyses from these six models were carried out in R Studio (RStudio Team, 2020) with R version 4.0.3 (R Core Team, 2020) using the following packages: r2glmm (Jaeger, 2017), readxl (Wickham & Bryan, 2019), mice (van Buuren & Groothuis-Oudshoorn, 2011), mitools

(Lumley, 2019), ordinal (Christensen, 2019) and miceadds (Robitzsch & Grund, 2021). For more details on how the models are expressed, see the post-registration: https://osf.io/wdkxz/.

Results

Descriptive statistics for demographics, family conflict, relationship quality and ESM variables in Wave I and Wave COVID-19 are provided in Table 1.

Table 1

Descriptives of Wave I and Wave COVID-19 (N = 173)

	Variables	Wave I				Wave COVID-19			
		Available n	*M (SD)*	*Md*	*Range*	*Available n*	*M (SD)*	*Mdn*	Range
Demographics	Age (years)	173	14.2 (1.8)	14	11-18	173	16.0 (1.9)	16	13-20
	Sex, % Females	173	89			173	89		
	Number of completed beeps	110	32.3 (13.7)	33	0-59	110	27.5 (16.2)	27	1-59
ESM	Irritability	168	2.4 (1.9)	1	1-7	110	2.1 (1.6)	1	1-7
	Stress	168	2.5 (1.9)	2	1-7	110	2.5 (1.8)	2	1-7
	Loneliness	168	1.6 (1.3)	1	1-7	110	1.8 (1.4)	1	1-7
Family conflict	Parental								
	Experience, % Yes					171	36.8		
	Burden					63	3.3 (1.1)	3	1-5
	Parent-child								
	Experience, % Yes					171	61.4		
	Burden					105	3.2 (0.9)	3	2-5
	Sibling								
	Experience, % Yes					171	57.9		
	Burden					99	3 (1.1)	3	1-5
Relationship	Paternal	147	6.8 (7.6)	7	-18-19				
	Maternal	145	9.9 (6.5)	12	-14-18				

Relationship quality and irritability, stress and loneliness

Results for irritability, stress and loneliness in daily life in Wave I compared to Wave COVID-19 are presented in Table 2. Analyses revealed a significant decrease in daily-life irritability scores and a significant increase in daily-life loneliness scores from Wave I to Wave COVID-19. Results showed no significant change in daily-life stress scores from Wave I to Wave COVID-19.

Associations between parent-child relationship quality and the levels of irritability, stress and loneliness are presented in Table 3. Results showed that paternal relationship quality was significantly associated with irritability at Wave I and Wave COVID-19; lower paternal relationship quality was linked to higher daily-life irritability. In addition, results showed that both paternal and maternal relationship quality was significantly associated with loneliness at Wave I; lower paternal and maternal relationship quality was linked to higher daily-life loneliness.

Changes in irritability, stress, and loneliness from Wave I to Wave COVID-19 as a function of paternal and maternal relationship quality are presented in Table 4. The interaction effect of timepoint with paternal and maternal relationship quality was significant for loneliness; the increase in loneliness scores from Wave I to Wave COVID-19 was greatest when paternal and maternal relationship quality was low. Figure 1-3 visualizes all associations between relationship quality (paternal and maternal) and irritability, stress and loneliness.

Figure 1

Changes in Daily-life Irritability from Wave I to Wave COVID-19 with Relationship Quality as a moderator

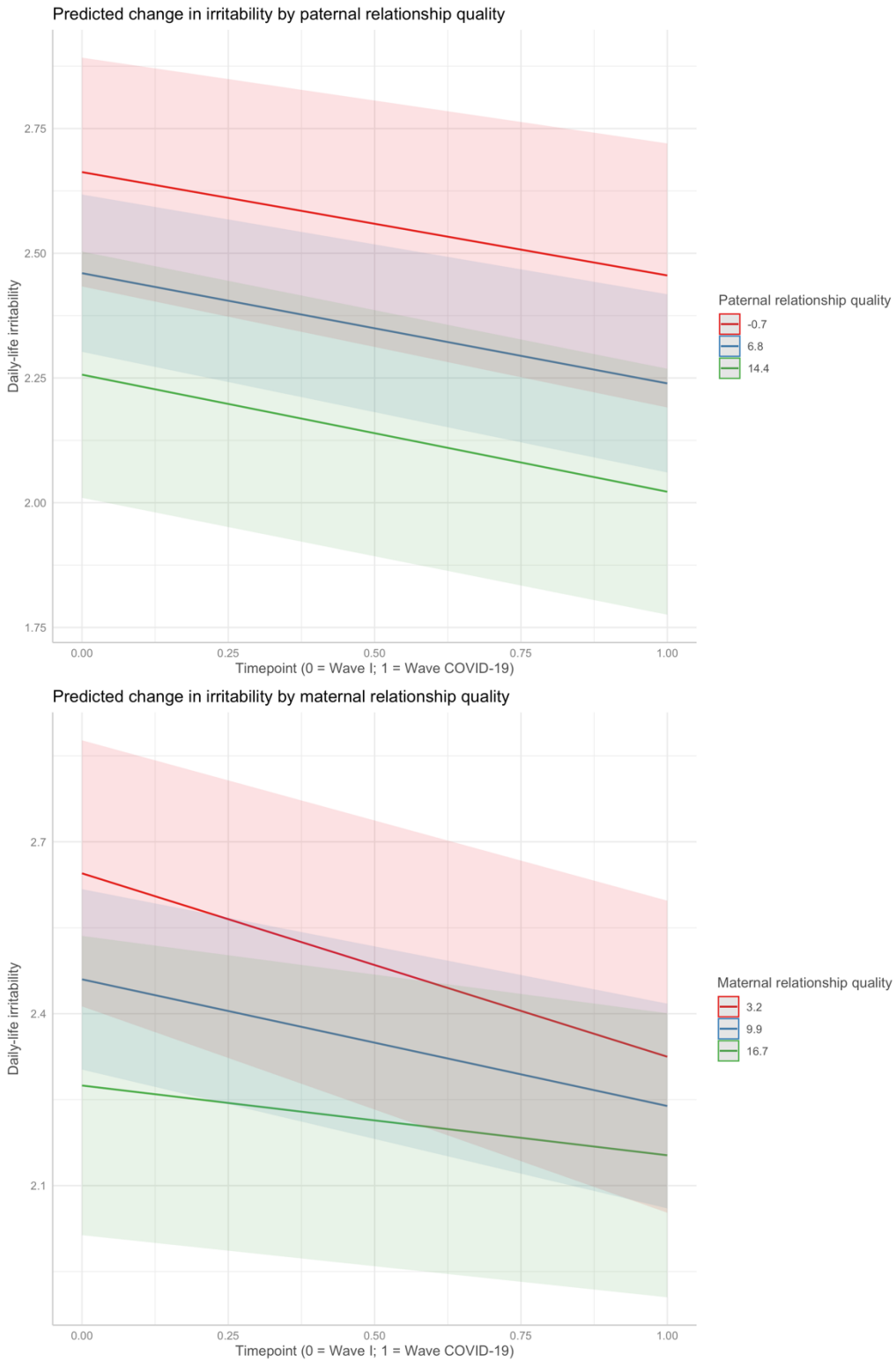


Figure 2

Changes in Daily-life Stress from Wave I to Wave COVID-19 with Relationship Quality as a moderator

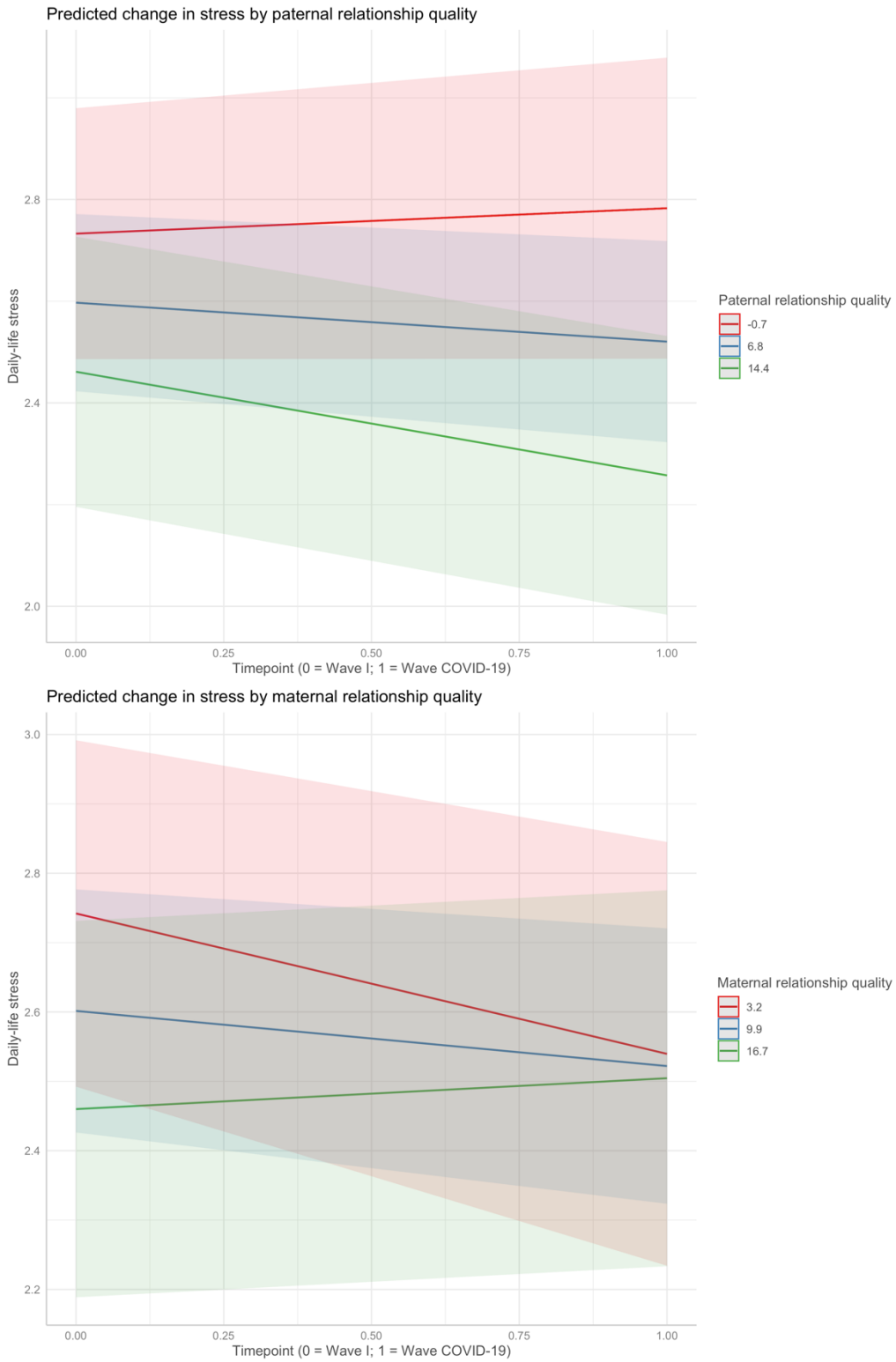
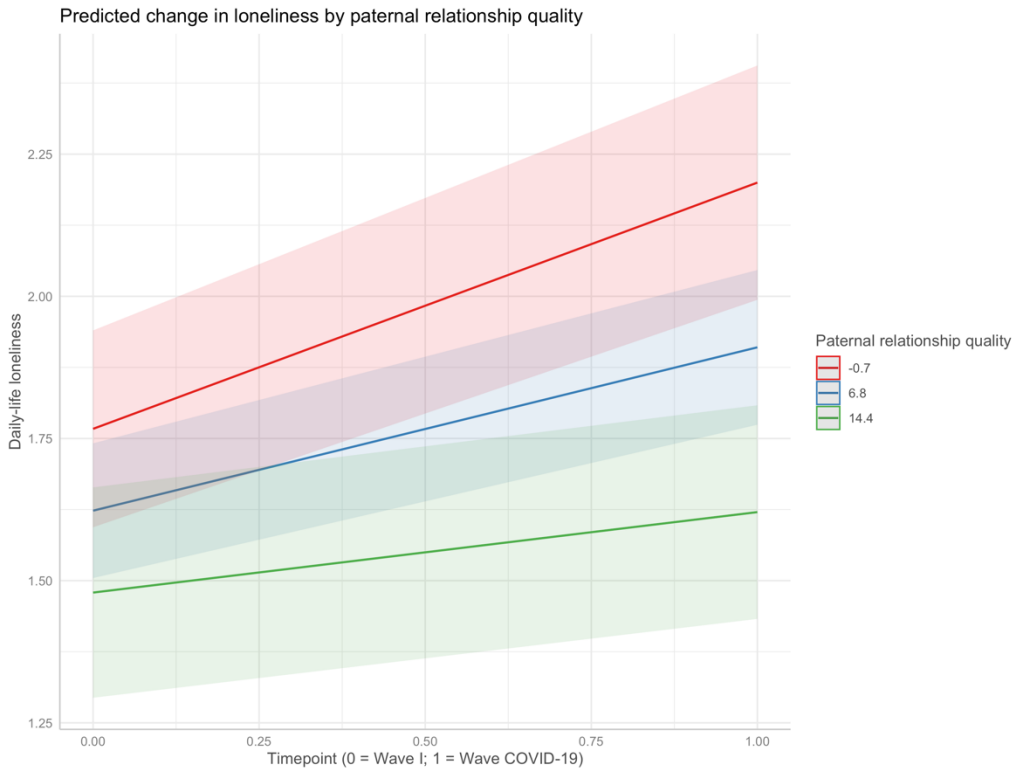
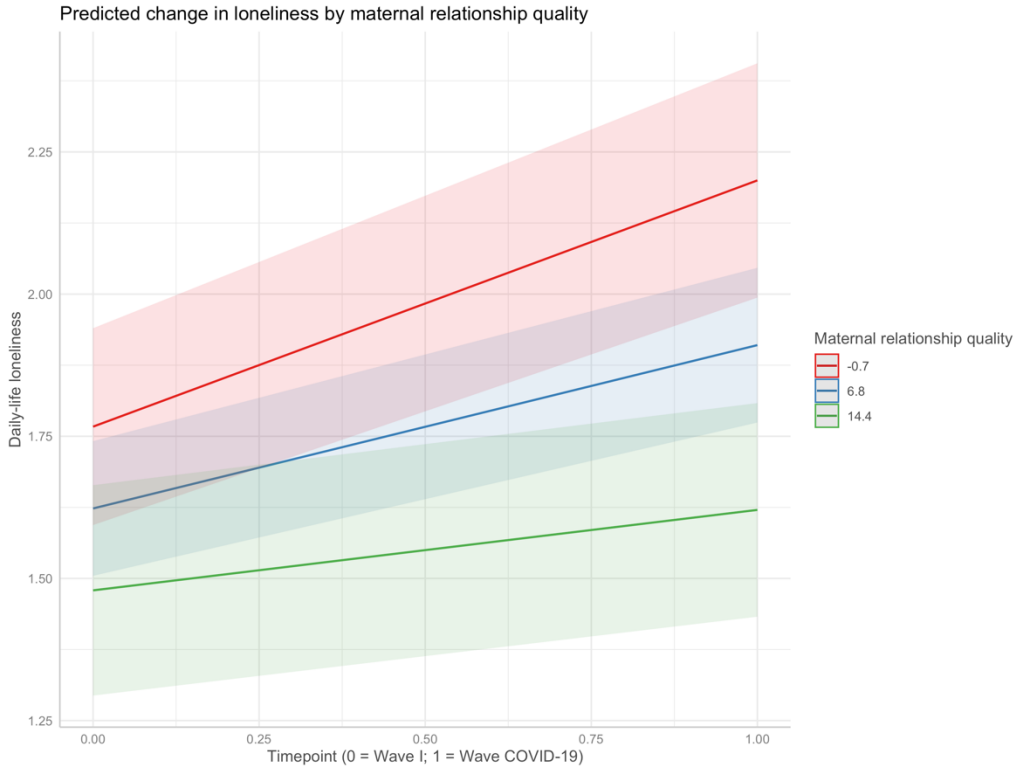


Figure 3

Changes in Daily-life Loneliness from Wave I to Wave COVID-19 with Relationship Quality as a moderator





Relationship quality and family conflict

Associations between paternal/maternal relationship quality and the experience and burden of family conflict are provided in Table 5. The analyses showed that the associations between paternal/maternal relationship quality and the experience of family conflict were not significant. However, results showed significant associations between relationship quality and the extent to which family conflict was experienced as a burden; lower paternal relationship quality was associated with experiencing parental and sibling conflict as more of a burden and lower maternal relationship quality was associated with adolescents experiencing parent-child conflict as more of a burden.

Table 2

Standard linear mixed model, predicting the change in irritability, stress and loneliness from Wave I to Wave COVID-19

	Timepoint			Age		Sex		Correlation
	β(SE)	R^2	*p*	*β (SE)*	*p*	*β (SE)*	*p*	*r*
Irritability	**-0.31(0.08)**	**.01**	**<.001**	**0.08(0.04)**	**.03**	0.24(0.24)	.31	0.62
Stress	-0.16(0.09)	.001	.07	**0.17(0.04)**	**<.001**	**0.68(0.26)**	**.008**	0.57
Loneliness	**0.19(0.07)**	**.004**	**.003**	0.05(0.03)	.10	0.16(0.18)	.38	0.40

Note: P-values < .05 are displayed in bold; R^2 = partial R^2; Correlations reflect between pre- and during-pandemic levels of irritability, stress and loneliness

Table 3

Standard linear mixed model, predicting levels of irritability, stress and loneliness at Wave I and Wave COVID-19 from low paternal/maternal relationship quality (RQ)

		Low paternal RQ			Low maternal RQ			Age		Sex	
		β (SE)	R^2	*p*	*β (SE)*	R^2	*p*	*β (SE)*	*p*	*β (SE)*	*p*
Wave I	Irritability	**-0.03(0.01)**	**.01**	**.04**	-0.02(0.02)	.003	.25	**0.09(0.05)**	**.08**	0.24(0.26)	.35
	Stress	-0.02(0.01)	.002	.10	-0.02(0.02)	.003	.27	**0.13(0.05)**	**.01**	**0.72(0.26)**	**.01**
	Loneliness	**-0.02(0.01)**	**.01**	**.03**	**-0.02(0.01)**	**.01**	**.05**	0.06(0.03)	.07	0.18(0.17)	.29
Wave COVID-19	Irritability	**-0.03(0.02)**	**.02**	**.03**	-0.01(0.02)	.003	.44	-0.03(0.06)	.66	0.08(0.38)	.83
	Stress	-0.03(0.02)	.02	.09	-0.02(0.02)	.01	.26	0.07(0.07)	.36	0.59(0.47)	.22
	Loneliness	-0.02(0.02)	.01	.25	-0.03(0.02)	.02	.07	-0.01(0.06)	.89	0.07(0.42)	.87

Note: P-values < .05 are displayed in bold; R^2 = partial R^2; parameter estimates were pooled using the Rubin's rule (Heymans & Eekhout, 2019).

Table 4

Standard linear mixed model, predicting the change in levels of irritability, stress and loneliness from Wave I to Wave COVID-19 with low paternal and maternal relationship quality (RQ) as moderators

	Timepoint			Low paternal RQ			Low maternal RQ			Timepoint x Low			Timepoint x Low			Age		Sex	
	β (SE)	R^2	*p*	*β (SE)*	R^2	*p*	*β (SE)*	R^2	*p*	*β (SE)*	R^2	*p*	*β (SE)*	R^2	*p*	*β (SE)*	*p*	*β (SE)*	*p*
Irritability	**-0.34(0.13)**	**.000**	**.01**	**-0.03(0.01)**	**.01**	**.01**	0.03(0.01)	.004	.07	-0.001(0.01)	.000	.88	0.01(0.01)	.000	.19	0.03(0.04)	.43	0.22(0.23)	.33
Stress	-0.13(0.24)	.000	.54	-0.02(0.01)	.001	.13	-0.02(0.02)	.004	.16	-0.02(0.01)	.01	.08	0.02(0.01)	.001	.08	**0.12(0.04)**	**.01**	**0.66(0.25)**	**.01**
Loneliness	**0.21(0.11)**	**.001**	**.05**	**-0.02(0.01)**	**.01**	**.04**	**-0.03(0.01)**	**.01**	**.01**	**-0.02(0.01)**	**.002**	**.01**	**-0.02(0.01)**	**.003**	**.003**	-0.003(0.03)	.92	0.14(0.17)	.42

Note: P-values < .05 are displayed in bold; R^2 = partial R^2; parameter estimates were pooled using the Rubin's rule (Heymans & Eekhout, 2019).

Table 5

Binary and ordinal logistic regression model, predicting family conflict and its perceived burden from low paternal and maternal relationship quality (RQ; n = 151)

		Low paternal RQ		Low maternal RQ		Age		Sex	
		β (SE)	*p*	*β (SE)*	*p*	*β (SE)*	*p*	*β (SE)*	*p*
Parental conflict	Experience[a]	-0.02(0.03)	.46	-0.04(0.03)	.19	-0.04(0.09)	.67	0.19(0.53)	.72
	Burden[b]	**-0.07(0.04)**	**.04**	0.01(0.04)	.89	-0.13(0.15)	.40	1.10(0.78)	.17
Parent-child conflict	Experience[a]	-0.00(0.03)	.94	-0.01(0.03)	.85	-0.08(0.09)	.40	0.54(0.50)	.29
	Burden[b]	-0.05(0.03)	.11	**-0.07(0.03)**	**.03**	0.13(0.11)	.22	0.90(0.65)	.17
Sibling conflict	Experience[a]	0.03(0.02)	.19	-0.03(0.03)	.28	-0.09(0.09)	.33	0.69(0.51)	.18
	Burden[b]	**-0.11(0.03)**	**.00**	0.02(0.04)	.53	0.02(0.11)	.88	-0.02(0.73)	.98

Note: P-values < .05 are displayed in bold.

[a]Logistic regression; [b]Ordinal logistic regression

Discussion

In line with the hypotheses, the current study found an increase in daily-life loneliness from before to during COVID-19. However, the results showed no change in daily-life stress scores and a decrease in daily-life irritability scores from before to during COVID-19. In addition, we found that low paternal relationship quality was associated with irritability scores in daily life during Wave I and Wave COVID-19. Both low paternal and maternal relationship quality was associated with loneliness scores during Wave I. Results confirmed the expected buffering effect of paternal and maternal relationship quality for loneliness. Nevertheless, whilst associations between relationship quality and these outcomes were statistically significant, the amount of variance explained by relationship quality was small. Given the small effect sizes, not all of our models had sufficient power to reliably detect these effects. Therefore, results should be interpreted with caution and require replication in more highly-powered studies. Regarding the expected associations of father and mother relationship quality with experiences of COVID-19-related family conflict and its perceived burden, our results showed that low paternal relationship quality was positively associated with experiencing parental and sibling conflict as a burden, whilst low maternal relationship quality was positively associated with experiencing parent-child conflict as a burden.

Irritability, stress and loneliness

The finding that adolescents reported feeling lonelier during the COVID-19 pandemic, in comparison with before the pandemic, is in line with emerging literature and suggests that adolescents are vulnerable to the detrimental effects of the COVID-19 pandemic and its associated physical distancing measures (Brooks et al., 2020; Gunnell et al., 2020; Nelson et al., 2020; Van Bavel et al., 2020). However, the effect size for the increase in loneliness was small. Coupled with our results showing no significant increase in stress and decreased irritability during COVID-19 relative to before the pandemic, this may suggest that increases in psychological distress during the early phase of the pandemic were minimal and specific. Whilst this may bring some relief, we must be careful not

to be complacent - our results only reflect the situation in the early phase of the pandemic and the small observed increase in loneliness may have grown as the pandemic progressed. Previous research in adolescents showed that loneliness is associated with negative mental health outcomes months or even years in the future (Hawkley & Cacioppo, 2010; McClelland et al., 2020) and as many of the pandemic's potential negative consequences are anticipated to follow later, after the initial acute phase of the pandemic (Brooks et al., 2020; Gunnell et al., 2020), continued monitoring of loneliness and other indicators of psychological distress is essential.

The lack of an increase in stress and the decrease in irritability is consistent with Achterhof and colleagues' (2021b) findings that indicate a decrease in anxiety symptoms in adolescents from Wave I to Wave COVID-19, within the same sample used in the current study. This may indicate a "positive" side-effect of the national lockdown, as this eliminated two well-known triggers for stress and irritability in adolescents, i.e. school and social contact. For example, adolescent studies show that the pressure of high demands at school - much more than those at home - is a major source of stress in their lives (Modin, 2011; Wiklund et al., 2012). Another study showed that adolescents' irritability is mainly triggered in a social environment (Toohey & DiGiuseppe, 2017). Consequently, whilst some aspects of the pandemic might have increased stress (i.e. worrying about their own and others' safety, as well as their education), others might have decreased stress (i.e. not being at school and reduced social interaction), resulting in stress scores remaining stable between Wave I and Wave COVID-19. Additionally, this finding, along with the increase in loneliness and decrease in irritability highlights the complexity of social interactions and experiences during adolescence. During this age period, social contact is indispensable, but at the same time these interactions are accompanied by stress and irritability in growing adolescents (Steinberg & Morris, 2001). Consequently, lockdown measures could increase loneliness in adolescents because their social needs are not being met, but on the other hand, may bring some relief due to reducing the stress and irritability that come with school and social interaction.

However, this should not be interpreted as indicating that closing schools and limiting social contact benefits adolescents by eliminating stress. In fact, both "stressors" are important for adolescents' development and the stress they elicit is adaptive for the development of social and stress-regulating skills (Andrews et al., 2020; Steinberg & Morris, 2001). The timing of our study should also be considered when interpreting the results; it took place during the first national lockdown and at the time, there was the prospect of relaxation in the restrictions. Whilst adolescents who were feeling more stressed and irritable may have felt unable to participate in the COVID-19 wave of this study, our results suggest this was not the case. Adolescents from the COVID-19 sample did not significantly differ in terms of irritability and loneliness from adolescents in the full Wave 1 sample who did not take part in the COVID-19 study - they even felt less stressed at Wave I in comparison to adolescents who did not participate in the COVID-19 wave. See the OSF project page for the study for these supplementary analyses: https://osf.io/wdkxz/. Although another study found that adolescents in the COVID-19 sample scored significantly higher on psychopathology at Wave 1 compared to participants who did not take part in the COVID-19 study, once age and sex were taken into account, this was no longer the case (Achterhof et al., 2021b).

Relationship quality and irritability, stress and loneliness

Our finding that adolescents with a lower-quality relationship with their father reported higher levels of irritability in daily life during Wave I and Wave COVID-19, converges with findings from previous cross-sectional literature (Brumariu & Kerns, 2010; Shpigel et al., 2012). Given that irritability may be a pre-cursor symptom of developing mental health problems (Brotman et al., 2017; Stringaris et al., 2018), these findings may point towards low paternal relationship quality as a vulnerability factor for psychopathology, as it may increase feelings of irritability in adolescent daily life. However, we found no significant association between maternal relationship quality and irritability.

We also found that adolescents with a lower quality relationship with their father or mother, reported higher levels of loneliness during Wave I, which is consistent with previous research that suggests a negative effect of low parental relationship quality on loneliness in middle and late childhood (de Minzi, 2006). Conversely, the perception of acceptance from both parents, as well as trust in their love protects children against loneliness (de Minzi et al., 2006).

In addition, our findings suggest a small buffering effect of high paternal and maternal relationship quality for the increase in loneliness scores from Wave I to Wave COVID-19. This indicates that adolescents with higher quality paternal and maternal relationships were slightly more protected against an increase in loneliness during the first national lockdown in comparison to adolescents with a lower paternal and maternal relationship quality.

These findings may add to a growing body of literature on the association between relationship quality and emotional experiences in everyday life (Sheinbaum et al., 2015; Torquati & Raffaelli, 2004) and on the buffering effect of high-quality relationships on the mental well-being of adolescents (Bowlby, 1973; Shpigel et al., 2012). This increases insights into the vulnerability and protective factors for pre-diagnostic precursors of actual psychopathology, i.e. loneliness. Moreover, these results seem to support the importance of a high-quality relationship with parents to help adolescents weather personal adversity.

Relationship quality and family conflict

Results within this sample show no significant associations between parental relationship quality and the experience of COVID-19-related family conflict. However, the amount of reported family conflict appeared high in this sample: 36.8% of adolescents reported parental, 61.4% parent-child and 57.9% sibling COVID-19-related conflict. Therefore, it is possible that the pandemic has increased the conflict in all families irrespective of relationship quality. Unfortunately, as there was no measure of family conflict at Wave 1, we could not investigate whether family conflict had increased

from pre- to mid-pandemic. This hypothesis should be addressed in future studies with family conflict data across multiple time points.

On the other hand, results showed significant associations between parental relationship quality and the burden of COVID-19-related family conflict. Low paternal relationship quality was associated with greater experienced burden of parental (between-parents) and sibling conflict, whilst low maternal relationship quality was associated with higher burden of parent-child conflict. These findings converge with recent research on parenting and the experience of social interactions in the SIGMA Wave I sample (N = 1913) that showed that paternal autonomy support, which is related to higher paternal relationship quality, was linked to the experience of non-parent social interactions, i.e. interactions with individuals other than their parents (Achterhof et al., 2021b). Additionally, maternal responsiveness, a parenting style that increases maternal relationship quality, was related to adolescents' experiences of interacting with their parents. As a consequence, our findings fall in line with this as also in the present study the paternal relationship is associated with the experience (i.e. the burden) of non-parent interactions, namely sibling and between-parent interactions (i.e. conflict), whilst the maternal relationship is associated with parent-child interactions (i.e. conflict). Our findings may be explained by the distinct but complementary caregiving roles that fathers and mothers often adopt (Kerns et al., 2015), which may influence different domains - and interactions - of adolescents' life (Palm, 2014). Whereas mothers generally function as a safe haven (i.e. listens, comforts and shows availability) that the child seeks in times of need, fathers are generally experienced as a play mate that functions as a secure base (i.e. sets boundaries, gives trust and supports autonomy) from which the child explores the world and engages in social relationships and interactions outside the parent-child relationship. These findings support the importance of both paternal and maternal relationship quality for the extent to which family conflict is experienced as burdensome (Shpigel et al., 2012; Hannum & Dvorak, 2004). This highlights the relevance of improving both the quality of the paternal and maternal relationship (i.e. holistic family approaches) when family conflict occurs and is experienced as burdensome in adolescents.

Strengths and limitations

The current study has several strengths. First, the data used within this study originates from an ongoing longitudinal cohort study with unique data from a subgroup of adolescents from before and during the COVID-19 pandemic, which enables the delineation of pre-existing (i.e. pre-pandemic) vulnerabilities for irritability, stress, loneliness and family conflict during COVID-19. Second, using ESM to assess daily life levels of irritability, stress and loneliness in adolescents increases ecological validity and reduces recall bias. We did not assess family conflict in daily life, primarily in order to minimise participant burden due to an already long ESM questionnaire. Whilst momentary assessments of family conflict may have yielded different results, research by Chung et al (2009) suggests that episodes of family conflict are rather rare events in adolescents' daily life, and may not be best captured by momentary assessments. Third, the study was post-registered, a form of pre-registration occurring after data collection (Benning et al., 2019). All research questions, hypotheses and analysis plans were determined and documented prior to data access, reducing the chances of data-dependent decision making and as such, researcher degrees of freedom. Additionally, all analysis code has been made available on the Open Science Framework, further increasing the transparency of this research. Given that routine use of open science practices in clinical psychology and developmental psychology is still the exception rather than the rule (e.g. Tackett et al., 2019), we feel the open science approaches used in the current study are a major strength.

Although the current study has several strengths, the findings should be interpreted within the context of its limitations. First, parent-child relationship quality was only assessed during Wave I and not during Wave COVID-19. Although, traditionally, parent-child relationship quality is hypothesized to be a stable characteristic in children (Bowlby, 1973), more recent research on this topic challenges the stability of relationship quality (Davila & Sargent, 2003). This raises the possibility that parent-child relationship quality may have changed between Wave I and Wave COVID-19. Therefore, it might be fruitful to assess the dynamic nature of the relationship quality over both the

long term (using longitudinal studies) and the short term (using Experience Sampling or daily diaries). Additionally, the analyses involving relationship quality were somewhat underpowered, due to a moderate level of missing data for this variable at Wave I.

Second, family conflict was measured by asking participants about the presence or absence of family conflict in relation to the COVID-19 pandemic. As a result, participants may have interpreted the question differently and assumed that questions were about conflicts about or directly related to the pandemic. This narrows our measurement of family conflict and therefore, the level of family conflict reported may be an underestimation. Also, the items used to assess family conflict were only included in Wave COVID-19, precluding comparison with family conflict in Wave 1. Further, the family conflict items were taken from a larger scale assessing COVID-related stressors and internal consistency for these items was low. Future research would benefit from employing well-validated measures of family conflict, which assess the construct more fully.

Third, although it is common in ESM research to use single items to minimize participant burden (Wright & Zimmerman, 2019), irritability, stress, and loneliness may be better captured with multiple items. Optimal items and combinations of items for assessing these constructs should be substantively investigated in future research. Fourth, the ESM compliance rates were lower in both studies (39.5% in Wave I with N = 1913 and 43.6% in Wave COVID-19, with N = 110) than would be expected from previous ESM studies conducted with adults, in both general and clinical samples (Rintala et al., 2019). There may be several reasons for this, including the short time in which ESM questionnaires were available to participants (questionnaires had to be started within 90 seconds of the notification). The length of the questionnaire may also have played a role, as recent research by Eisele et al. (2020) in young adults demonstrated that questionnaire length negatively impacts compliance. Moreover, participants were also asked to complete ESM during school hours, and even though schools agreed to this, there may still have been barriers to completion of ESM questionnaires during lessons. We also did not incentivize compliance which may result in lower ESM compliance

rates, but – in comparison to other ESM studies – we believe it enhanced our data quality. Last, non-significant results should be interpreted within the context of the effect sizes, as some hypotheses were not sufficiently powered to detect small effects while these may have been detected in a larger sample.

Future research

Given that the current study is limited only to the period of the first national lockdown and the COVID-19 pandemic appears to be not only invasive but also long-lasting, understanding how this crisis affects adolescents' mental health and family relationships over time is important. Further insights into the impact of COVID-19 on adolescents' daily life outcomes and family conflict, and the specific roles of father and mother relationship quality, require well-powered, longitudinal studies, with multimethod approaches, to investigate whether adolescent and family well-being worsens or recovers from this global crisis. For example, large ongoing cohort studies of youth mental health, e.g. SIGMA (Kirtley et al., 2021). ALSPAC (2001; Kwong et al., 2021) and ABCD (Karcher & Barch, 2021) can provide opportunities to look at the evolution of psychosocial distress over time.

Implications

Findings from the current study can provide researchers, clinicians, parents, adolescents and policy makers with insights into the impact of the COVID-19 pandemic and its measures on adolescents' daily-life experiences and their families during the first national lockdown. Even though during this first lockdown, adolescents were not as affected as we would have expected, we caution against complacence regarding young people's mental health and well-being, given that the most deleterious effects of the pandemic may only emerge much later (Brooks et al., 2020; Gunnell et al., 2020). Our findings indicated a small but statistically significant contribution of both paternal and maternal relationship quality to adolescents' daily-life experiences, and we emphasize the need for holistic family therapy approaches – including both fathers and mothers – to improve relationship

quality in adolescents facing adversity. Before these findings are translated into practice, further replication is essential.

Conclusions

The current study provides small, but positive support for the prediction of an increase in daily-life levels of loneliness from before to during COVID-19 and for the role of both paternal and maternal relationship quality as a moderator in this relationship. In addition, the current study provides no evidence for change in daily-life stress, and finds a decrease in daily-life irritability from before to during COVID-19. Also, an association between paternal relationship quality and irritability is demonstrated as well as an association between both paternal and maternal relationship quality and daily-life loneliness. No significant associations were found between parental relationship quality and the frequency of family conflict, however findings from the study do provide evidence for a link between both paternal and maternal relationship quality and how burdensome family conflict was experienced. The findings of this study may suggest that the impact of the pandemic on the daily lives of adolescents during the first national lockdown is not as bleak as what was expected. However, continued monitoring of young people's well-being and mental health is still warranted, as our results only reflect the situation during the early phase of the pandemic, which may have changed as the pandemic progressed. Future research on the link between relationship quality and adolescent' daily life experiences and family conflict in large cohort studies is needed to see how this evolves as the pandemic progresses.

Chapter 6: The role of parent-child attachment in the association between loneliness and self-harm thoughts and behaviours in daily life

Article submitted and under revision

Available as a preprint online:

Janssens, J. J., Lafit, G., Simsa, B., Bosmans, G., Achterhof, R., Hagemann, N., Myin-Germeys, I., & Kirtley, O. J. (2023). The role of parent-child attachment in the association between loneliness and self-harm thoughts and behaviours in daily life. https://osf.io/preprints/psyarxiv/xgfsk

Supplementary materials for chapter are available online: https://osf.io/yqxp7/

Abstract

Adolescence is a critical period for self-harm thoughts and behaviours (SHTBs) and loneliness is an important risk factor. However, no research has investigated how loneliness is associated with adolescent SHTBs in real time and whether this association is influenced by parent-child attachment relationships, which correlate with both loneliness and SHTBs. We used Experience Sampling Methodology (ESM) and self-report questionnaires to examine the role of loneliness and parent-child attachment in SHTBs in a general population adolescent sample (*N*=1602). Multilevel analyses provide evidence for loneliness as a short-term risk factor for self-harm thoughts, and the emotion regulation function of self-harm behaviours (i.e., downregulation of loneliness). The relationship between loneliness and SHTBs was stronger for those with a more insecure paternal and maternal attachment relationships. These results illuminate *when* (i.e., moments of loneliness) and *why* (i.e., loneliness downregulation) adolescents think about and engage in self-harm, offering critical guidance to clinicians and researchers.

Introduction

Self-harm refers to both non-suicidal and suicidal self-injurious behaviours, including self-poisoning (NICE, 2023), and is a leading cause of death and injury worldwide (WHO, 2022). These behaviours are strongly related (Klonsky, 2011; Poudel et al., 2022) and highly dynamic, meaning the underlying intent or method can vary greatly over time within individuals. Indeed, the same individual may engage in non-suicidal self-harm but change intention or switch to other methods over time (Andover et al., 2012; Kapur et al., 2013; Lilley et al., 2008). Adolescence is a critical period for the onset of self-harm thoughts and behaviours (SHTBs), with lifetime prevalence rates of up to 18% (Fox et al., 2015; Lim et al., 2019; Swannell et al., 2014) and a peak around the age of 14-15 (Gandhi et al., 2018). Moreover, self-harm is often repeated among adolescents, and it is strongly associated with completed suicide (Kiekens et al., 2018; Liu et al., 2022). However, knowledge about *when* adolescents are most at risk for engaging in self-harm and *how* this risk may be reduced is lacking. Consequently, investigating short-term risk and protective factors is crucial to advance prevention and intervention opportunities for self-harm in adolescents (Kiekens et al., 2021).

Loneliness — the 'deficiency of a person's network of social relations in some important way, either quantitatively or qualitatively' (Perlman & Peplau, 1981, p. 31) — has emerged as a crucial factor related to self-harm risk (Calati et al., 2019; Gandhi et al., 2018; McClelland et al., 2020). Within the suicide literature, loneliness is subsumed under the key concept of thwarted belongingness, which refers to the fundamental unmet "need to belong" (Baumeister & Leary, 1995, p.1; Van Orden et al., 2010). Thwarted belongingness is a central tenet of the Interpersonal Psychological Theory of suicide (IPT; Joiner, 2005; Van Orden et al., 2010), and also features within the Integrated Motivational-Volitional model (IMV; O'Connor, 2011; O'Connor & Kirtley, 2018) as a risk factor implicated in the emergence of self-harm thoughts. Thwarted belongingness differs from loneliness as it also comprises the absence of reciprocal caring relationships (Ma et al., 2019). However, loneliness has been used as an index of thwarted belongingness in previous literature

(Coppersmith et al., 2019; Janssens et al., 2024, preprint). Individuals with a history of self-harm thoughts or behaviours experience loneliness more intensely than those without (McClelland et al., 2021), and loneliness is prospectively associated with suicidal ideation (McClelland et al., 2020).

Loneliness may play a particularly important role in adolescents' risk for self-harm due to the profound relational shifts that normatively occur during this developmental period (Sawyer et al., 2018). Specifically, adolescence is characterized by crucial changes in social relationships, including an increase in peer orientation and a shift in the need for physical proximity to parents to a need for their emotional availability (Bosmans & Kerns, 2015). These transitions increase the risk of relationship needs being unmet (Achterhof et al., 2022; Bamps et al., 2022), which results in the experience of loneliness (Lasgaard et al., 2011). In fact, about 80% of adolescents experience loneliness at least sometimes (Hawkley & Cacioppo, 2010). These feelings of loneliness may hinder reliance on adaptive strategies (e.g., seeking support from others) to deal with intense stress during adolescence, thereby increasing the risk for self-harm. Thus, adolescence is a critical period for both loneliness and self-harm (Lasgaard et al., 2011). Accordingly, prior research revealed that adolescents who report SHTBs experience significantly more loneliness (Gandhi et al., 2018; Lasgaard et al., 2011).

To date, studies have mainly examined associations between loneliness and self-harm with traditional retrospective assessment methods that are subject to recall bias and unable to unravel *when* an individual is at increased risk for self-harm (McClelland et al., 2020). A promising methodological approach that is uniquely suited to answer this *when*-question, by enabling us to capture fluctuations in loneliness and self-harm within individuals over time, is Experience Sampling Methodology (ESM). This assessment technique requires individuals to complete brief smartphone questionnaires during their everyday life, multiple times a day for several days (Csikszentmihalyi & Larson, 1987; Myin-Germeys et al., 2018; Myin-Germeys & Kuppens, 2022), thereby reducing issues such as recall bias and low ecological validity. Despite the suitability of this method for investigating

loneliness and self-harm, only three ESM studies in (emerging) adults have investigated the short-term association between loneliness, or loneliness used as index of thwarted belongingness (Coppersmith et al., 2019), and self-harm thoughts. For an overview of the current ESM literature on interpersonal processes, e.g., loneliness, and self-harm, see Janssens et al. (2024, preprint). Whilst two studies found evidence for a concurrent association (Coppersmith et al., 2019; Kleiman et al., 2017), one study found a prospective association (Mou et al., 2018). That is, individuals who felt more lonely, were at increased risk for suicidal ideation in the following hours (Mou et al., 2018). However, this within-person association has not yet been examined with great temporal precision (i.e., how loneliness is related to self-harm risk over minutes/hours) in adolescents. Consequently, we lack vital knowledge about the temporal associations between loneliness and SHTBs that could be used to inform effective in-the-moment interventions for SHTBs, e.g., just-in-time adaptive interventions.

Understanding *who* is most vulnerable to this risk process and which factors can modify and reduce the risk of self-harm is a necessary next step to optimize prevention and treatment. One key factor that could act as a potential protective, and modifiable, factor that has been previously related to SHTBs (Gandhi et al., 2016; Janssens et al., 2022; Koenig et al., 2021; Lewis et al., 2022) and loneliness (Janssens et al., 2021; Torquati & Raffaelli et al., 2004) in daily life is: the quality of the parent-child attachment relationship. Indeed, studies have provided evidence for the protective effect of attachment on self-harm (Gandhi et al., 2016; Glazebrook et al., 2016; Koenig et al., 2021; Santangelo et al., 2017; Santens et al., 2018; Zortea et al., 2021). However, findings are conflicting and studies have not yet investigated to what extent parent-child attachment relationships can modify or reduce the negative effect of loneliness on self-harm (Bulat, 2024).

According to Attachment Theory, parent-child attachment relationship quality is key to children and adolescents' mental health (Bowlby, 1973; Mikulincer & Shaver, 2012). Bowlby (1969/1973) suggested that the parent-child attachment bond is shaped by the experiences children

have with their parent as available, responsive, and attuned to their physical and emotional needs. Children internalize these experiences, which then determine the degree of trust they have as adolescents in the availability of care and support from others. This guides their future interpersonal behaviour when intense negative emotions are experienced, e.g., seeking support and finding connection when experiencing loneliness (Cassidy, 2016; Hawkley & Cacioppo, 2010). Accordingly, it is suggested that adolescents with low-quality parent-child attachment relationships lack trust in care and support from others, experience higher levels of loneliness (Cavanaugh & Buehler, 2016; Yan et al., 2018), and are insufficiently able to adaptively cope with adverse feelings of loneliness, resulting in (thoughts of) self-harm (Brumariu & Kerns, 2010). Therefore, an ESM study that investigates within-person, temporal associations between loneliness and SHTBs, and how attachment moderates these moment-to-moment associations, in adolescents' daily life is timely and significantly advances our understanding of the microprocess at play during self-harm. This could enable identification of loneliness as a short-term risk factor for self-harm (i.e., *when* adolescents are at increased at risk) and refine our understanding of *how* this risk may be reduced (i.e., via high-quality attachment bonds).

Finally, ESM allows us to further explore the most frequently reported emotional regulation function of self-harm, i.e., immediate emotional relief (Kleindienst et al., 2008). According to the functional model of self-harm (Nock & Prinstein, 2004; Nock, 2009), self-harm behaviour is reinforced when the behaviour produces desired outcomes, e.g., a decrease in feelings of loneliness. Indeed, while feelings of loneliness will carry over from one moment to the next (i.e., emotional inertia; Kuppens et al., 2010), self-harm behaviour may influence this transfer by promoting a decrease in loneliness. Previous studies have provided empirical support for the functional model of self-harm (Izadi-Mazidi et al., 2019; Rasmussen et al., 2016), including that adolescents reported reduced feelings of loneliness both during and after self-harm behaviour (Laye-Gindhu & Schonert-Reichl, 2005). However, these studies are limited in their accuracy and reliability, as participants were reflecting on past behaviours, rather than reporting current behaviours.

Taken together, the current post-registered ESM study fills important gaps in our understanding of self-harm by providing answers to the following research questions:

(1) To what extent is loneliness associated with self-harm thoughts in the next minutes/hours at the within-person level? And do paternal and maternal attachment relationship quality moderate this association?
(2) To what extent are low levels of paternal and maternal attachment relationship quality associated with higher levels of loneliness at the between-person level?
(3) [Exploratory] To what extent is the change in loneliness from one timepoint (i.e., beep) to the next timepoint (i.e., next beep) moderated by self-harm behaviours within that same time interval at the within-person level (i.e., indicating an emotion regulation function of self-harm)? And do paternal and maternal attachment relationship quality moderate this association?

Regarding research question 1, we hypothesized that adolescents that report loneliness would be more likely to think about self-harm in the next 90-minute time interval (H1) and that adolescents that report higher levels of loneliness would be more likely to report higher levels (i.e., greater intensity) of self-harm thoughts in the next 90-minute time interval (H2). In addition, we hypothesized that the within-person association between loneliness and self-harm thoughts would be stronger in adolescents with lower-quality parent-child attachment relationships (H3). For research question 2, we predicted that adolescents who reported lower levels of paternal and maternal attachment relationship quality, would be more likely to report higher levels of loneliness in their daily lives (H4). Our hypotheses for research question 3 were that adolescents that engaged in self-harm behaviours within a 90-minute time interval would experience a stronger decrease in loneliness within that same time interval (i.e., “immediate relief effect”) (H5a). Further, we explored whether adolescents that engaged in self-harm behaviours within a 90-minute time interval experienced a stronger increase in loneliness within a subsequent 90-minute time interval (i.e., “prolonged effect”) (H5b). Finally, we hypothesized that these moment-to-moment associations

between loneliness and self-harm behaviours would be stronger in adolescents with lower-quality parent-child attachment relationships (H5c). For more details on decisions regarding whether an hypothesis was considered confirmatory or exploratory, see 'power analysis' section and our post-registration on the OSF page: https://osf.io/yqxp7/.

Transparency and Openness

Preregistration

After data collection, but before data were accessed, all hypotheses and detailed plans for analyses were post-registered (Benning et al., 2019) on the Open Science Framework (OSF) using the registration template for ESM research (Kirtley et al., 2021). To transparently report slight deviations to our post-registration, we created a transparent changes document at the OSF page of this study: https://osf.io/yqxp7/.

Data, materials, code, and online resources

All analytic code and materials are publicly available and can be accessed online on the OSF page of this study: https://osf.io/yqxp7/. Data are not publicly available, but are available upon application through a secure data checkout system operated by the Center for Contextual Psychiatry, Data cuRation for Open Science (DROPS): https://redcap.gbiomed.kuleuven.be/surveys/?s=WDYAFAHWK4. For a description of DROPS, see Kirtley, O. J. (2022).

Reporting

This study involved an analysis of existing data rather than new data collection. We report all data exclusions, manipulations and all measures in the study.

Ethical approval

This study was performed in line with the principles of the Declaration of Helsinki. The study received full ethical approval from the UZ/KU Leuven Medical Ethics Committee (S61395). Information that could identify subjects will not be published and informed consent was obtained.

Method

Participants and recruitment

For the current study, we used pre-existing data from the first wave of the SIGMA project (Kirtley et al., 2021), which was already used in two previous studies on attachment and self-harm (Janssens et al., 2022) and attachment and loneliness (Janssens et al., 2021). The SIGMA project is an ongoing, large-scale study investigating mental health in Flemish adolescents since 2018. During the first wave, 22 schools across Flanders (Belgium) were included, providing cross-sectional data from N=1913 adolescents that were recruited from the general population. To recruit potential participants and their caregivers, information letters were distributed via schools after the school board was informed and had agreed with participation. Participants were included if they were in their first (aged 12-13), third (aged 14-15) or fifth (aged 16-17) year of mainstream secondary education, had an adequate command of the Dutch language and had provided informed consent (from themselves and their caregivers). Of all adolescents included in the first wave, 63% of participants were female (n = 1207) and 55% (n = 1048), 22% (n = 424) and 23% (n = 441) were in their first, third and fifth year of mainstream secondary education, respectively. The age ranged from 11 to 20 (M = 13.76 years, SD = 1.86 years).

Of these N=1913 adolescents, we had to exclude 133 participants due to invalid (e.g., no data in the self-harm variable). This resulted in N=1780 participants that we were able to use for this study. To calculate power (see section ‘Power analysis’), we used a 10% (n = 178) subsample stratified

according to the number of participants in the full sample reporting current SHTBs, leaving us with the remaining data from N=1602 adolescents for the main analyses.

Procedure

Between January 2018 and June 2019, participants were informed about the study purposes and during an in-school testing sessions of 100 minutes, they completed a large battery of self-report questionnaires on a tablet provided by the research team, using the REDCap application (Harris et al., 2009). After participants were guided through an ESM demo questionnaire, they received a smartphone (Motorola Moto E4) and were instructed to complete 10 daily ESM questionnaires during six days via the Mobile Q application (Meers et al., 2020). Beeps were randomly distributed in window of 90 minutes (i.e., semi-random signal-contingent), but to reduce burden on school participation, participants received beeps all at the same "*random*" time. It took on average 162.8 seconds to complete one ESM questionnaire (39 to 46 items depending on branching).

The sampling design and density was selected based on their suitability to measure continuous variables, such as daily-life levels of loneliness. Participants were given 90 seconds to begin completing the survey and complete each item, but were not able to suspend or delay a response. Afterwards, participants were incentivized with a 10-euro gift voucher for on online or physical store. No feedback was provided on their compliance and various steps were taken to ensure participant safety and wellbeing. For example, the SIGMA team provided support information sheets to each participant with contact details to relevant help services (e.g., Zelfmoord1813). More details on the procedure for the SIGMA project are discussed by Kirtley et al. (2021).

Retrospective measures (non-ESM)

Attachment relationship quality

The Dutch translation of the Inventory for Parent and Peer Attachment (IPPA; Armsden & Greenberg, 1987; Noom et al., 1999) was included in the large battery of self-report questionnaires. Both paternal and maternal attachment relationship quality were assessed with 12 items (e.g., *My*

mother respects my feelings; *I feel angry with my mother*) from three subscales (*Trust*, *Alienation* and *Communication*), which resulted in two sum scores: one for paternal attachment relationship quality and one for maternal attachment relationship quality. Responses were given on the following scale: 'almost never', 'sometimes', 'often' and 'almost always'. Higher scores reflected greater attachment relationship quality. A previous study by Janssens et al. (2021) using the same dataset confirmed a two-factor structure (i.e., sum scores for father and mother separately) to be more appropriate than a one-factor structure (i.e. composite score for parental attachment relationship quality), using a confirmatory factor analysis. Paternal and maternal attachment relationship quality were moderately correlated (r = .42) and both scored high on internal consistency (Cronbach's α = 0.88 for paternal attachment and 0.90 for maternal attachment).

Age and gender

Two items were included in the self-report questionnaire battery to assess age and gender. Participants could indicate if they identified as male, female or other.

National background

To our knowledge, no standard race/ethnicity questions or response categories exist in Belgium — a common issue in European countries (Jugert et al., 2022) — therefore we asked participants about their level of identification with any non-Belgian country or people as a proxy of national background.

Daily-life measures (ESM)

Self-harm thoughts and behaviours

Two self-constructed items were included in the ESM questionnaire to assess current SHTBs. Both items were presented in a fixed order at each beep, varying across the 10 beeps per day. The first item, assessing current self-harm thoughts, was on a 7-point Likert scale (i.e., Since the last beep, have you thought about harming yourself?) from 1 = 'not at all' to 7 = 'very much'. If participants responded with a score higher than two, they were provided with the second item, assessing current

self-harm behaviours (i.e., Since the last beep, have you actually harmed yourself on purpose?) with the response options, yes or no.

Loneliness

One item was included in the ESM questionnaire to assess loneliness. This item was presented in a fixed order at each beep, varying across the 10 beeps per day, and on a 7-point Likert scale from 1 = 'not at all' to 7 = 'very much' (i.e., *I feel lonely*).

Company

One multiple-choice item was included in the ESM questionnaire, i.e. *who is with me?*. This item was presented in a fixed order at each beep, varying across the 10 beeps per day. Response options were: *core family*, *other family*, *friend(s)*, *other peers*, *teacher*, *other people* and *nobody.* A dummy variable that indicates whether they were in company with someone, yes ('1') or no ('0') was created and used for the analyses.

The full ESM questionnaire is available online in the ESM item repository (www.esmitemrepository.com, dataset 'sigma'; Kirtley, Hiekkaranta et al., 2020).

Missing data

ESM compliance was 41% across all participants included in the study. Participants with completely missing data in the age, gender or attachment relationship quality variables were excluded from the analyses. Attachment relationship quality data was imputed with a multiple imputation model by chained equations (MICE) when participants had not fully completed the 12 items assessing paternal and maternal attachment relationship quality. Age and gender were used as predictors and quality of this imputed dataset was checked with density plots. More details on handling missing data can be found on the OSF page of this study: https://osf.io/yqxp7/.

Data analyses

Power analysis

Because of the fixed sample sizes (i.e., data were pre-existing), we determined whether the sample sizes were large enough to detect the effect sizes we anticipate to calculate power (i.e., a sensitivity power analysis). We took a two-step Monte Carlo simulation approach (Lafit et al., 2021), as we found no indication of the distribution of the variables, i.e. loneliness and current SHTBs using an adolescent sample, within the existing literature. Because of a data check-out system (Kirtley, 2022; Kirtley et al., 2020) we have in place in our lab, we were able to request a 10% stratified subsample of the data and leave the remaining 90% unseen, which we then used for our main analyses. The subsample was stratified according to the proportion of participants that reported current SHTBs. The analyses are conducted in the subsample, resulting in model parameters and effect sizes that were used as input for running the analyses in 1000 Monte Carlo simulations. The proportion of Monte Carlo simulations where the effect size is different from zero (null hypothesis is rejected at $p < .05$) is the calculated power and we considered a power of ≥ 0.80 as sufficient.

For the first hypothesis on loneliness and presence/absence self-harm thoughts within the next 90-minute time interval (H1), the results show that the binary logistic mixed-effects model was underpowered (.71). Therefore, we consider this hypothesis as exploratory. For our fourth hypothesis on the association between attachment relationship quality and loneliness, our standard linear mixed-effects model was sufficiently powered (.99 and .84 for paternal and maternal attachment relationship quality, respectively). For H5a, regarding the immediate relief effect of self-harm behaviours on loneliness, the results show that the standard linear mixed-effects model was sufficiently powered (=1). From the beginning, we considered H2, H3, H5b and H5c as exploratory. For more details on these decisions, see our post-registration on the OSF page: https://osf.io/yqxp7/.

Loneliness and self-harm thoughts

We analyzed how loneliness is related to the presence or absence of self-harm thoughts in the next 90 minutes (H1) using a binary logistic mixed-effects model. In this model, self-harm thoughts are coded as “1” (i.e., all the non-zero responses) and no self-harm thoughts as “0” (i.e.,

zero responses). In this model, the presence/absence of self-harm thoughts at timepoint T was set as the outcome variable and loneliness at the previous timepoint (i.e., T-1) was the predictor variable. Loneliness was person-mean centered and lagged within days. We controlled for age, gender (both assessed at baseline) and company (assessed at each beep) at the previous timepoint (i.e., T-1). By controlling for company, we minimize the risk of confounding as company may influence both loneliness (Bamps et al., 2024) and SHTBs (Husky et al., 2017; Nock et al., 2009; Shingleton et al., 2013). Given the two-level structure of the data (i.e., repeated measurements within persons), we include random intercepts to account for the differences between individuals and random slopes to allow for the possibility that the relationship between the predictor and the outcome can vary from person to person. Within this model, random intercepts were included for persons, and random slopes for loneliness at the previous timepoint (i.e., T-1) and company at the previous timepoint (i.e., T-1).

To explore to what extent higher levels of loneliness are associated with higher levels (i.e., intensity) of self-harm thoughts in the next 90-minute time interval (H2), a standard linear mixed-effects model was used. Self-harm thoughts at timepoint T were set as the outcome variable and loneliness at the previous timepoint (i.e., T-1) was set as the predictor variable. Loneliness was person-mean centered and lagged within days. We controlled for age, gender (both assessed at baseline) and company at the previous timepoint (i.e., T-1). Random intercepts were included for persons, and random slopes for loneliness at the previous timepoint (i.e., T-1) and company at the previous timepoint (i.e., T-1).

Loneliness, self-harm thoughts and attachment relationship quality

We investigated whether associations between loneliness and self-harm thoughts (both presence/absence and intensity) in daily life were moderated by attachment relationship quality. For this, we set in the binary logistic (for presence/absence of self-harm thoughts) and standard linear (for the intensity of self-harm thoughts) mixed-effects model, self-harm thoughts at timepoint T as the outcome variable and loneliness at the previous timepoint (i.e., T-1) and the interaction of

attachment relationship quality (with father/mother) and loneliness at the previous timepoint (i.e., T-1) as the predictor variables. Loneliness was person-mean centered and lagged within days. We controlled for age, gender (both assessed at baseline) and company (assessed at each beep) at the previous timepoint (i.e., T-1). Random intercepts were included for persons, and random slopes for loneliness at the previous timepoint (i.e., T-1) and company at the previous timepoint (i.e., T-1) , given the two-level structure of the data (i.e., repeated measurements within persons).

Attachment relationship quality and loneliness

To investigate whether paternal and maternal attachment relationship quality are associated with loneliness, we used a standard linear mixed-effects model. In this model, momentary loneliness was set as the outcome variable, allowing for varying intercepts, and levels of paternal and maternal attachment relationship quality were set as predictor variables. We controlled for age, gender (both assessed at baseline), company and loneliness at the previous timepoint (i.e., T-1) (assessed at each beep). Loneliness was person-mean centered and lagged within days. Because the data has a two-level structure, we included random intercepts for persons and random slopes for loneliness at the previous timepoint (i.e., T-1), and company at timepoint T.

For more details on sample sizes, data collection procedure, variables, prior knowledge of the data and the analysis plan, see post-registration: https://osf.io/jc8pf/?view_only=a6081d4e350841eebfb8b59f058a22a6 .

Loneliness and self-harm behaviours

We exploratory analyzed whether changes in loneliness within a 90-minute time interval are moderated by self-harm behaviours within that same time interval using a standard linear mixed-effects model (i.e., immediate relief effect) (H5a). However, the wording of the items was not designed with this research question in mind (i.e., participants were asked at each timepoint whether they engaged in self-harm behaviours *since the last* beep), which makes it difficult to disentangle whether the decrease in loneliness at timepoint T occurred before or after the actual self-harm act within that same time interval. Therefore, we considered this analysis as exploratory. For this model,

we set loneliness at timepoint T as the outcome variable and the presence of current self-harm behaviours at timepoint T (0 = no current self-harm behaviours; 1 = current self-harm behaviours), loneliness at the previous timepoint (i.e., T-1) and the interaction term of these two predictor variables that were assessed at each beep as the independent variables. Loneliness was person-mean centered and lagged within days. We controlled for age, gender (both assessed at baseline) and company (assessed at each beep) at timepoint T. Random intercepts for persons and random slopes for self-harm behaviours at timepoint T and loneliness at the previous timepoint (i.e., T-1) were included given the two-level structure of the data (repeated measurements within persons).

To investigate to what extent the change in loneliness within a 90-minute time interval is moderated by self-harm behaviours within a previous time interval (H5b), another standard linear mixed-effects model was used. However, as the wording of the items was not designed with this research question in mind, it is difficult to disentangle whether we captured the immediate relief effect, tested with H5a (i.e., initial decrease in loneliness) when adolescents reported self-harm behaviours or the prolonged effect of H5b (i.e., subsequent increase in loneliness). Therefore, we considered this analysis as exploratory. Loneliness at timepoint T was the outcome variable and the presence of self-harm behaviours (0 = no current self-harm behaviours; 1 = current self-harm behaviours) at the previous timepoint (i.e., T-1) and loneliness at the previous timepoint (i.e., T-1) were predictor variables that were assessed at each beep. Loneliness was person-mean centered and lagged within days. We controlled for age, gender (both assessed at baseline) and company at timepoint T (assessed at each beep). In addition, we control for the presence of current self-harm behaviours at timepoint T to examine the unique effect of self-harm behaviours at the previous timepoint (i.e., T-1) on loneliness at timepoint T. We included the two-way interaction of self-harm behaviours at the previous timepoint (i.e., T-1) and loneliness at the previous timepoint (i.e., T-1). Random intercepts for persons and random slopes for self-harm behaviours at timepoint T and loneliness at the previous timepoint (i.e., T-1) were included given the two-level structure of the data (repeated measurements within persons).

Loneliness, self-harm behaviours and attachment relationship quality

We exploratory investigated whether associations between loneliness and self-harm behaviours within the same (i.e., immediate relief effect) or previous (i.e., prolonged effect) time interval were moderated by attachment relationship quality. Within these two standard linear mixed-effects models, we set loneliness at timepoint T as the outcome variable and the presence of current self-harm behaviours at timepoint T (0 = no current self-harm behaviours; 1 = current self-harm behaviours), loneliness at the previous timepoint (i.e., T-1), the two-way interaction term of these two predictor variables that were assessed at each beep and the three-way interaction of attachment relationship quality (with father/mother), loneliness at the previous beep (i.e., T-1) and self-harm behaviours at timepoint T (for the immediate relief effect) or the previous timepoint (i.e., T-1) (for the prolonged effect) as the independent variables. Loneliness was person-mean centered and lagged within days. We controlled for age, gender (both assessed at baseline) and company (assessed at each beep) at timepoint T. Random intercepts for persons and random slopes for self-harm behaviours at timepoint T and loneliness at the previous timepoint (i.e., T-1) were included given the two-level structure of the data (repeated measurements within persons).

Statistical software

R version 4.3.1 was used for all analyses. To run the sensitivity power analysis and main analyses, the following packages were used: jtools (Long, 2020); GLMMadaptive (Rizopoulos, 2023), MASS (Venables & Ripley, 2002), kableExtra (Zhu, 2021), tidyverse (Wickham et al., 2019), esmpack (Viechtbauer & Constantin, 2023), here (Müller, 2020), missMethods (Rockel, 2022), truncnorm (Mersmann et al., 2023), progress (Csardi & Fitzjohn, 2019), lme4 (Bates et al., 2015), lmerTest (Kuznetsova, Brockhoff & Christensen, 2017), readr (Wickham, Hester & Bryan, 2023), psych (Revelle, 2023), mitools (Lumley, 2019) and mice (van Buuren & Groothuis-Oudshoorn, 2011).

Results

Descriptive statistics for demographics, attachment relationship quality, loneliness, age, gender and company are provided in Table 1. Twenty-six percent of the full SIGMA sample indicated that they identified with at least one country other than Belgium (i.e., Italian, Turkish, Moroccan, Kurdish, Berber, Polish, or any other country/group). Of the full sample (N=1602), 667 adolescents have not reported any self-harm thought or behaviour during the ESM period, 513 adolescents have reported self-harm thoughts (but no self-harm behaviours) and 412 adolescents have reported both self-harm thoughts and behaviours at least within one of the 90-minute time windows (Table 1).

Table 1

Descriptive statistics for full sample (N=1602)

Variables	n (%)	M (SD)	Mdn	Range
		Demographics		
Age		13.69 (1.84)	13	11-20
Gender (% females)		63.53		
		Retrospective measures		
Attachment relationship quality				
Paternal		17.78 (7.17)	19	-8-28
Maternal		20.75 (5.89)	22	-8-28
		Daily-life measures		
Self-harm thoughts and behaviours				
No thoughts/behaviours	667 (42%)			
Thoughts only	513 (32%)			
Thoughts and behaviours	412 (26%)			

Intensity of thoughts[a]	4 (2.16)	4	1-7
Intensity of thoughts[b]	4 (2.16)	4	1-7
Loneliness	1.65 (1.43)		1-7
Company (% yes)	91.21		0-1
	Overall compliance		
Number of completed beeps	24.63 (12.75)	24	1-59
Average beep response	41%		

Note. [a] For thoughts only. [b]For thoughts and behaviours groups.

Loneliness and self-harm thoughts (exploratory)

Exploratory analyses suggested that loneliness was significantly associated (OR = 1.01, p = <.001) with the presence of self-harm thoughts within the next 90-minute time interval (Table 2). Additional exploratory analyses revealed that higher momentary levels of loneliness were significantly associated (β = 0.02, p = .001) with higher levels of self-harm thoughts (i.e., intensity) within the next 90-minute time interval.

Loneliness, self-harm thoughts and attachment relationship quality (exploratory)

Exploratory analyses showed that the significant association between loneliness and self-harm thoughts (presence and intensity) within a next 90-minute time interval was moderated (OR = 1.01, p = .05 for presence; β = 0.005, p < .001 for intensity) by maternal attachment relationship quality; the effect of loneliness at the previous timepoint (i.e., T-1) on the presence and intensity of self-harm thoughts was stronger when maternal attachment relationship quality was low (Table 2). Results showed no significant moderation effects (OR = 1.01, p = .14 for presence; β = 0.001, p = .32 for intensity) of paternal attachment relationship quality on the association between loneliness and self-harm thoughts within a next 90-minute time interval.

Loneliness and attachment relationship quality (confirmatory)

Confirmatory analyses revealed that lower levels of paternal and maternal attachment relationship quality (assessed at baseline) were significantly associated (β = 0.02, $p < .001$ for father; β = 0.02, $p < .001$ for mother) with higher levels of daily-life loneliness (Table 3).

Loneliness and self-harm behaviours (exploratory)

Exploratory analyses revealed that the change in loneliness within a 90-minute time interval was moderated (β = -0.14, $p = .003$) by self-harm behaviours within that same time interval; the decrease in loneliness was significantly stronger when self-harm behaviours were reported (Table 4). Additional exploratory analyses revealed no significant moderation effect (β = -0.14, $p = .06$) of self-harm behaviours within a 90-minute time interval on the change in loneliness within a *next* 90-minute time interval (Table 4).

Loneliness, self-harm behaviours and attachment relationship quality (exploratory)

Additional exploratory analyses suggested that the significant association between loneliness and self-harm behaviours within the same 90-minute time interval was moderated (β = 0.02, $p = .02$) by paternal attachment relationship quality; the effect of self-harm behaviours on the change in loneliness within that same 90-minute time interval was stronger when paternal attachment relationship quality was low (Table 4). Moderation effects of maternal attachment relationship quality (β = 0.000, $p = .97$) were not significant.

Table 2

Binary and standard linear mixed-effects model, predicting the presence/absence and the intensity of self-harm thoughts in the next 90-minute time interval

	Self-harm thoughts at T			
	Presence/absence		Intensity	
	OR (SE)	*p*	β (SE)	*p*
Model without attachment relationship quality				
Loneliness at T-1	**1.01 (0.06)**	**<.001**	**0.02 (0.008)**	**.001**
Age	1.05 (0.04)	.24	0.01 (0.01)	.13
Gender	0.95 (0.15)	.75	-0.01 (0.04)	.78
Company at T-1	0.83 (0.16)	.25	-0.003 (0.02)	.88
Model with attachment relationship quality				
Loneliness at T-1	**1.27 (0.08)**	**<.001**	**0.13 (0.03)**	**<.001**
Age	0.95 (0.04)	.23	-0.001 (0.01)	.91
Gender	0.81 (0.15)	.15	-0.03 (0.04)	.48
Company at T-1	0.92 (0.15)	.58	-0.000 (0.02)	.99
Attachment relationship quality				
Paternal	**1.05 (0.01)**	**<.001**	**0.01 (0.003)**	**.002**
Maternal	**1.06 (0.01)**	**<.001**	**0.01 (0.003)**	**.003**
Attachment relationship quality x loneliness at T-1				
Paternal	1.01 (0.00)	.14	0.001 (0.001)	.32
Maternal	**1.01 (0.00)**	**.05**	**0.005 (0.001)**	**<.001**

Note. P-values <.05 are displayed in bold.

Table 3

Standard linear mixed-effects model, predicting the daily-life levels of loneliness from paternal and maternal attachment relationship quality

	Loneliness at T	
	β (SE)	*p*
Attachment relationship quality		
Paternal	**0.02 (0.003)**	**<.001**
Maternal	**0.02 (0.004)**	**<.001**
Loneliness at T-1	**0.07 (0.01)**	**<.001**
Age	0.02 (0.01)	.07
Gender	0.01 (0.05)	.76
Company at T	**-0.54 (0.04)**	**<.001**

Note. P-values <.05 are displayed in bold.

Table 4

Standard linear mixed-effects model, predicting the change in loneliness within a 90-minute time interval with self-harm behaviours within that same (H3a) or previous (H3b) time interval as moderator

	Loneliness at T	
	β (SE)	*p*
Hypothesis 3a: testing the immediate relief effect		
Model without attachment relationship quality		
Self-harm behaviours at T	**0.44 (0.15)**	**.003**
Loneliness at T-1	**0.08 (0.05)**	**.04**
Age	**0.11 (0.05)**	**.04**
Gender	-0.02 (0.20)	.93
Company at T	**-0.54 (0.16)**	**<.001**
Self-harm behaviours at T x loneliness at T-1	**-0.14 (0.07)**	**.003**
Model with attachment relationship quality		
Self-harm behaviours at T	**0.78 (0.39)**	**.05**
Loneliness at T-1	0.16 (0.11)	.13
Age	**0.09 (0.03)**	**.007**
Gender	0.08 (0.13)	.52
Company at T	**-0.6 (0.1)**	**<.001**
Self-harm behaviours at T x loneliness at T-1	0.2 (0.2)	.31
Attachment relationship quality x loneliness at T-1 x self-harm behaviours at T		
Paternal	**0.02 (0.009)**	**.02**
Maternal	0.000 (0.01)	.97
Hypothesis 3b: testing the prolonged effect		
Model without attachment relationship quality		
Self-harm behaviours at T-1	**0.44 (0.15)**	**.003**
Loneliness at T-1	0.08 (0.05)	.09
Age	**0.11 (0.05)**	**.04**
Gender	-0.02 (0.20)	.93

Company at T	**-0.54 (0.16)**	**<.001**
Self-harm behaviours at T	**0.76 (0.18)**	**<.001**
Self-harm behaviours at T-1 x loneliness at T-1	-0.14 (0.07)	.06
Model with attachment relationship quality		
Self-harm behaviours at T-1	-0.48 (0.51)	.34
Loneliness at T-1	0.18 (0.14)	.21
Age	0.10 (0.05)	.08
Gender	-0.02 (0.21)	.92
Company at T	**-0.54 (0.16)**	**<.001**
Self-harm behaviours at T	**0.74 (0.19)**	**<.001**
Self-harm behaviours at T-1 x loneliness at T-1	0.32 (0.26)	.23
Attachment relationship quality x loneliness at T-1 x self-harm behaviours at T-1		
Paternal	0.01 (0.01)	.34
Maternal	0.01 (0.01)	.40

Note. P-values <.05 are displayed in bold.

Discussion

General summary of the results

In the current ESM study, we found that adolescents' loneliness was significantly associated with the presence and intensity of self-harm thoughts within the next 90-minute time interval. In addition, exploratory analyses suggest that the significant association between loneliness and the presence and intensity of self-harm thoughts within the next 90-minute time interval was moderated by maternal attachment relationship quality (i.e., the effects were stronger when maternal attachment relationship quality was low). Further, we found that adolescents with lower levels of paternal and maternal attachment relationship quality were more likely to experience higher levels of loneliness in their daily lives. As an exploratory aim of our study, we explored the emotional regulation function of self-harm behaviours. Results from these analyses revealed that engaging in self-harm behaviours was significantly associated with a stronger decrease in loneliness within that same 90-minute time interval. Moreover, analyses suggest that the significant association between loneliness and self-harm behaviours within the same 90-minute time interval was moderated by paternal attachment relationship quality (i.e., the effect of self-harm behaviour on the decrease in loneliness was stronger when paternal attachment relationship quality was low). Our exploratory analyses suggested no significant moderation effect of self-harm behaviours on the change in loneliness within the *next* 90-minute time interval.

Loneliness and self-harm thoughts

In line with emerging literature (Calati et al., 2019; Gandhi et al., 2018; McClelland et al., 2020, 2021) and consistent with our hypotheses, results revealed that the more lonely adolescents feel, the more likely they are to think (and have more intense thoughts) about self-harm in the next 90-minute time interval. Interpreting these findings within the context of the IMV model (O'Connor, 2011; O'Connor & Kirtley, 2018), our results suggest that loneliness acts as a motivational moderator, i.e., a risk factor that leads to the emergence of self-harm thoughts. Our results are also consistent with the IPT (Joiner, 2005; Van Orden et al., 2010), which suggests that loneliness in the form of

thwarted belongingness is an important predictor of self-harm thoughts. These findings seem to contradict earlier findings in (emerging) adults that only found evidence for a concurrent association between loneliness and self-harm thoughts (Coppersmith et al., 2019; Kleiman et al., 2017). However, lower sampling frequencies were used in these studies which may have prevented temporal associations from being detected. As this is the first study to investigate the temporal within-person association of loneliness and self-harm thoughts in adolescents, these findings support loneliness as a critical warning signal that predicts (an increase in) adolescent self-harm thoughts within a 90-minute time window. As such, these findings contribute essential knowledge that can be used to tailor prevention and intervention to *when* support is most needed.

Attachment relationship quality and loneliness

The finding that lower levels of paternal and maternal attachment relationship quality are associated with higher levels of momentary loneliness converges with previous literature (Janssens et al., 2021; Torquati & Raffaelli et al., 2004). From an attachment perspective (Bowlby, 1969, 1973), it is theorized that these adolescents lack trust in others' availability and support, limiting their ability to establish social connections with others (Pouravari et al., 2022). Moreover, these results suggest that the relationships with both parents have value in fulfilling the relationship needs during adolescence, despite the normative transitions that occur during this phase (Lasgaard et al., 2011). This adds to the current literature on the protective effect of attachment relationship quality on negative emotional experiences in daily life (Sheinbaum et al., 2015; Torquati & Raffaelli, 2004), which may be precursors for psychopathology such as self-harm.

Loneliness and self-harm behaviours

Results from the current study offer support for the emotional regulation function of self-harm (Nock & Prinstein, 2004; Nock, 2009), as they revealed that adolescents who engage in self-harm behaviours within a 90-minute time interval experience a stronger decrease in loneliness within that same time interval (i.e., "immediate relief effect"). This reveals, at least to some extent, *why* adolescents may harm themselves which is vital knowledge for developing appropriate

treatment that is tailored to the underlying motives. These findings indicate that adolescents may use self-harm behaviours as a rapid means to reduce their distress associated with loneliness (Gandhi et al., 2018; Laye-Gindhu & Schonert-Reichl, 2005).

Loneliness, self-harm thoughts and behaviours and attachment relationship quality

Results suggest stronger associations between loneliness and self-harm thoughts for those whose maternal attachment relationship quality is low, and between loneliness and self-harm behaviours when paternal attachment relationship quality is low. This implies that adolescents with lower-quality attachment bonds with their mother and father are vulnerable to developing harmful strategies (i.e., SHTBs) to regulate daily-life loneliness. Although future research is needed to explore mother-father differences further, a possible explanation could be found in prior literature that relates the mother-child relationship to more internalizing problems (Bureau et al., 2009; Deneault et al., 2021; Paquette, 2004) and the father-child bond to more externalizing behaviours and the expression of emotions (Brand et al., 2010; Hennigar et al., 2020). This stems from the idea that fathers' physical play with the child helps them to learn the skills needed to regulate behaviour (Deneault et al., 2021). Although up for debate (Nock, 2009), self-harm thoughts could be considered an internalising problem, linked to the mother-child relationship, and the engagement of self-harm behaviour as externalising behaviour, linked to the father-child bond. However, these results highlight the unique role of both the paternal and maternal attachment relationship in the daily-life process of adolescent self-harm. Whilst feeling lonely is a common experience that generally motivates the search for connection, if adolescents lack trust in the availability of and support from others, their experience of loneliness may be left untended, with severe consequences (Hawkley & Cacioppo, 2010).

Strengths and limitations

The current ESM study has several strengths. To our knowledge, this is the first study that uses ESM to unravel within-person, temporal associations between loneliness and SHTBs in adolescents' daily lives. Using ESM to assess loneliness and SHTBs increases ecological validity and

reduces recall bias. In fact, this study provides the first evidence for loneliness as a short-term risk factor for adolescent self-harm (i.e., *when* adolescents are at increased risk) and adds to our understanding of *why* individuals engage in self-harm behaviours (i.e., to downregulate feelings of loneliness). Moreover, by investigating how these moment-to-moment associations are moderated by attachment relationship quality – a modifiable factor, this study advances prevention and intervention opportunities as this increases knowledge about *how* the risk of adolescent self-harm may be reduced.

Given the need for greater transparency, replicability, and reproducibility in suicide research (Kirtley et al., 2022) and in clinical psychology research more broadly (Tackett et al., 2017, 2019) , we post-registered our study — a form of pre-registration when pre-existing data will be used (Benning et al., 2019) — as well as sharing code for our power and main analyses on the OSF. We consider this transparency a major strength of the current study. .

Despite these strengths, our study also has limitations. First, although our study provides key insights into the role of adolescent attachment at a trait level, emerging research suggests a state-like component of attachment which is not captured with the retrospective questionnaire we used (Fraley, 2007; Kobak & Bosmans, 2018). This highlights the need to develop and validate appropriate ESM items to assess attachment in the daily life of adolescents, to capture all of its meaningful fluctuations as they occur naturally in adolescents' everyday lives.

Second, ESM compliance was rather low (41%) in the sample in comparison to other adolescent ESM studies, e.g., 88% (Hutchinson et al., 2021) and 81% (Schwartz-Mette et al., 2022). One reason for this may be the length of the ESM questionnaire (i.e., 46 items), as previous research revealed that longer questionnaires (i.e., > 30 items) negatively impact compliance (Eisele et al. 2022).

Third, we were limited in our assessment of race/ethnicity due to the lack of standardized options for assessing these — a common issue in European research. Given evidence the relevance of considering ethnicity in relation to self-harm, e.g., differences in rates of hospital presentation for

self-harm among adolescents from minority ethnic groups (Farooq et al., 2021), we suggest researchers recruit diverse samples in terms of national/ethnic background, but crucially, that researchers also investigate potential explanatory factors for this relationship by examining social determinants of health (Jugert et al., 2021). Also, participants were asked to complete questionnaires during school hours which may have affected compliance. Moreover, by not rewarding participants per questionnaire completed, we may have reduced data quantity, although data quality may have been protected by this.

Fourth, assessing SHTBs *since the last beep* presented three methodological constraints, it limited our ability (1) to investigate the immediate relief and prolonged effect of self-harm behaviours on loneliness, (2) to control for autoregressive effects needed to investigate whether loneliness incrementally predicts self-harm thoughts, and (3) to explore different timescales on which the association between loneliness and SHTBs occurs. Despite these constraints, we believe this approach was the best option to capture SHTBs within a general adolescent population sample as we expect low numbers of SHTBs in this population.

Lastly, some effect sizes were small and some hypotheses were underpowered resulting in several hypotheses to be considered exploratory. Therefore, it is encouraged to interpret findings from this study with caution. Future research is required to replicate these findings in larger samples and with higher compliance. However, we consider our simulation-based power analysis to be valuable for multiple reasons. For example, whilst power calculations are still often neglected in ESM research (Trull & Ebner-Priemer, 2020), they provide much-needed transparency about which analyses are exploratory and require further confirmatory testing. Moreover, these power calculations can provide parameters that aid other researchers in conducting power analyses for similar studies.

Future research

Several research avenues can be proposed for the future. First, future research should explore interactions of paternal and maternal attachment relationship quality to clarify potential

buffering effects on SHTBs. For example, it could be that adolescents with low-quality attachment bonds with both parents might be most at risk for loneliness precipitating SHTBs, or that a high-quality attachment bond with one parent buffers against the impact of a low-quality attachment bond with the other parent (Dagan & Sagi-Schwartz, 2018).

Second, research would benefit from the development and validation of appropriate ESM items to investigate the state-like (as opposed to trait-like) component of adolescent attachment. This would enable a more reliable investigation of the associations between attachment, loneliness and self-harm in adolescents, revealing novel targets for prevention and intervention. Scholars have begun this work by developing a state attachment scale for adults (Gillath et al., 2009) and state attachment items for children (Cuyvers et al., 2023). However, as a set of items for adolescents is still missing, we need to prioritize research that develops and validates gold-standard ESM items for adolescent state attachment.

Third, more research into the timescales (minutes, hours, days) on which the association between loneliness and self-harm exists is needed to further refine the predictive value of loneliness, benefitting both research and the clinical practice. For example, future research could explore how fast the effect of loneliness on SHTBs unfolds over time by assessing both loneliness and SHTBs at the momentary level (i.e., “at the beep”) using varying sampling frequencies. Researchers could combine a traditional ESM measurement (i.e., 1 to 10 beeps a day) with a burst measurement (i.e., ESM surveys spaced 10 minutes apart over 1h during a high SHTB risk period) to reveal on which exact timescale this effect operates (Coppersmith et al., 2023). Similar type of research from another field explored six different timescales to explore the effect of parent-adolescent conflict on adolescent ill-being (Bülow et al., 2023). Importantly, researchers should use appropriate temporal models that control for autoregressive effects to examine the incremental increase of SHTB risk by loneliness (Coppersmith et al., 2023).

Fourth, investigating to what extent loneliness is differentially related to non-suicidal SHTBs or suicidal SHTBs can be an interesting future research avenue as this may increase our scientific

understanding and help tailor prevention and treatment strategies to address the underlying intent of each behaviour. Indeed, understanding whether loneliness is related to non-suicidal versus suicidal self-harm may help us predict when a life is in acute danger. However, we stress that the risk of suicidal behaviour may be equally high when non-suicidal or suicidal self-harm is reported, because the underlying intent is not always so clear for individuals (Klonksy et al., 2011) and can switch from moment to moment (Andover et al., 2012).

Finally, the current ESM study already provides some insight into the within-person, temporal association between loneliness — which is part of the key concept of thwarted belongingness (Van Orden et al., 2010) — and self-harm. However, it would greatly advance our understanding of self-harm if current ideation-to-action theories were further tested using ESM to see whether their propositions are supported over shorter timeframes, in daily life. This could generate valuable, theory-based, insights into what factors predict the emergence of thoughts, behaviours or the translation of thoughts into behaviours, over which timescales, and what targets should be of paramount importance in the prevention and management of SHTBs.

Implications

Given the current lack of knowledge on short-term risk factors for adolescent self-harm, our findings are informative for clinicians. They highlight that loneliness is important for self-harming thoughts and behaviour, making it an important target in prevention and intervention. For example, Just-In-Time Adaptive Interventions (JITAIs; Coppersmith et al., 2022) – a form of Ecological Momentary Interventions (Myin-Germeys et al., 2016) that draw from evidence-based psychotherapies, offer promising ways to address loneliness in adolescents' daily lives. Additionally, including parents in treatment could improve its efficiency and efficacy (Miner et al., 2016). For example, Attachment-Based Family Therapy interventions (Diamond, 2014) focus on resolving attachment ruptures and repairing trust between adolescents and their parents, and have shown empirical support for suicide risk reduction in adolescents (Diamond et al., 2016). These types of

interventions may increase adolescents' trust in others, which may be crucial for establishing connections with others when they feel lonely.

Conclusions

The current ESM study provides evidence for loneliness as a short-term risk factor for self-harm thoughts, thereby extending our understanding of when adolescents think about self-harm. Moreover, findings suggest that lower-quality attachment relationships with their mother put adolescents at increased risk for self-harm thoughts at times when they feel lonely. In addition, exploratory analyses support the emotional regulation function of self-harm behaviours, thereby refining our understanding why they engage in self-harm behaviours. We believe and hope these results can guide clinicians in their work, e.g., including parents in treatment of adolescent self-harm, and stimulate future research on this topic, e.g., further exploring timescales of these associations.

Chapter 7: A systematic review of interpersonal processes and their measurement within experience sampling studies of self-injurious thoughts and behaviours

Article submitted and under revision

Available as a preprint online:

Janssens, J. J., Kiekens, G., Jaeken, M., & Kirtley, O. J. (2023). A systematic review of interpersonal processes and their measurement within experience sampling studies of self-injurious thoughts and behaviours. https://osf.io/preprints/psyarxiv/fmuc5.

Supplementary materials for chapter are available online: https://osf.io/dxvsh/

Abstract

Self-injurious thoughts and behaviours (SITBs) are a leading cause of death, and interpersonal processes (IPs) appear to play a role in SITBs. This systematic review synthesises the literature on IPs and SITBs in daily life and addresses four critical questions: (1) Which IPs have been assessed and how, (2) How are differences in IPs *between* individuals associated with SITBs?, (3) How are differences in IPs *within* individuals associated with SITBs? and (4) Do IPs relate differently to self-injurious thoughts than behaviours? Our review followed PRISMA guidelines and eligible literature was screened until 25 April 2024. We identified 58 Experience Sampling studies (32.76% daily-diary studies) of which most focused on IPs from major SITBs theories (e.g., thwarted belongingness) but largely used inconsistent operationalizations. Results from 39 studies investigating within-person associations were mixed. Based on 26 studies, whether differences in IPs between individuals relate to SITBs remains unclear. Three studies have investigated whether IPs relate to the transition from thoughts to behaviours, but temporal models are needed to draw firm conclusions. Studies investigating IPs and SITBs in daily life are largely inconclusive. Psychometrically validated measures are warranted, and future daily-life studies would benefit from drawing on ideation-to-action frameworks.

Introduction

Self-injurious thoughts and behaviours (SITBs) are a leading cause of death worldwide and refer to any thought or act of self-injury of an individual . More than 700,000 people die by suicide every year (WHO, 2019) and the number of individuals who think about attempting suicide and make a (non-fatal) suicide attempt is even greater (Mortier et al., 2018; Nock, Borges, Bromet, Cha, et al., 2008), with lifetime prevalence rates in adolescents in the 12.1-18.0%, 4.0-9.9%, 4.1-6.0% range for suicidal thoughts, plans, and attempts, respectively (Lim et al., 2019; Nock, Borges, Bromet, Cha, et al., 2008; Nock et al., 2013). These prevalence rates are 22.3%, 6.1%, and 3.2% for emerging adults (Mortier et al., 2018) and 9.2%, 3.1%, and 2.7% for adults (Nock, Borges, Bromet, Alonso, et al., 2008). Among adolescents and emerging adults, non-suicidal self-injury (NSSI) is also a significant public health issue. The lifetime prevalence rate of NSSI is estimated between 16.9-22.1% (Gillies et al., 2018; Lim et al., 2019; Muehlenkamp et al., 2012; Swannell et al., 2014; Voss et al., 2020) for adolescents and 13.4-22.8% for emerging adults (Kiekens et al., 2023; Sivertsen et al., 2019; Swannell et al., 2014). These findings and the strong association between NSSI and suicidal thoughts and behaviors (Hamza et al., 2012; Kiekens et al., 2018; Ribeiro et al., 2016) highlight the importance of investigating risk and protective factors for SITBs together to identify who is at risk (i.e., between-person level), when momentary risk of SITBs increases among individuals who report SITBs (i.e., within-person level), and whether there are differences between non-suicidal and suicidal forms of self-injury.

Interpersonal processes (IPs), defined as 'the interplay of cognitive, motivational, and behavioural activities in social interaction' (Snyder & Stukas, 1999), have been associated with SITBs for decades (Peel-Wainwright et al., 2021; Van Orden et al., 2010). There are currently three major ideation-to-action models of suicidal behaviour: the Interpersonal Psychological Theory (IPT; Joiner et al., 2005; Van Orden et al., 2011), the Three-Step Theory (3ST; Klonsky & May, 2015), and the Integrated Motivational-Volitional model (IMV; O'Connor, 2011; O'Connor & Kirtley, 2018). All three

of these ideation-to-action models make a distinction between the emergence of suicidal thoughts and the subsequent transition to behaviour. In these models, it is proposed that the emergence and risk of transitioning from suicidal thoughts to behaviour are determined by IPs. For example, based on the IPT, the IMV model features the interaction of thwarted belongingness and perceived burdensomeness as a moderator in the emergence of suicidal ideation. In addition, theoretical models of NSSI also highlight the importance of IPs. For example, the Four-Function Model of NSSI (Bentley et al., 2014) indicates that individuals may engage in NSSI to decrease interpersonal demands, as well as to generate attention and support (Bentley et al., 2014), with meta-analytic evidence showing 44% of individuals report engaging in NSSI for interpersonal reasons (Taylor et al., 2018). The Benefits and Barriers Model (Hooley & Franklin, 2017) proposes that communication and affiliation benefits play an important role in the emergence of NSSI. Most recently, the NSSI Family Distress Cascade Theory (Waals et al., 2018) conceptualizes the impact of NSSI at the family level as an interpersonal interaction and complementary escalation between the caregivers and the individual who self-injures (Watzlawick et al., 1974). Importantly, however, none of these models explicitly differentiate between NSSI thoughts and the transition to NSSI behaviour.

Three IPs that are common across most theoretical models and have been studied extensively are social connectedness, thwarted belongingness and perceived burdensomeness. Social connectedness is a broad term, defined as one's subjective sense of connection to the world, including close others, strangers and the community (Lee & Robbins, 1995; Seppala et al., 2013). Social rejection, social support and attachment are related constructs to social connectedness (Joiner, 2005; Klonsky & May, 2015; O'Connor & Kirtley, 2018), and belongingness is a construct intertwined with social connectedness. Existing literature sometimes characterises social connectedness as an aspect of belongingness (Lee & Robbins, 1995), whereas others consider it a separate but related construct (Seppala et al., 2013). Within the IPT, thwarted belongingness is a state in which the fundamental "need to belong" (Baumeister & Leary, 1995, p. 1) is unmet, conceptualized as a multidimensional construct with two main aspects: loneliness and the absence of reciprocally caring

relationships (Van Orden et al., 2010). Perceived burdensomeness is defined as a mental state in which an individual perceives that close others would be better off without them, and is also defined as a multidimensional construct involving liability and self-hate (Van Orden et al., 2010).

In the literature, other IPs such as social interactions (Brown & Plener, 2017; Conwell et al., 2002) and loneliness (Calati et al., 2019) have also been studied separately in the context of SITBs. For example, Calati et al. (2019) reviewed 40 observational studies and concluded that social isolation and loneliness were associated with suicidal outcomes. In addition, interpersonal problems, e.g., conflicts (Stepp et al., 2008), and experiences, e.g., rejection (Cawley et al., 2019), were previously related to suicide-related behaviours, i.e., self-harm and attempt. A final IP that raises concern is the encouragement of others to engage in self-injurious behaviours (Dyson et al., 2016). However, the specific role of these IPs in SITBs remains unclear (McClelland et al., 2020; Stewart et al., 2017).

Several studies have investigated associations between IPs and SITBs (e.g., Assavedo & Anestis, 2016; Brailovskaia et al., 2020; Venta et al., 2014), and mostly relied on cross-sectional and traditional prospective surveys, retrospectively assessing IPs and SITBs at a single or handful time points throughout development. Whilst such studies provided insights into the general and longer-term between-person relationships between IPs and SITBs, recent research has shown that IPs and SITBs are both dynamic constructs that fluctuate in the short-term within individuals with a history of SITBs (Czyz et al., 2019; Kaurin et al., 2020). Therefore, it is necessary to move beyond retrospective assessment methods, as this allows for capturing between and within-person differences, reduces recall bias (Esposito et al., 2022; Gratch et al., 2021), and increases ecological validity (Sedano-Capdevilla et al., 2021). Disentangling between and within-person associations is critical to determine whether IPs can help clarify who is most at risk and when individuals' risk of SITBs is increased in daily life. One approach to this is to use the experience sampling method (ESM), also referred to as ecological momentary assessment (EMA), where participants complete brief assessments over days or weeks in their natural environment on a mobile or wearable device (Csikszentmihalyi & Larson,

1987; Myin-Germeys et al., 2018; Stone & Shiffman, 1994). Daily diaries are a particular case of ESM studies in which assessments occur only once daily, typically at the end of the day.

The scientific advantages of using ESM to investigate IPs (Hermans et al., 2019) and SITBs (Kiekens et al., 2021; Kleiman & Nock, 2018) are manifold, and ESM studies of SITBs have already delivered valuable new insights, for example, by revealing different profiles of suicidal ideation (Kleiman et al., 2018). Given these advantages, it is no surprise that ESM studies on SITBs are burgeoning as we move into a digital era. While past reviews have focused on momentary factors related to SITBs (Ammerman & Law, 2021; Gee et al., 2020; Hepp et al., 2020; Sedano-Capdevila et al., 2021; Rodriguez-Blanco et al., 2018), none of these specifically considered the role of IPs, with some focusing on only specific outcomes: suicidal ideation (Ammerman & Law, 2021), functions of NSSI (Hepp et al., 2020), and a broader range of (mostly intrapersonal) factors (Rodriguez-Blanco et al., 2018). In addition, these previous reviews have also not discussed measurement and timescale issues, leaving critical questions unanswered— how can we measure IPs and SITBs in daily life? Over what timescales do relationships between IPs and SITBs exist? Therefore, a comprehensive review focusing specifically on the role of IPs and how they have been investigated in ESM studies is timely to synthesise findings and reduce fragmentation of a rapidly growing literature . In the following section, we outline three areas in ESM research on IPs and SITBs where synthesis is required to fill key knowledge gaps and help move the field forward.

Characterisation and measurement of IPs and SITBs in daily life

ESM research is a field replete with complexity and methodological challenges that have rarely been substantively examined in previous studies or reviews within the SITB literature. While several ESM studies (e.g., Hallensleben et al., 2019; Parrish et al., 2021) have focused on the relationship between SITBs and thwarted belongingness and burdensomeness from the IPT (Joiner, 2005; Van Orden et al., 2011), it is clear from the broader ESM literature that this approach offers the potential to capture a much broader array of IPs in daily life that are of relevance to SITBs (e.g.,

Coppersmith et al., 2019; Glenn et al., 2022). To build a cumulative science of IPs in the context of SITBs, it is relevant to create a systematic overview of the range of IPs that have been investigated in ESM studies, and the extent to which the evidence for the relationship between particular IPs and SITBs converges or diverges.

The added value of ESM for capturing behaviours, feelings, and experiences in daily life is in large part predicated on our ability to accurately measure the constructs of interest. However, in ESM research where questionnaires are kept necessarily short to reduce participant burden, single-item, unvalidated measures of constructs are common (Horstmann & Ziegler, 2020; Wright & Zimmerman, 2019). Discussions around measurement issues in ESM (Kirtley et al., 2021; Mestdagh & Dejonckheere, 2021) are unfolding against the backdrop of the replication crisis in psychological science (Shrout & Rodgers, 2018), and therefore a thorough investigation of the methods used to assess IPs in ESM studies on SITBs is warranted to tackle potential threats to validity in this literature.

Deconstructing the nature of the short-term relationship between IPs and SITBs

To understand when an individual is at risk for SITBs and to facilitate prevention and intervention in daily life, it is critical to clarify how IPs are contemporaneously and temporally associated with SITBs. Determining on what time scale risk and protective factors relate to SITBs is a critical (Coppersmith et al., 2023), yet neglected, consideration theoretical models that differentiate between the emergence of self-injurious thoughts and the potential transition to behavior. Based on cross-sectional studies using retrospective self-report surveys (Chu et al., 2017; Van Orden et al., 2006), we may expect associations between thwarted belongingness, perceived burdensomeness and suicidal ideation in daily life. Our review, therefore, seeks to clarify the timescales (minutes, hours, days) over which IPs are — if at all — associated with SITBs, which is an essential step in the pathway toward real-time interventions for SITBs (Coppersmith et al., 2023; Kiekens et al., 2021).

Alongside the question of temporality is the level at which the relationship between IPs and SITBs plays out, which is a question that ESM is uniquely placed to answer. ESM can clarify between-

person differences in IPs, for example, whether mean levels of daily-life belongingness differ between individuals who do or do not engage in SITBs, and within-person differences, such as whether belongingness is more strongly associated with SITBs for some individuals than others. Further, current reviews of ESM studies investigating within-person associations between risk/protective factors and SITBs have mainly focused on affective states and SITBs in daily life (Hepp et al., 2020; Rodríguez-Blanco et al., 2018; Sedano-Capdevila et al., 2021), but relationships between SITBs and IPs have not received equal attention. Therefore, our review aims to provide a comprehensive overview of the relationships between IPs and SITBs in daily life considering both between- and within-person associations.

Understanding within-person variability in IPs and how this relates to the presence of SITBs

Current theoretical models and research on SITBs fall short of explaining within-person variability in IPs among individuals with a history of SITBs, while research from other domains has shown the dynamic nature of IPs. Better understanding the degree to which IPs vary within individuals who report SITBs (e.g., individual variation in momentary levels of social connectedness, thwarted belongingness and perceived burdensomeness) and how this differs between people who do and do not engage in SITBs and/or between subgroups of individuals who engage in SITBs would be theoretically and clinically relevant. Moreover, understanding to what extent within-person variability in IPs relates to within-person variability in SITBs may strengthen our knowledge about the development of acute SITB risk. Between-person differences in (within-person) variability was illustrated in seminal work by Kleiman et al. (2018), who identified distinct profiles of suicidal ideation based on mean levels and within-person variability. Some individuals appear to experience highly variable levels of suicidal ideation over time, whereas others experience more stable high or low levels of suicidal ideation (Kleiman et al., 2018). As we can expect meaningful differences in individuals' experiences of both IPs and SITBs (Czyz et al., 2019; Kaurin et al., 2020), studies could also provide insights into how dynamic profiles (digital phenotypes) of IPs and SITBs are related among

people who engage in SITBs. Existing ESM research encompasses a range of SITBs beyond suicidal ideation, but the extent to which such profiles may be observed in other types of SITBs, such as NSSI thoughts or urges, and how this relates to potential profiles that characterize how IPs are experienced is unknown. Such information would provide meaningful information to researchers and clinicians.

The current review

To address these knowledge gaps, our systematic review aims to answer four research questions:

1. Which IPs have been assessed in ESM studies of SITBs and how have they been assessed?
2. How are differences in IPs between individuals associated with SITBs? (i.e., who is at risk for SITBs?)
3. How are differences in IPs within individuals associated with SITBs? (i.e., when is momentary risk increased among individuals?)
4. Do IPs in daily life differentially relate to self-injurious thoughts rather than behaviours?

Method

Open science practices

The protocol for our systematic review was pre-registered on PROSPERO [CRD42021267009] using the NIRO-SR template (Topor et al., 2020). We report our findings according to the PRISMA 2020 statement on preferred reporting items for systematic reviews and meta-analyses (Page et al., 2020). All study materials, including the full search syntax, data extraction forms, and quality assessment tools, can be found on the Open Science Framework (OSF): https://osf.io/dxvsh/.

Search strategy

Embase, Medline, Web of Science, Proquest Psychology, and the OSF Preprints databases were searched on July 21, 2021. The databases were searched on three domains: 'suicide', 'non-suicidal self-injury' and the 'experience sampling method'. To ensure completeness within our search, IPs were not added to the search query. Instead, we applied this criterion during the screening of the articles. The final updated search was on 25th of April 2024. On the suggestion of a subject librarian at the time, we used Europe PMC instead of OSF Preprints to search for preprints, as this database is more user-friendly, and allows exportation, increasing reproducibility. All deviations from the registered protocol and the search strategies for each database are documented and can be found on the OSF page in the supplementary files: https://osf.io/dxvsh/.

Selection criteria

Studies were included if they: (1) examined non-suicidal or suicidal self-injurious thoughts/urges and behaviours; (2) investigated the association between IPs and SITBs in daily life; (3) made use of an intensive longitudinal method, i.e. ESM, EMA, Ambulatory Assessment (AA) or daily diary; (4) in any of the following study designs: cross-sectional, case-control, longitudinal or prospective study. Studies were included irrespective of participants' age, sex, and history of psychiatric disorder, and the year and language of publication. Studies were excluded if they did not specifically investigate the association between IPs and SITBs in daily life (e.g., studies investigating functions of NSSI). Given that investigating the methodological approaches used in ESM studies of IPs and SITBs was one of our research questions, studies were included regardless of their methodological quality.

See Figure 1 for the PRISMA flow diagram (Haddaway et al., 2022) of the search. One additional paper, co-authored by GK, was subsequently added to the review as despite being indexed in databases during the period covered by our updated search, this paper was not returned by the search terms.

Data extraction

Two reviewers (MJ and JJJ) extracted data from 58 selected studies. A third reviewer (OJK) checked a 25% random subsample of the data for consistency and clarity. Data extracted were study characteristics, demographic and clinical descriptions of the sample, and characteristics of SITBs. As main outcomes, we extracted: (1) the description of IPs studied; (2) a description of the results, including the association between IPs and SITBs; and (3) the assessment of IPs, including ESM item characteristics.

Critical appraisal

A composite reporting quality assessment tool for ESM studies, adapted from Liao et al. (2016) and Trull & Ebner-Priemer (2020), was developed, as no specific tool exists to assess quality or risk of bias in ESM studies. Our composite quality assessment tool is available at https://osf.io/dxvsh/.

One reviewer (JJJ) assessed each record's methodological and reporting quality. Uncertainties were resolved by the senior author (OJK). Unpublished preprint literature was also included in our search. However, given that OSF Preprints has no export function, we changed our protocol and used Europe PMC for our updated search (see transparent changes document: https://osf.io/dxvsh/).

Synthesis

We produced a narrative synthesis because of the heterogeneity of methods and populations. MJ and JJJ synthesized the results, supervised by OJK and GK.

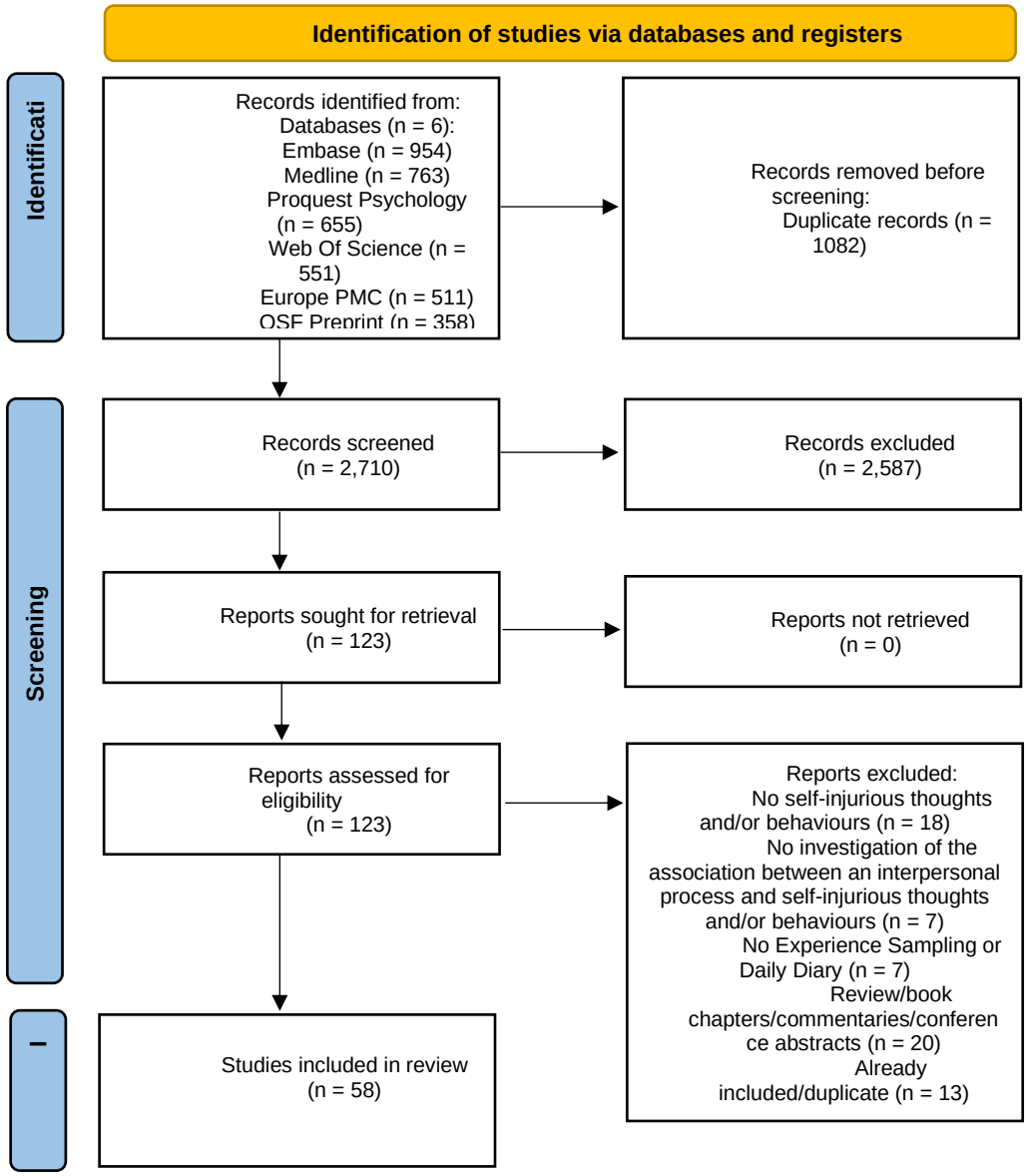
Results

Search results and sample characteristics

The complete search produced 4408 records, of which 1698 were duplicates. This resulted in the inclusion of 58 studies in this review (Figure 1).

Figure 1

PRISMA flow diagram (Haddaway et al., 2022)



From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

Table 1 describes the sample and ESM characteristics of each study. Studies were conducted in the USA (n=36), Canada (n=6), Germany (n=6), France (n=1), Belgium (n=4), Korea (n=1), Australia (n=1) and North America and Europe combined (n=1). Two studies did not report where they were conducted. Studies used 49 unique samples ranging from 16 to 1780 participants (mean age between 13.6 to 47.7 years). Overall, participants were predominantly female and White/Caucasian (11 studies did not report participants' ethnicity/race). Samples were recruited in community (n=28), clinical (n=21), and a combination of community and clinical settings (n=8). One study did not report the recruitment setting. Seventeen studies were adolescent samples (10-18 years), 14 studies sampled

emerging adults (18-29 years), 15 studies were conducted in adult samples (30+ years old), and 11 studies used a combined sample. Thirty-five studies reported their participants' lifetime prevalence rate of SITBs, ranging from 29.2% to 100% for NSSI and from 0% to 100% for a history of suicide attempts. Thirty-three studies also measured the recency of SITBs at baseline, which ranged from the previous 24 hours to the past year.

Of the 58 included studies, 77.59% (n=45) measured SITBs and 82.8% (n=48) IPs with ESM, with 65.52% (n=38) assessing both constructs in daily life. All studies had one ESM data collection period, ranging from 2 days up to 8 weeks. Most studies (n=28) used a signal-contingent sampling strategy, followed by interval-based sampling (n=20) and event-contingent sampling (n=2). Eight studies combined different sampling strategies. The sampling density ranged from 1 in daily diary studies (n=19) to 12 daily assessments. Most studies used smartphones (n=40) or palmtop computers (n=6) to send notifications, while eight studies did not use a dedicated device and either sent a link and a password for an online questionnaire via e-mail. Compliance ranged from 31% to 92% across studies, with 16 studies not reporting compliance rates.

[Table 1 can be found on the OSF page: https://osf.io/dxvsh/]

Quality assessment

Table 2 presents the reporting quality across all ESM studies (see supplementary Table 1 for an overview of individual studies). While most studies provided some rationale for using ESM (n=55, 94.8%) and described information regarding procedures to enhance compliance (n=49, 84.5%) and the technology used (n=47, 81.0%), few studies reported information on crucial methodological aspects of their ESM protocol, such as the sampling design (n=11, 19.0%) and density (n=19, 32.8%), and sample size (n=12, 20.7%). In addition, few studies (n=28, 48.28%) reported descriptive information regarding valid data (e.g., mean per person, range, participants above and below 80% threshold) or design features that addressed potential bias or burden (e.g., item-randomization to reduce participant burden; n=11, 19.0%). Similarly, most studies did not comply or only partially

complied with the reporting quality criteria for the results. For instance, few studies reported the response latency (n=8, 13.8%), and whether missing data were related to participant characteristics (n=10, 17.2%). Also, only four studies included in this review pre- or post-registered their hypotheses, research questions, analysis plan, or methods, and only fifteen studies (25.86%) have made their data or materials publicly available.

[Table 2 can be found on the OSF page: https://osf.io/dxvsh/]

1. Which IPs have been assessed in ESM studies of SITBs and how have they been assessed?

Interpersonal constructs

Eighteen studies investigated primary IPs from contemporary models of SITBs: connectedness, including peer, general, and social connectedness (n=4); belongingness, including family, peer, and thwarted belongingness (n=11); and perceived burdensomeness (n=15; Table 3). Other IPs investigated by more than one study were social and professional support (n=9), loneliness, including COVID-19-related loneliness (n=8), interpersonal experiences (n=4), social context (n=4), interpersonal events (n=5), interpersonal/social stressors (n=4), interpersonal coping strategies (n=3), negative interpersonal/social interactions (n=2), attachment (n=5) and interpersonal conflict (n=2; Table 3). Table 3 also includes several IPs (e.g., interaction partners and social interaction appraisals) that were investigated by only one study.

Assessment of IPs: Questionnaires and ESM items

Table 3 presents details on how ESM items were operationalized (i.e., item wording, time framing, and response options). The assessment of IPs was heterogeneous, as various instruments were used. Except for seven studies that investigated IPs using a retrospective self-report questionnaire, the majority of studies (n=51) investigated IPs in daily life using an ESM measure. From those, 11 studies based their ESM measure of IPs on standard, retrospective self-report questionnaires. Twenty-four of the 50 studies did not report the full wording of their ESM items that assessed IPs. Of the 23 studies that did report full-text wordings of their ESM items, there was

considerable variation in operationalization with studies using different items for the same interpersonal construct or similar items to assess different constructs. For example, across the studies we reviewed, connectedness was assessed using three different ESM item operationalizations, perceived burdensomeness was assessed using ten different ESM item operationalizations, belongingness was assessed using nine different ESM item operationalizations, support was assessed using ten different ESM item operationalizations, both interpersonal experiences and social context were assessed using three different ESM item operationalizations, and coping strategies/behaviour were assessed using three different item operationalizations. Further, there was a considerable amount of overlap in the item wordings that were used to assess different constructs.

[Table 3 can be found on the OSF page: https://osf.io/dxvsh/]

There was a high heterogeneity in the timeframes (e.g., referencing to the last 24 hours, since the past beep, right now) and response options that were used to operationalize the same or a similar construct. To assess IPs in daily life, the majority of studies used a 5-point Likert response scale (n=14), twelve studies used a 7-point scale, six studies used a 6-point scale, six studies used a binary yes/no scale, four studies used a Visual Analogue Scale (VAS), three studies used sliding scales, two studies used a 10-point scale and another two studies used a 3-point scale.

Between- and within-person design

Table 4 presents the main findings of the ESM studies. Associations between IPs and SITBs were investigated at the between-person (n=26) and within-person level (n=39).

[Table 4 can be found on the OSF page: https://osf.io/dxvsh/]

2. How are differences in IPs between individuals associated with SITBs?

IPs associated with suicidal thoughts/urges

Across the eleven studies that focused on IPs and suicidal thoughts/urges (Al-Dajani & Czyz, 2022; Al-Dajani et al., 2022; Depp et al., 2016; Hadzic et al., 2020; Hutchinson et al., 2021; Kaurin et

al., 2022; MacNeil et al., 2022; Oppenheimer et al., 2020; Parrish et al., 2021; Parrish et al., 2024; Smith et al., 2024), there are three types of study designs that enabled a better understanding of associations at the between-person level (Table 4). First, three studies investigated cross-sectional associations between IPs and suicidal thoughts across the monitoring period (Al-Dajani et al., 2022; Hadzic et al., 2020; Kaurin et al., 2022) and found that individuals who reached out to personal support more often (Al-Dajani et al., 2022), experienced higher mean levels of perceived burdensomeness (Hadzic et al., 2020) and perceived their interaction partners more often as cold or dominant (Kaurin et al., 2022) than their peers during their everyday lives were more likely to think (more severely) about suicide across the ESM period.

Second, six studies investigated how differences between individuals in suicidal thoughts/urges, measured at baseline, prospectively relate to IPs assessed with ESM in daily life (Hadzic et al., 2020; MacNeil et al., 2022; Oppenheimer et al., 2020; Parrish et al., 2021; Parrish et al., 2024; Smith et al., 2024). The conclusion we can draw from these studies is that individuals who report thinking about suicide (more) at baseline compared to others, experience higher levels of perceived burdensomeness in their daily lives (Hadzic et al., 2020; MacNeil et al., 2022; Parrish et al., 2021). Three studies investigated whether suicidal thoughts at baseline were associated with daily-life thwarted belongingness, but found conflicting results (Hadzic et al., 2020; Parrish et al., 2021; Smith et al., 2024).

Finally, three studies sought to advance understanding of between-person prospective associations between IPs at baseline and suicidal thoughts/urges in daily life (Al-Dajani & Czyz, 2022; Depp et al., 2016; Hutchinson et al., 2021). These studies found that individuals who experience higher levels of perceived burdensomeness (Al-Dajani & Czyz, 2022) and lower levels of peer connectedness (Hutchinson et al., 2021), and endorse more negative appraisals towards social interactions (Depp et al., 2016) at baseline, are more likely to think (more severely) about suicide in daily life. To date, however, only one study investigated the two-way interaction of thwarted

belongingness and perceived burdensomeness at baseline, revealing no significant association with daily level of suicidal urge intensity (Al-Dajani & Czyz, 2022).

IPs associated with suicidal behaviours

Of the studies reviewed, four studies focused on between-person prospective associations between IPs and suicidal behaviours across the ESM period (Czyz et al., 2021; Kim et al., 2023; Parrish et al., 2021; Parrish et al., 2024). All four of these studies have investigated how history of suicidal behaviours, measured at baseline, are associated with IPs in daily life. Each specific IP was, however, only examined by one study, leaving the evidence base poorly substantiated. Findings from these studies suggest that history of suicidal behaviours does not predict how IPs are experienced in daily life.

IPs associated with NSSI thoughts/urges

Two studies investigated associations between IPs and NSSI thoughts (Christensen et al., 2023; Franssens et al., 2023), suggesting that individuals who perceive less emotional social support (Christensen et al., 2023), and more interpersonal distrust and rejection (Franssens et al., 2023) in everyday life are the ones most likely to also experience NSSI thoughts in daily life. Importantly, however, these studies also revealed that perceived emotional social support (Christensen et al., 2023) and insecure attachment assessed at baseline (Franssens et al., 2023) are not prospectively associated with an increased risk for NSSI thoughts in daily life.

IPs associated with NSSI behaviour

Eight studies investigated between-person associations of IPs and NSSI (Berghoff et al., 2022; Christensen et al., 2023; Czyz et al., 2019b; Dodd et al., 2022; Koenig et al., 2020; Santangelo et al., 2017; Schwartz-Mette et al., 2022; Turner et al., 2017). Both cross-sectional and prospective All three types of study designs were adopted, which provided three novel insights (Table 4). First, engaging in NSSI does not seem to be cross-sectionally associated with relying on support (Czyz et al., 2019b) or

feelings of attachment towards a best friend (Koenig et al., 2020) across the ESM period. However, NSSI was cross-sectionally related to feelings of attachment towards mother across the monitoring period (Koenig et al., 2020).

Second, based on findings from three prospective studies (Santangelo et al., 2017; Schwartz-Mette et al., 2022; Turner et al., 2017), we can conclude that individuals who report more frequently engaging in NSSI behaviours at baseline show greater instability in their attachment levels, are less securely attached to their mother and best friend (Santangelo et al., 2017) and felt more lonely during COVID-19 (Schwart-Mette et al., 2022). Individuals that report (more) NSSI behaviours at baseline seem to be less frequently in contact with their family/peers and are less likely to seek support to cope with distress and perceive support from peers during their everyday life (Turner et al., 2017).

Third, findings from two prospective studies allow us to understand how between-person differences in IPs at baseline may increase the risk for NSSI behaviours in daily life. These studies suggest that differences in perceived emotional support (Christensen et al., 2023) and interpersonal problems (Dodd et al., 2022) at baseline are not associated with increased risk for NSSI behaviours in daily life.

IPs associated with self-harm thoughts

Two studies investigated between-person associations of attachment (relationship quality) and self-harm thoughts, irrespective of intent (Janssens et al., 2022; Janssens et al., 2023b). These prospective studies suggest that individuals with higher levels of paternal and maternal attachment insecurity are more likely to think about self-harm in their daily lives (Janssens et al., 2022), whilst the other study shows that maternal attachment relationship quality is a protective factor that can buffer the negative effect of adverse childhood experiences on the intensity of self-harm thoughts in daily life (Janssens et al., 2023b).

3. How are differences in IPs between individuals associated with SITBs?

IPs associated with suicidal thoughts/urges

Of the studies reviewed, 21 studies focused on within-person relationships between a specific IP and suicidal self-injurious thoughts (Al-Dajani & Czyz, 2022; Al-Dajani et al., 2022; Ammerman & Jacobucci, 2023; Brown et al., 2022; Coppersmith et al., 2019; Czyz et al. 2019a; Defayette et al., 2023; Glenn et al., 2022; Hallensleben et al., 2019; Hamilton et al., 2024; Husky et al., 2017; Jacobucci et al., 2022; Kleiman et al., 2017; Mou et al., 2018; Mournet et al., 2022; Nock et al., 2009; Rath et al., 2019; Sels et al., 2022; Smith et al., 2024; Stanley et al., 2021; Victor et al., 2019). Twelve studies have investigated contemporaneous (concurrent) associations between an IP and suicidal thoughts/urges (Al-Dajani & Czyz, 2022; Coppersmith et al., 2019; Czyz et al., 2019a; Defayette et al., 2023; Hallensleben et al., 2019; Hamilton et al., 2024; Kleiman et al., 2017; Mournet et al., 2022; Nock et al., 2009; Rath et al., 2019; Smith et al., 2024; Stanley et al., 2021). Based on these studies, we can conclude that belongingness (Al-Dajani & Czyz, 2022; Coppersmith et al., 2019; Hallensleben et al., 2019; Kleiman et al., 2017; Rath et al., 2019), burdensomeness (Coppersmith et al., 2019; Czyz et al., 2019a; Hallensleben et al., 2019; Kleiman et al., 2017; Mournet et al., 2022; Rath et al., 2019; Smith et al., 2024), support (Hamilton et al., 2024; Mournet et al., 2022), loneliness (Mou et al., 2018; Mournet et al., 2022) and connectedness (Czyz et al., 2019a; Hamilton et al., 2024) are contemporaneously related to suicidal thoughts/urges within the same assessment period (Table 4).

Eighteen studies have investigated temporal within-person associations between an IP and suicidal thoughts/urges (Al-Dajani & Czyz, 2022; Al-Dajani et al., 2022; Ammerman & Jacobucci, 2023; Brown et al., 2022; Coppersmith et al., 2019; Czyz et al., 2019a; Defayette et al., 2023; Glenn et al., 2022; Hallensleben et al., 2019; Husky et al., 2017; Jacobucci et al., 2022; Kleiman et al., 2017; Mou et al., 2018; Mournet et al., 2022; Nock et al., 2009; Sels et al., 2023; Smith et al., 2024; Victor et al., 2019). Whilst we find no convergent evidence for a prospective association between higher-than-usual perceived burdensomeness and the intensity of suicidal thoughts/urges (Al-Dajani & Czyz, 2022; Coppersmith et al., 2019; Czyz et al., 2019a; Glenn et al., 2022; Hallensleben et al., 2019;

Jacobucci et al., 2022; Kleiman et al., 2017; Mournet et al., 2022; Rath et al., 2019; Smith et al., 2024), we do find evidence for a prospective effect of the interaction between perceived burdensomeness and thwarted belongingness on suicidal thoughts/urges (Al-Dajani & Czyz, 2022). This interaction effect suggests that when people experience momentary elevated levels on both perceived burdensomeness and thwarted belongingness, there is an increased risk for experiencing suicidal thoughts/urges. Of note, this effect seemed to play out across hours rather than days as it was only found for suicidal thoughts at the next time point on average 1-2 hours later (Hallensleben et al., 2019) and not the next day (Al-Dajani & Czyz, 2022). It should be mentioned, however, that these studies did not control for the self-predictive effect of suicidal thoughts over time (i.e., the autoregressive effect), leaving it uncertain whether the interaction of these IPs uniquely increases risk.

In fact, to date, only three studies have controlled for autoregressive effects which enables the reliable identification of IPs that incrementally predict suicidal thoughts/urges (Coppersmith et al., 2019; Jacobucci et al., 2022; Sels et al., 2023). These studies found evidence for a predictive effect of thwarted belongingness on suicidal thoughts, but only when more dense sampling schedules were used (e.g., at least 4 assessments daily; Jacobucci et al., 2022; Sels et al., 2023), thereby suggesting that the time scale on which these IPs operate in predicting suicidal thoughts operates is more likely to occur across hours rather than days (Table 4).

IPs associated with suicidal behaviours

One study has investigated within-person associations between IPs and suicidal behaviour, and found that both thwarted belongingness and burdensomeness were concurrently, but not prospectively, associated with suicidal behaviour across two hours (Rogers, 2023).

IPs associated with NSSI thoughts/urges

Eight studies investigated temporal within-person associations of IPs and NSSI thoughts/urges (Franssens et al., 2023; Haliczer & Gordon, 2023; Hepp et al., 2021b; Shingleton et al., 2013; Turner et

al., 2016a; Turner et al., 2016b; Turner et al., 2019; Victor et al., 2019), suggesting that being alone (Shingleton et al. 2013; Turner et al., 2016b), rejection (Franssens et al., 2023; Hepp et al., 2021b), interpersonal distrust (Franssens et al., 2023) and perceived social support (Turner et al., 2019) are contemporaneously associated with daily-life NSSI thoughts/urges.

Additionally, conflict (Turner et al., 2016a/b), rejection (Victor et al., 2019) and perceived social support (Turner et al., 2016a) have been found to prospectively predict NSSI thoughts/urges in real time. However, one study suggests that the nature of this relationship might be dependent on whether they disclosed their NSSI behaviour, such that when individuals disclosed their NSSI behaviour, the perceived social support that followed was positively associated with next-day urges (Turner et al., 2019).

IPs associated with NSSI behaviours

Five studies investigated within-person associations of a specific IP and engagement in NSSI behaviour (Haliczer & Gordon, 2023; Kyron et al., 2023; Nock et al., 2009; Turner et al., 2016a; Turner et al., 2016b), indicating that both conflict (Haliczer & Gordon, 2023; Turner et al., 2016a) and rejection (Nock et al., 2009; Turner et al., 2016b) are prospectively associated with the presence of NSSI behaviours at the next assessment point.

4. Do IPs in daily life differentially relate to self-injurious thoughts rather than behaviours in real-time?

IPs associated with suicidal thoughts/urges and behaviours

Of all studies that investigated both IPs and SITBs in daily life, five studies included both suicidal thoughts/urges and behaviours (Defayette et al., 2023; Janssens et al., 2023a; Mereish et al., 2023; Nock et al., 2009; Shingleton et al., 2013), but none of these studies investigated whether an IP relates differently to suicidal thoughts, behaviours, or the transition from suicidal thoughts to behaviours.

IPs associated with NSSI thoughts/urges and behaviours

Of all studies that investigated both IPs and SITBs in daily life, twelve studies included both NSSI thoughts/urges and behaviours (Christensen et al., 2023; Czyz et al., 2019b; Haliczer & Dixon-Gordon, 2023; Halverson et al., 2022; Hepp et al., 2021a; Koenig et al., 2020; Janssens et al., 2023a; Mereish et al., 2023; Nock et al., 2009; Shingleton et al. 2013; Turner et al., 2016a; Turner et al., 2019). Three of these studies investigated whether an IP is associated with NSSI thoughts/urges, behaviours or both (Christensen et al., 2023; Halverson et al., 2022; Hepp et al., 2021a). One study suggests that perceived emotional support is associated with both NSSI urges and behaviors (Christensen et al., 2023). However, evidence regarding the role of interpersonal stress in NSSI urges versus behaviours is mixed (Halverson et al., 2022; Hepp et al., 2021a).

Three studies investigated IPs that are related to the transition from NSSI thoughts/urges to behaviours (Nock et al., 2009; Turner et al., 2016b; Turner et al., 2019). Social rejection (Nock et al., 2009), being alone (Nock et al., 2009; Turner et al., 2019), and having an argument or conflict with someone (Turner et al., 2016b) were with retrospective assessments associated with acting upon self-injurious thoughts. Another study showed that greater perceived support was associated with a lower likelihood of resisting engaging in NSSI behaviour when intense same-day NSSI urges were experienced (Turner et al., 2019). Finally, one study found that talking to someone was one of the most commonly used alternative behaviours (Nock et al., 2009). Yet, none of these studies have controlled for NSSI thoughts/urges in the prediction of NSSI behaviours which could explain findings by their association with NSSI thoughts/urges.

Discussion

General summary of study findings

This review identified 58 ESM studies that assessed IPs and/or SITBs These studies were conducted in the USA (n=36), Europe (n=11), and Canada (n=6), and represent data from 49 unique

samples. Most studies did not investigate primary IPs from major theoretical models, with the measurement of IPs being highly heterogeneous. The findings indicate that perceived burdensomeness is positively related to SITBs at the between- and within-person level. However, based on the current literature, no firm conclusions can be made regarding the timescale on which IPs operate (minutes, hours, days). Moreover, the findings from studies investigating other IPs remain ambiguous due to the highly diverse ways in which constructs are operationalized. In light of these challenges, more research is necessary to clarify whether variations in IPs are linked to SITBs and to identify whether specific IPs are associated with the emergence of self-injurious thoughts and the subsequent progression to behavior in real-time. In the subsequent sections, we discuss the implications of the findings for each question addressed in this review.

Assessment of IPs (RQ 1)

Whilst ESM provides the necessary temporal precision and ecological validity to reliably test the dynamic IPs from contemporary models on SITBs, only 18 out of 58 studies have investigated tenets of the three primary IPs from major theoretical models (i.e., connectedness, belongingness and perceived burdensomeness). In total, over 50 other IPs were investigated, highlighting a proliferation of investigated constructs. Moreover, the assessment of IPs in ESM studies of SITBs was highly heterogeneous, resulting in a fragmented literature. For example, perceived burdensomeness was operationalized in 10 different ways (see Table 3). However, as only 53.45% of the included studies have reported the full text of their items (Table 2), we cannot ascertain the exact degree of inconsistency in ESM measurement. In addition, some constructs measured with similar ESM items were considered different between studies, and similar constructs were assessed with a variety of items, referred to as “jingle” and “jangle” fallacies (Gonzalez et al., 2021), respectively. While measurement issues occur across psychological research (Flake & Fried, 2020), they are especially common in ESM research due to single-item measures and the accompanying challenges of psychometrically validating them (Fritz et al., 2023). These measurement issues hamper comparison

across studies, and may create an illusion of broader support and convergent evidence for an association between a given IP and SITBs, while in fact the evidence is highly heterogeneous and fragmented.

Future research would benefit from transparently reporting measurement details and finding consistency in defining constructs and their operationalizations (e.g., item wording, timeframe, and response options). For guidance about transparent reporting of ESM items, we direct readers to Trull and Ebner-Priemer, 2020 and Flake and Fried, 2020. Open science practices, such as pre- and post-registration and open materials —increasingly used in ESM (Kirtley et al., 2020), clinical psychology (Dora et al., 2023; Tackett et al. 2017, 2019), and suicide research (Kirtley et al., 2022) — offer opportunities for increasing measurement transparency and replicability in ESM research on IPs and SITBs. One open science measurement initiative, the ESM Item Repository (Kirtley et al., 2024; www.esmitemrepository.com), enables researchers to contribute their ESM items to an open bank of items, increasing their discoverability and transparency.

Additionally, we believe the current literature would benefit from further defining and clarifying constructs and using standardised assessment methods. Although it may be valuable to use standardized, retrospective, self-report questionnaires — for example, the Interpersonal Needs Questionnaire (INQ), which is used to assess IPs with reasonable reliability (Hill et al., 2015; Mitchell et al., 2020; Van Orden et al., 2012) — as a basis for developing ESM items, such questionnaire items are not always directly portable to the ESM context (Eisele et al., 2021). We encourage researchers and funders to prioritize studies that develop validated ESM items to assess certain IPs and SITBs. This could lead to a set of gold standard ESM items per construct, which facilitates comparison across studies, scientific communication between researchers, and the building of a cumulative evidence base. Some researchers have begun this crucial work by developing ESM items to assess SI, thwarted belongingness, and perceived burdensomeness (Forkmann et al., 2018). However, specific ESM items to assess a broad range of IPs and SITBs have yet to be developed and validated.

Between-person relationships (RQ2)

All four studies investigating the association between perceived burdensomeness and SITBs suggest an association with self-injurious thoughts so that individuals with (higher levels of) suicidal thoughts/urges, reported higher levels of perceived burdensomeness (Al-Dajani & Czyz, 2022; Hadzic et al., 2020; MacNeil et al., 2022; Parrish et al., 2021). However, the extent to which the level of connectedness or belongingness — two other prominent IPs in theoretical models — are related to SITBs remains unclear, as the reviewed studies reported divergent results at the between-person level (Czyz et al., 2021; Hadzic et al., 2020; Hutchinson et al., 2021; Parrish et al., 2021; Smith et al., 2024). While emerging evidence among adolescent inpatients suggests that greater belongingness (family or peer) attenuates the adverse impact of perceived burdensomeness on same-day suicidal urge intensity (Al-Dajani & Czyz, 2022), more work is needed to evaluate this interaction in relation to SITBs as this is considered a key component in the process of developing self-injurious thoughts according to the Interpersonal Theory of Suicide (Joiner, 2005).

The evidence regarding between-person associations of social support and SITBs remains ambiguous (Al-Dajani et al., 2022; Christensen et al., 2023; Czyz et al., 2019b; Turner et al., 2017). Given that social support is posited as a motivational moderator within the Integrated Motivation-Volitional model of SITBs (O'Connor & Kirtley, 2018), more work investigating relationships between social support and SITBs at the between-person level would be theoretically valuable. Regarding associations between attachment and SITBs, evidence suggests that individuals with higher attachment quality are less likely to report engaging in SITBs (Janssens et al., 2022; Janssens et al., 2023a; Janssens et al., 2023b; Koenig et al., 2020; Santangelo et al., 2017). However, more research is needed that resolves conflicting findings and further explores associations between IPs and SITBs.

Although we find evidence that IPs play a role in the manifestation of NSSI thoughts/urges and behaviours in daily life (Four-Function Model of NSSI, Benefits and Barriers Model and the Family Distress Cascade Theory; Bentley et al., 2014; Hooley & Franklin, 2017; Waals et al., 2018), current

NSSI theories do not differentiate between thoughts and behaviours. This hinders the evaluation of specific predictions for NSSI models, indicating a need for further theory development.

At this stage, ESM studies that investigate IPs across subgroups that are specifically vulnerable to SITBs are lacking. For example, individuals in specific developmental stages, socioeconomic groups, clinical settings, or marginalized populations (e.g., LGTBQIA+ or multiracial youth) are at a greater risk for SITBs and are especially vulnerable to certain negative IPs, e.g., rejection and limited social support (Plener et al., 2015; Wiglesworth et al., 2022). Indeed, the interpersonal shifts that occur during adolescence — a phase where SITBs peak (Gandhi et al., 2018; Hawton et al., 2012) — could contribute to the heightened vulnerability for SITBs. However, more research is needed that reveals between-subgroup differences in within-person IPs that play out in the everyday lives of adolescents, as this may provide the information required to tailor the prevention and management of SITBs to the specific needs of young individuals. Additionally, and consistent with SITB research more broadly (Franklin et al., 2017), the ESM evidence regarding the protective role effect of IPs on SITBs is still in its infancy and this area of research deserves further exploration, as this may open up novel directions for research and practice. While this review highlights the investigation of several protective IPs (e.g., social connectedness, belongingness, support), our understanding of the role of a broader array of IPs and their interplay with established risk factors for SITBs (e.g., increased distress; Kuehn et al., 2022) remains limited. Future research could extend our knowledge on how to mitigate the impact of certain risk factors, and potential novel IP as protective factors, are essential to target and promote in prevention and intervention efforts.

To fully harness the potential of ESM and take into account the dynamic nature of IPs and SITBs, we may need to focus on the examination of between-person/group differences in within-person associations and fluctuations. For example, it may be relevant to reveal the extent to which momentary fluctuations in thwarted belongingness are associated with within-person fluctuations in SITBs, and differ between people who do and do not engage in SITBs, or between subgroups of

individuals who engage in SITBs. This would provide knowledge into how individual sociodemographic, psychosocial, and clinical variables (e.g., frequency and severity of SITBs) are related to the salience of particular within-person associations between IPs and SITBs.

Within-person relationships (RQ3)

Initial support was provided for a negative, contemporaneous, within-person association between connectedness and suicidal thoughts/urges (Czyz et al. 2019a; Hamilton et al., 2024). Additionally, convergent evidence revealed that thwarted belongingness was contemporaneously related to suicidal thoughts/urges (Coppersmith et al., 2019; Hallensleben et al., 2019; Kleiman et al., 2017; Rath et al., 2019), but evidence regarding the prospective effect of thwarted belongingness on suicidal thoughts/urges was mixed. Similarly, there is converging evidence regarding a contemporaneous association between burdensomeness and suicidal thoughts/urges (Coppersmith et al., 2019; Czyz et al., 2019a; Hallensleben et al., 2019; Kleiman et al., 2017; Mournet et al., 2022; Rath et al., 2019; Smith et al., 2024), but evidence for a prospective association was again inconclusive (Coppersmith et al., 2019; Czyz et al., 2019a; Hallensleben et al., 2019; Jacobucci et al., 2022; Mournet et al., 2022; Rath et al., 2019; Sels et al., 2022). Moreover, studies investigating the theoretically important interaction between perceived burdensomeness and thwarted belongingness revealed positive within-person associations with suicidal thoughts/urges (Hallensleben et al., 2019; Rath et al., 2019) and suicidal urge intensity (Al-Dajani & Czyz, 2022). Some evidence was found for the within-person relationships between social context, rejection, support, loneliness, and SITBs (Brown et al., 2022; Husky et al., 2017; Mou et al., 2018; Mournet et al., 2022; Nock et al., 2009; Shingleton et al., 2013; Turner et al., 2016b). However, more research using homogeneous assessment methods is required before firm conclusions about specific relationships of IPs with SITBs in daily life can be made. Moreover, information about specific timeframes (i.e., minutes/hours between ESM prompts) that were used to test these within-person associations is largely missing in the current literature. Yet, this is essential information for researchers to determine optimal ESM

sampling schemes to capture relationships between IPs and SITBs, and for clinicians to know the relevant time window in which to intervene.

ESM studies have the unique potential to unravel the timescales at which within-person associations between IPs and SITBs occur and which IPs are related to the transition from thoughts to behaviours. This knowledge is fundamental to improving daily-life prevention and intervention. Therefore, it is crucial that researchers report the average time between assessments in future studies. This could reveal and further refine the predictive value of short-term interpersonal warning signals. However, it is possible that the typical sampling frequency of ESM studies is not dense enough to detect the underlying time dynamic of within-person associations. This may result in finding only contemporaneous associations, whilst another study with more assessments per day may reveal a temporal association (Epskamp et al., 2018). Indeed, our review shows that the full range of timeframes in which certain associations can exist has yet to be explored as most findings to date appear to come from associations within the same assessment window. Moreover, temporal models that control for autoregressive effects are required to reliably identify which IPs incrementally predict risk of thoughts, behaviours, and the transition from thoughts to behaviours. Therefore, future research could investigate associations between IPs and SITBs using varying sampling frequencies to provide knowledge about the time scale on which IPs affect SITBs in daily life. An example of this type of research from another field measured IPs, such as parent-adolescent conflict, over six different timescales (Bülow et al., 2023). Furthermore, ESM could not only shed light on interpersonal warning signals but also offer exciting opportunities to test the ecological validity of novel NSSI models (e.g., Benefits and Barriers Model and the Family Distress Cascade Theory; Hooley & Franklin, 2017; Waals et al., 2018).

At this point, ESM studies investigating both IPs and SITBs have mainly investigated associations at a between- or within-person level to increase understanding of who is most at risk for SITBs and when risk is increased. However, additional investigation of variability in IPs and SITBs could

increase our understanding of how IPs fluctuate differently in the daily lives of individuals who do and do not engage in SITBs and/or between subgroups of SITBs. As a result, this may enable the identification of new intervention targets (e.g., distal or contextual factors that influence instability in interpersonal processes) that can help us move forward in preventing and managing SITBs.

Associations between IPs and self-injurious thoughts versus behaviours (RQ 4)

Given that ESM can generate insights beyond between-person associations of IPs and SITBs and increase our understanding of when individuals may translate their thoughts into behaviours, this methodology is especially suited to test current ideation-to-action theories. Three studies have investigated whether an IP relates to the transition from self-injurious thoughts to behaviours (Nock et al., 2009; Turner, Cobb, et al., 2016; Turner, Yiu, et al., 2016). However, all of these studies have investigated these associations retrospectively at the day (Turner et al., 2016a; Turner et al., 2016b; Turner et al., 2019) or beep level (Nock et al., 2009). Individuals were more likely to act upon their thoughts if they felt rejected (Nock et al., 2009), were alone (Nock et al., 2009; Turner et al., 2019) or had an argument or conflict with someone (Turner et al., 2016b). Interestingly, individuals who felt supported were less likely to refrain from NSSI when they had experienced NSSI urges that same day (Turner et al., 2019). However, more research is needed that differentially investigates whether specific IPs are associated with self-injurious thoughts, behaviours, or both as this is crucial to prevention and treatment development. Therefore, we encourage future researchers to include both self-injurious thoughts and behaviours when investigating relevant associations with IPs.

Moreover, future research should consider using temporal models to reliably identify which IPs are associated with the transition from thoughts to behaviours. Studies could test ideation-to-action theories and the hypothesized pathways within these. For example, within the IMV model (O'Connor & Kirtley, 2018), it is hypothesized that feeling defeated results in feelings of entrapment which, in turn, leads to suicidal ideation. This central mediation pathway is moderated by specific dynamic processes, such as thwarted belongingness and perceived burdensomeness. An ESM study

may empirically test these predictions by investigating the association between defeat, entrapment, and suicidal ideation over hours in real-time, and the extent to which thwarted belongingness and perceived burdensomeness influence the relationship between entrapment and suicidal ideation.

Yet, there are several challenges in setting up an ESM study to investigate key IPs and SITBs that warrant discussion. Decisions regarding the ESM protocol (i.e., timing and frequency of ESM prompts) should be made based on the estimated burden and feasibility of using ESM within the group of interest. For example, previous research by Kleiman et al. (2017) and Coppersmith et al. (2023) revealed that SITBs can vary greatly over the course of a day, and research by Turner et al (2019) suggests that SITBs might be more endorsed during the evening. This encourages repeated assessment of SITBs throughout the day and evening. A combination with event-contingent sampling and burst ESM surveys — ESM prompts spaced at a higher frequency, such as when intense self-injurious thoughts/urges are experienced — could advance understanding of IPS related to the manifestation of intense thoughts and those related to the subsequent engagement in behavior (e.g., Kiekens et al., 2023). Despite the often expressed concerns of ethics committees, previous research demonstrates that repeatedly asking about SITBs using ESM does not intensify self-harm thoughts or the risk of engaging in self-harm behaviours (Blades et al., 2018; Coppersmith et al., 2022b). However, adolescents reporting SITBs during an ESM period are more likely to report ESM beep-disturbance, i.e., a sense of being disrupted/inconvenienced by the ESM questionnaires, than those not reporting SITBs during the ESM period, and at moments when adolescents' self-harm thoughts were more vs. less intense, they also reported higher beep-disturbance (Kirtley et al., 2023). Consequently, researchers must take active steps to minimize unnecessary burden, such as curtailing questionnaire length — as increased burden is associated with the length of the ESM questionnaire, not with increased sampling frequency (Eisele et al., 2022).

In addition to this, assessing specific IPs and SITBs in daily life can be challenging as both can be rare, e.g., interpersonal conflict and suicide attempts. The low prevalence of events can reduce the

statistical power of studies, necessitating either larger datasets (with more participants, more observations, or longer ESM assessment periods) to reliably establish associations. However, research in clinical samples (e.g., individuals hospitalized for suicidal thoughts), collaborations between researchers, and data sharing can advance cumulative evidence-building (Kirtley et al., 2022).

Clinical implications

Some preliminary implications for clinical practice can be formulated. First, the empirical evidence for the role of perceived burdensomeness in self-injurious thoughts at both the between- and within-person level suggests that clinicians and practitioners should be vigilant for about the role IPs play in their clients. However, more research is needed to detect risk within minutes or hours, which is necessary for the prevention and clinical management of SITBs. In addition, future research that identifies what may reduce feelings of perceived burdensomeness is essential. Second, findings suggest associations between a broad range of other IPs and SITBs and, therefore, incorporating an interpersonal view within treatment for SITBs could be useful, e.g., including family members in treatment among youth with SITBs (e.g., Glenn et al., 2019).

Finally, this review highlights the potential of ESM to provide clinical practice with a more reliable representation of how IPs play out in the daily lives of individuals with SITBs. For example, if visualisations of and individual information on clients' daily-life interpersonal experiences can be fed back into the therapy room, psychoeducation may be facilitated, and therapy can be adapted to the dynamic nature of these experiences (Weermeijer et al., 2023; Weermeijer et al., in press). A promising future research avenue here is the development of real-time and just-in-time adaptive interventions (i.e., an intervention that is tailored to the individual's needs and provided at the time it is most needed) by further identifying dynamic, within-person fluctuations in interpersonal factors that increase risk for SITBs (Coppersmith et al., 2022a).

Conclusions

This review reflects a proliferation of investigated IPs in relation to SITBs that were assessed in highly heterogeneous ways. This hampers our ability to reliably interpret and synthesise findings across the literature. Studies found convergent evidence for the association between perceived burdensomeness and SITBs at the between- and within-person level. However, results from studies investigating other interpersonal processes were mixed. Future researchers are encouraged to prioritize research that develops and validates gold standard ESM items that assess interpersonal processes so that constructs can be operationalized in a consistent manner. Further, advanced temporal models that control for autoregressive parameters and use high sampling frequencies (i.e., over minutes/hours) can help unravel the timescales of associations and further examine whether interpersonal processes are related to thoughts, behaviours, or the transition from thoughts to behaviours

Chapter 8: Open science in suicide research is open for business

Published (with open access) as:

Kirtley, O. J., Janssens, J. J., & Kaurin, A. (2022). Open science in suicide research is open for business. Crisis: The Journal of Crisis Intervention and Suicide Prevention. https://doi.org/10.1027/0227-5910/a000859

The electronic supplementary material is available with the online version of the article at: https://doi.org/10.1027/0227-5910/a000859

Introduction

Suicide claims more than 700,000 lives globally every year (World Health Organization, 2021) and affects approximately 135 people per individual who dies by suicide (Cerel et al., 2019). Those affected by suicide – from people with lived experience to policy-makers – are depending on researchers to provide reliable evidence: a prerequisite of effective prevention and treatment. However, not all evidence is equal; studies with small sample sizes may produce spurious results (Carpenter & Law, 2021) and measures may be unable to capture suicidal thoughts and behaviors in a reliable and valid way (Millner et al., 2020), which can compromise the generalizability of findings.

The quality of the research methods used to generate evidence is the key to determining the credibility we afford it (Vazire et al., 2021). Although we have undoubtedly made progress over the years in our understanding of suicide, recent research does not appear to have built upon previous work to the extent it could have done – mostly because of major methodological limitations in suicide research and publication bias limiting insights into the full range of existing findings (Franklin et al., 2017; Pirkis, 2020).

To build on what has come before us, we need to be able to see what we are building on. Beyond unpublished null-findings, there are many other reasons the evidence base is incomplete. Journal word limits may preclude sufficiently detailed descriptions of methods and statistical analysis to enable replication, abandoned research questions and analysis plans may not be reported as they make for a messier story, or after a long period of data collection, the original hypotheses and analysis plans may have become hazy, or could have changed based on knowledge of the data.

How can we strengthen the foundations of our evidence base for the future and in doing so, "future-proof" suicide research? We can take active steps to tackle the problematic research practices described earlier, which threaten transparency (openness about the research process), reproducibility (obtaining the same results again using the same data), and replicability (obtaining

similar results with identical methods in new studies) of research. Open science practices, including registration of hypotheses and analytic plans before data collection (preregistration) and sharing analytic code and materials, can help to address research practices that may threaten the transparency, reproducibility, and replicability of research (Munafò et al., 2017).

Conversations about transparency, reproducibility, and replicability have just begun to blossom in clinical psychology and psychiatry research (Tackett et al., 2017, 2019), and have only recently begun to open up formally in suicide research (Carpenter & Law, 2021). Following a proposal by the International Association for Suicide Prevention (IASP) Early Career Group, Crisis recently adopted the Registered Reports (RRs) article format (Pirkis, 2020); Carpenter and Law (2021) published an introduction to open science for suicide researchers; and the authors of the current editorial presented a symposium on open science practices at the 2021 IASP World Congress.

In this editorial, we use examples from our and others' work to demonstrate the opportunities for future-proofing research by implementing open science practices, and we discuss some of the challenges and their potential solutions. We cover implementing open science practices in new, ongoing, and concluded studies, and discuss practices in order of being "low" to "high" threshold to implement (based on Kathawalla et al., 2021). Space constraints preclude us from covering all open science practices and there are undoubtedly more researchers using open science practices in suicide research than we are aware of and whose work we have included here. To highlight the open science work of as many researchers as possible, we have sometimes provided examples in Electronic Supplementary Material 1 (ESM 1) rather than in the text. We hope readers will help us add to these examples via our "living" reading list (https://osf.io/v6y3t/). Readers interested in a broad overview of open science practices are directed to the work of Carpenter and Law (2021), Kathawalla et al. (2021), and Tackett et al. (2019).

Implementing Open Science Practices Into New Studies

In this section, we describe open science practices that researchers can implement when starting new studies – an excellent time to introduce open science practices into the research workflow. When implementing an open science practice for the first time in a new study, it is helpful to weigh the learning curve of acquiring new skills inherent to a study (e.g., new analytic techniques) against the complexity of the open science practice to be implemented. Open science practices are skills that develop over time (Nosek et al., 2019), and we recommended introducing one practice per new project to build these practices up into a full open science repertoire (Quintana, 2020a).

The first and last authors' initial foray into open science was a full preregistration – a relatively advanced open science practice – that, combined with learning new statistical software and techniques, made for a challenging initiation into open science. However, there are also benefits to adopting multiple open science practices simultaneously, especially for new PhD students, such as the second author; using open science practices was simply how she was trained to conduct research, as opposed to them being "special" practices to adopt.

Preprints

A growing number of suicide researchers (e.g., Coppersmith et al., 2020; DelPozo-Banos et al., 2021; Kaurin, Wright, Hallquist et al., 2020; O'Connor et al., 2018) post a version of their manuscript online, prior to peer review, known as a preprint (commonly posted on PsyArXiv for psychology, SocArXiv for sociology, MedArXiv for clinical articles, etc.). This is because preprints increase access to research beyond barriers of publishers' paywalls and the successive upload of revised manuscript versions transparently shows the evolution of an article. Moreover, sharing work ahead of peer review on Twitter aids development of professional networks (especially for early career researchers [ECRs]), facilitates collaboration, and encourages offers of support and advice from the broader scientific community. Preprints automatically receive a digital object identifier (DOI) and are therefore citable. This can be particularly useful for ECRs, who need to demonstrate output to progress committees and grant application panels, but could otherwise wait months or even years for

papers to be published in a journal. Although most journals allow researchers to submit preprinted manuscripts, we advise researchers to check individual journals' preprint policies on the journal website or using the ROMEO/SHERPA database (https://v2.sherpa.ac.uk/romeo/). For a comprehensive guide to preprinting, see Moshontz et al. (2021).

Sharing Study Materials and Code

Descriptions of the materials and analysis code provide insights into the inner workings of a study, but there are few substitutes for seeing the actual documents. Examples of materials that can be shared include questionnaires (Holman & Williams, 2019; Robinson & Wilson, 2020), interventions (Dobias et al., 2021), and analysis code (Kaurin, Wright, Dombrovski et al., 2020; Kothgassner et al., 2020). For example, researchers using experience sampling methods can make their experience sampling questionnaires open via the Experience Sampling Method Item Repository (Kirtley, Hiekkaranta et al., 2019; https://esmitemrepository.com). Beyond enabling others to gain a greater understanding of the research process, sharing study elements also enables reuse of materials and code (with permission and attribution), preventing resource wastage. It also means study materials or analytic approaches are citable. It may not be possible to share proprietary questionnaires or stimuli, but we recommend that researchers share whatever they can, and use nonproprietary materials where possible. Sharing code – and data, which we discuss later – also facilitates rigorous peer-review, by enabling reviewers to examine in detail or even reproduce analyses, as experienced by the first author during peer review of a recent paper (Kirtley, Hussey et al., 2021).

Preregistration

In the process of designing and conducting a study, every decision is a "forking path" (Gelman & Loken, 2013) that takes the study in a different direction. Often, many of these decisions are not reported in the final manuscript, which hampers replicability. Knowledge about data may also endanger replicability when it influences our hypotheses and (unregistered) analysis plans, leading to data-dependent decision-making and, at worst, questionable research practices. Examples of

questionable research practices include hypothesizing after the results are known (HARKing), running many different statistical tests until statistical significance is achieved (p-hacking), and selective reporting of results (cherry-picking).

To avoid these pitfalls and instead increase transparency and replicability, researchers can create a preregistration for their study: a time-stamped, uneditable plan for a study's research questions, hypotheses, and analyses, made before data are collected/accessed and analyzed (Nosek et al., 2018). Some researchers may already be familiar with the concept of preregistration from registration of clinical trials or systematic reviews/meta-analyses. Commonly, nontrial research is preregistered on the Open Science Framework (OSF) website (https://osf.io/prereg/), where researchers have the option of using a general template or several specific templates depending on the nature of their research, for example, using preexisting data (Mertens & Krypotos, 2019; van den Akker et al., 2019), functional magnetic resonance imaging (fMRI) (Beyer et al., 2021), cognitive modeling (Cruwell & Evans, 2021), experience sampling (Kirtley, Lafit et al., 2021), or qualitative methods (Hartman et al., 2019). For examples of preregistration in the suicide and self-injury field, see Holman and Williams (2019); Knipe and Rajapakse (2021); Robinson and Wilson (2020); Warne et al. (2020); Dobias et al. (2021); Kaurin, Wright, Hisler et al. (2020). Preregistration is also flexible, as even with careful forethought, unexpected issues can arise that require changes to the recruitment procedure or analysis plan. Such changes should be documented rigorously, for example, in a transparent changes document (Mellor et al., 2019).

A common concern about preregistration is that it can slow progress when lengthy ethical approval and recruitment processes already cause time pressure. Our first preregistrations were slow, but we completed subsequent preregistrations faster as our skills improved. This "front-loading" of effort meant we considered our analysis plan in much more detail before accessing data, including writing analytic code in advance, which ultimately sped up the analysis and write-up of the manuscript because we had been able to anticipate some of the challenges we would face and to

develop contingency plans. Again, a preregistration on the OSF receives a DOI, meaning that this rich and detailed plan for a study can be shared, for example, with other researchers to encourage replication or with grant review panels to demonstrate ongoing work.

Registered Reports

For RRs, researchers write the introduction and method sections of a manuscript, including a full analysis plan (Stage 1), which is peer reviewed before data collection or analysis. When a Stage 1 manuscript receives in-principle acceptance, it is stored in an online repository, and the journal commits to publishing the full manuscript based on the rationale, hypotheses, and quality of the analysis plan. After data collection and analysis, the full Stage 2 manuscript is peer reviewed. Subject to reviewers' evaluation of whether researchers adequately adhered to the Stage 1 plan, the full manuscript is published regardless of the directionality and statistical significance of the results (Chambers & Tzavella, 2021).

More than 300 journals now offer the RR format (Chambers & Tzavella, 2021) and Crisis recently became the first specialist suicide research journal to offer RRs (Pirkis, 2020). Emerging research on RRs suggests they outperform "traditional" article types on various criteria, including quality and rigor of methodology and analysis, novelty, and creativity (Soderberg et al., 2021). In addition to the benefits of preregistration (e.g., guarding against questionable research practices, and increasing transparency), greater use of RRs in suicide research could reduce publication bias. This will reduce resource wastage, as suicide researchers may otherwise have spent time and funding trying to replicate published effects that were in fact spurious. Resources will also be saved by predata collection/analysis peer review, when suboptimal methodological and analytic choices can still be addressed.

The second author's first paper was an RR using preexisting data (Janssens et al., 2021). Because Stage 1 RRs are accepted based on the quality and value of the research questions and analysis plan, this encouraged her to carefully consider theory when building her rationale and to

devote considerable time to optimizing her analysis plan. As a novice researcher, she found the two-step approach an invaluable learning process, which increased her confidence when eventually analyzing the data and interpreting the results. The peer review process also felt more collaborative, rather than adversarial, and eliminated the worry that if results did not support her hypotheses, it would reduce likelihood of publication.

An important concern for researchers when considering the RR format is the impact on project timelines: If data collection cannot begin until after Stage 1 acceptance – and in some cases, approval of ethical amendments due to protocol changes arising from Stage 1 peer review – this can slow down the research (Chambers & Tzavella, 2021). We suggest that an RR is something to be planned into a project from the outset, when the potential delays to data collection can be factored into the overall project timeline. More experienced researchers who are new to open science may find it easier to first attempt a full preregistration, before embarking upon their first RR, as this will enable them to build the necessary skills and to have more control over the timeline. For ECRs, an RR may be a good place to start in developing their open science repertoire – especially when supervised by a mentor with some experience in preregistration – but possible delays during the RR process should not negatively impact an ECR's progression. In the second author's case, she worked on the RR simultaneously with another paper that was not dependent on the results of the RR, reducing pressure for the RR process to move rapidly. For RRs using preexisting data, there are also additional considerations regarding controlling data access to reduce the likelihood of data-dependent decision-making. See Kirtley (2022) for a discussion of this issue.

Sharing Data

Researchers are increasingly encouraged (and in some cases required by funders and journals) to share their data, by storing them in public repositories, such as the OSF, or a restricted access repository (e.g., the Harvard Dataverse: https://dataverse.harvard.edu/). Sharing data facilitates verification, increases the trustworthiness of results, and aids collaborative efforts such as

meta-analytic work. Providing codebooks and metadata also helps to ensure transparency and reproducibility (Weston et al., 2019). Concerns about data sharing and potential solutions have been covered elsewhere (see Simons, 2018).

Increasing numbers of suicide researchers are choosing to share their data in the interests of transparency, reproducibility, and potential reuse (Holman & Williams, 2019; Knipe et al., 2021; Millner, 2016; Robinson & Wilson, 2020), including from meta-analyses (Kothgassner et al., 2020) and narrative reviews (Kirtley, Rodham et al., 2019). Sharing data for reuse can also facilitate collaboration and research synergy, for example, the sharing of real-time suicide data from the early phase of the COVID-19 pandemic (Pirkis et al., 2021). Sharing data can also inform conceptual choices in future research. There is a surge in experience sampling studies and there are many unknowns that impact the way we design our studies (Kirtley, Lafit et al., 2021) to capture the everyday lives of people at risk for suicide. For instance, little research has examined the "true" timescale of an emergent suicidal crisis, and it is unlikely that the length of a suicidal episode is the same between or even within individuals. When knowledge is scarce, collaboration is key to developing theoretically principled guidelines for designing future studies. Sharing data might aid the comparison of key parameters and consideration of how these are affected by sampling choices and facilitate multisite collaborations (as recently initiated by the last author).

Implementing Open Science Practices Into Ongoing and Concluded Studies

Although starting to implement open science practices at the outset of the study may be the optimal scenario, we urge researchers not to feel as though they have missed the open science "boat" because their study has already commenced or concluded.

Researchers can self-archive the postprint of their accepted journal article as a low-threshold way of "opening up" concluded studies. Materials and code can be shared retrospectively, although

for established research groups, this may be something that occurs gradually over time. Deidentified data from concluded studies can also be shared, providing that consent for data sharing was obtained from participants. See Soderberg et al. (2019) for examples of institutional review board (IRB) and consent form text for data sharing. If such consent was not obtained, researchers may be able to share a synthetic version of the dataset to facilitate transparency and reproducibility (Kirtley, Hussey et al., 2021; Quintana, 2020b; Sandford et al., 2021). Where researchers have not accessed the data in an ongoing or concluded study, they can postregister their study (Benning et al., 2019). Additionally, some journals offer RRs for ongoing and concluded (i.e., pre-existing data) studies, where researchers can prove they have not accessed the data (e.g., with a signed statement from a data manager). See Kirtley (2022), Kirtley, Lafit et al. (2021), and Weston et al. (2019) for a further discussion of postregistration and RRs for preexisting data.

Conclusion

Use of open science practices in suicide research is still the exception rather than the rule, but a growing number of researchers are embracing the opportunity to future-proof their research. While other fields of research may have a head start, open science in suicide research is definitely now open for business.

Chapter 9: Concluding Discussion

9.1 Preface

Within this PhD project, I have focused on specific risk factors for self-harm in adolescents, the extent to which attachment relationship quality is associated with these risk factors, and whether attachment relationship quality may act as a potential protective factor in these associations. Throughout, I specifically focused on identifying best methodological practices for ESM research on self-harm. In this final chapter, I will first provide a summary of the main findings and how these answer the main objectives as laid out in **Chapter 2**:

- **Objective 1**: Investigation of associations between specific risk factors (i.e., ACEs and loneliness) and self-harm and the extent to which attachment is associated with these risk factors and moderates these associations
- **Objective 2**: Evaluation and advancement of methodological approaches and open science aspects within this literature

I will discuss four key lessons that can be drawn from this PhD and relate them to the broader literature. Next, I will present future research avenues, translations from research carried out within this PhD project to the clinical practice and suggestions for societal changes. Subsequently, I will consider the methodological strengths and limitations of this PhD project and conclude.

9.2 Summary of main findings

The first objective of this PhD thesis was to investigate associations between specific risk factors (i.e., ACEs and loneliness) and self-harm and the extent to which attachment relationship quality is associated with these risk factors and attenuates these associations. This enabled us to

formulate an answer to the following two critical questions: *who* is at risk for self-harm (i.e., adolescents with low-quality parental attachment relationships and more ACEs) and *when* is momentary risk increased among vulnerable individuals (i.e., during moments of loneliness). In addition, the results of this PhD project further increase our understanding of *why* individuals may engage in self-harm (i.e., to downregulate negative feelings, such as loneliness). Indeed, the findings presented in **Chapter 3** show that adolescents with lower-quality attachment relationships with their parents are more likely to report lifetime self-harm thoughts and behaviours and think about self-harm in their daily lives. In **Chapter 4**, we found that adolescents who report more ACEs are more likely to report lifetime and current self-harm thoughts and behaviours, and that a high-quality maternal attachment relationship attenuates the association with lifetime self-harm thoughts and behaviours and the intensity of current self-harm thoughts.

In **Chapter 5**, we have broadened our knowledge about the power of attachment in adolescent mental health by revealing that individuals with higher-quality attachment relationships with their parents feel less irritable and lonely in their daily lives and are less impacted by the COVID-19 pandemic in terms of daily-life levels of loneliness. In **Chapter 6**, empirical work shows that the more lonely adolescents feel, the more likely they are to think (and have more intense thoughts) about self-harm in the next 90-minute time window. This association was attenuated when adolescents had a higher-quality attachment relationship with their mother. In addition, evidence revealed that adolescents engaging in self-harm behaviours experience a decrease in loneliness (i.e., a relief effect). This association was attenuated for adolescents with a higher-quality attachment relationship with their father. These findings suggest that loneliness is a critical warning signal that increases the risk of adolescent self-harm thoughts and that adolescents may use self-harm behaviours as a means to reduce their distress associated with loneliness, but that higher-quality attachment relationships may act as a potential protective factor in these associations.

The second objective of this PhD thesis was to evaluate and advance methodological approaches and open science aspects within this literature. **Chapter 7** provides a comprehensive

overview of interpersonal processes (IPs) that are assessed in ESM studies of self-harm and how these have been assessed. This review reflects a proliferation of IPs that have been investigated in relation to self-harm and an immense heterogeneity in the ways these IPs were assessed. This results in a fragmented literature that hinders comparison across studies and cumulative evidence-building. Future research would benefit from the implementation of open science practices (e.g., transparently reporting measurement details) and working towards consistency in defining constructs and their operationalizations. Therefore, in **Chapter 8**, we have provided examples of ours and other's work to demonstrate the opportunities and solutions to challenges of implementing open science practices in self-harm research.

9.3 Flemish adolescents are at risk for self-harm

This PhD project draws on unique data from one of the largest studies on adolescent mental health in Flanders, i.e., SIGMA (N=1913), which enabled us to elucidate the current mental health status of Flemish youth. As such, the results showed that as many as one in five adolescents engages in self-harm behaviours (i.e., 21%) or thinks about self-harm (i.e., 20%) at some point throughout their lifetime. Of those who report self-harm thoughts, 82% thought about actually ending their life. Of those who report self-harm behaviours, 6.5% have tried to take their own life (**Chapter 3**). Although evidence is often found for a larger number of individuals thinking about self-harm rather than actually engaging in it (Nock et al., 2013), these findings do align with previous retrospective research worldwide (Farkas et al., 2023; Lim et al., 2019; Swannell et al., 2014) and indicate that too many young individuals are struggling and not (yet) adequately supported in developing or adopting adaptive strategies that help them deal with intense negative emotions.

Moreover, by assessing self-harm in adolescents' day-to-day context using Experience Sampling Methodology (ESM) – a novel and unique aspect of SIGMA, we were able to observe self-harm thoughts and behaviours with increased ecological validity and reduced recall bias. These findings revealed that one in four adolescents (i.e., 25%) harmed themselves during the ESM period,

and more than half of the adolescents (i.e., 57%) thought about engaging in self-harm behaviour at least once during the momentary assessment period (**Chapter 3**). Despite the need for replication of these findings in other community ESM studies, these high rates underscore the critical importance of prioritizing adolescents for help, and supporting further research to enhance our ability to predict, prevent, and manage self-harm in this age group. For example, one question that this PhD project was unable to answer due to methodological constraints (i.e., assessing self-harm thoughts and behaviours *since the last beep,* using branched questions), but remains open for future research is *when* adolescents translate their self-harm thoughts into behaviours – key knowledge to improve daily-life prevention and intervention.

This PhD thesis, however, was able to provide essential knowledge that can be used to optimize and tailor help initiatives by identifying *which* adolescents should be targeted and *when* support is most needed. First, adolescents with lower-quality attachment bonds with their father and mother and adolescents who have experienced a higher number of adverse childhood experiences (ACEs) seem at increased risk for self-harm thoughts and behaviours both in terms of lifetime history and in the short-term, during daily life (**Chapter 3** and **4**). As the first study to investigate associations between parent and peer attachment relationship quality and self-harm, these findings add to earlier literature on parental attachment relationships and self-harm (Gandhi et al., 2016; Santens et al., 2018; Zortea et al., 2019) and extend previous retrospective research (Bruffaerts et al., 2010; Cleare et al., 2018; Glassman et al., 2007; Madge et al., 2011; Sahle et al., 2021) to prospective associations in daily life. Moreover, these findings fit within a diathesis-stress framework (Rubinstein, 1986; van Heeringen, 2012) — the backdrop to the IMV model (O'Connor & Kirtley, 2018) — by suggesting that a certain number of ACEs ("stress") can precipitate self-harm. However, not all adolescents exposed to the same amount of ACEs will develop self-harm; it will depend on the presence and influence of other distal vulnerability factors ("diatheses") (van Heeringen, 2012), e.g., attachment relationship quality (O'Connor & Kirtley, 2018). This suggests that both ACEs and attachment relationship quality are important person-level targets in the prevention of self-harm thoughts and behaviours. One

question that this PhD has not answered, however, is whether specific subgroups (e.g., LGTBQA+, multiracial youth) might be more at risk for self-harm than others, this could further refine our efforts in identifying *who* to target.

Second, in line with emerging literature (Calati et al., 2019; Gandhi et al., 2018; McClelland et al., 2020, 2021) and consistent with our hypotheses, results revealed that the more lonely adolescents feel, the more likely they are to think about self-harm in the next 90-minute time interval (**Chapter 6**). Interpreting these findings within the context of the IMV model (O'Connor, 2011; O'Connor & Kirtley, 2018), our results suggest that loneliness acts as a motivational moderator, i.e., a short-term risk factor that leads to the emergence of self-harm thoughts. As this is the first study to investigate the temporal within-person association of loneliness and self-harm thoughts in adolescents, these findings support loneliness as a critical warning signal that predicts (an increase in) adolescent self-harm thoughts within a 90-minute time window. However, more research into the exact timescales of the association between loneliness and self-harm to further refine the predictive value of loneliness would benefit both research and clinical practice.

9.4 Attachment is important throughout development

While research (Barlow et al., 2016; Lionetti et al., 2015; Roseboom, 2023) and current popular media content (Singh, 2023; Van Nuffel, 2023; Wils, 2023) predominantly emphasise the importance of attachment during infancy and early childhood, this PhD project demonstrates that attachment matters beyond these early years well into adolescence. Findings reveal that adolescents with higher-quality attachment bonds feel less irritable and lonely in their daily life, aligning with previous literature (Brumariu & Kerns, 2010; de Minzi et al., 2006; Shpigel et al., 2012), and seem to handle stressful situations better than their peers with lower-quality attachment relationships (**Chapter 5**). Indeed, results show that adolescents with higher-quality attachment bonds are less likely to think about or engage in self-harm behaviours when they experience negative intense

emotions such as loneliness and are less impacted by ACEs and the COVID-19 pandemic (**Chapter 4, 5** and **6**).

These findings contribute to a growing body of literature on the association between relationship quality and emotional experiences in everyday life (Sheinbaum et al., 2015; Torquati & Raffaelli, 2004) and on the buffering effect of high-quality relationships on the mental well-being of adolescents (Bowlby, 1973; Shpigel et al., 2012). This supports the importance of restoring, strengthening and maintaining high-quality attachment relationships with parents throughout adolescence to help navigate personal adversity. However, a critical unanswered question for future research is *how* parents can maintain a high-quality attachment bond with their child growing up, as the needs of these children vary with age (Steinberg & Morris, 2001).

9.5 Father and mother attachment plays a unique role

A distinctive aspect of this PhD thesis is the inclusion of both parent-child relationships in all empirical studies, facilitating a comprehensive understanding of the unique and complementary roles of father and mother attachment relationships in adolescent mental health. Firstly, we found evidence for associations with both the maternal and paternal attachment bond and self-harm thoughts and behaviours, daily-life loneliness, perceived burden of family conflict during COVID-19 and the number of ACEs (**Chapter 3 to 6**). This converges with previous literature on self-harm (Gandhi et al., 2016; Santens et al., 2018; Zortea et al., 2019), loneliness (de Minzi et al., 2006), conflict (Henry et al., 2015) and ACEs (Baer & Martinez, 2006).

Even more interesting is the evidence we were able to provide for the unique associations between a specific parental attachment bond and adolescent mental health outcomes. For example, paternal attachment relationship quality was associated with daily-life levels of irritability, burden of between-parents conflict during COVID-19 and the decrease in loneliness when adolescents engaged in self-harm behaviours (i.e., emotion regulation function), whilst maternal attachment relationship quality was not associated with any of these outcomes. In fact, maternal attachment relationship

quality was associated with the burden of parent-child conflict during COVID-19, the presence and intensity of self-harm thoughts in the next 90 minutes and the impact of ACEs on self-harm thoughts and behaviours (**Chapter 3 to 6**).

These findings may be explained by the distinct but complementary caregiving roles that fathers and mothers often adopt (Kerns et al., 2015), which may influence different domains – and interactions – of adolescents' lives (Palm, 2014). Whereas mothers generally function as a safe haven (i.e., listening, comforting, and being available in times of need), fathers are generally experienced as a playmate who offers a secure base (i.e., sets boundaries, gives trust, advice and encouragement, and supports autonomy) enabling adolescents to explore the world and engage in social relationships and interactions beyond the parent–adolescent relationship. Indeed, whilst mothers' function of safe haven may be specifically important in the context of ACEs, fathers may focus more on supporting exploration when their adolescent feels safe (Grossman & Grossman, 2020; Keijsers et al., 2010; Venta et al., 2020) and learning skills to regulate behaviour (Deneault et al., 2021).

Our evidence highlights the relevance of improving both the quality of the paternal and maternal attachment relationships (i.e., holistic family approaches) in addressing adolescent mental health problems, e.g., loneliness and self-harm. By acknowledging and further investigating these unique roles and potential buffering effects, future research can develop targeted prevention and intervention that leverages the strengths of both mother and father attachments to promote adolescent mental health development.

9.6 Three methodological issues need addressing

This PhD thesis was able to shed light on three methodological issues that need addressing. First, the current ESM literature on interpersonal processes (IPs), e.g., attachment, and self-harm exhibits a proliferation of constructs that are operationalized in highly diverse ways resulting in a fragmented literature. In **Chapter 7**, we revealed that more than 50 IPs were investigated in the ESM literature on IPs and self-harm, and that one specific IP, i.e., perceived burdensomeness, was

operationalized in 10 different ways. In addition, some constructs measured with similar ESM items were considered different between studies, and similar constructs were assessed with a variety of items, referred to as “jingle” and “jangle” fallacies (Gonzalez et al., 2021), respectively. While measurement issues occur across psychological research (Flake & Fried, 2020), they are especially common in ESM research due to single-item measures and the accompanying challenges of psychometrically validating them (Fritz et al., 2023). These measurement issues hamper comparison across studies and may create an illusion of broader support and convergent evidence for an association between a given IP and SITBs, while in fact the evidence is highly heterogeneous and fragmented. Future research would benefit from finding consistency in defining constructs and their operationalizations.

Second, the majority of the ESM literature on IPs and self-harm falls short in transparently reporting measurement details, such as the full text of their ESM items (53.45%), the rationale for their sampling design (19.0%) and density (32.8%), and justification of sample size (20.7%). Moreover, only a limited amount of studies (7%) pre- or post-registered their hypotheses, research questions, analysis plan or methods. This hinders measurement transparency and replicability – a cornerstone of scientific research (Nosek et al., 2022), thereby undermining scientific progress and having far-reaching implications for the integrity, credibility, and impact of our research.

A third and final methodological issue that needs addressing is the limited use of high-sampling frequencies that can help unravel the timescales of associations, and appropriate temporal models that control for autoregressive effects which enables the reliable identification of specific IPs that incrementally predict self-harm. In fact, to date, only 5% of ESM studies on IPs and self-harm have controlled for autoregressive effects (Coppersmith et al., 2019; Jacobucci et al., 2023; Sels et al., 2023).

9.7 Future research

Following the findings of my PhD, I would like to propose five research avenues for the future.

First, investigating *how* parents can maintain or restore a high-quality attachment bond with their adolescents, considering the evolving nature of this relationship and unique challenges and needs that arise during this developmental stage (Smetana & Rote, 2019; Steinberg & Morris, 2001), may yield valuable insights and practical guidance. For example, research indicates that authoritative parenting (i.e., mixture of high behavioural control and high responsiveness) is related to more relationship cohesion, lower conflict and greater adolescent disclosure to parents (Smetana & Rote, 2019). However, recent work shows that parents are in the dark when it comes to finding the delicate balance between providing support for their adolescent's immediate "well-being" and sufficient opportunities for growth in the long-term, i.e., "well-becoming" (Keijsers, 2021).

Second, I would like to explore the role of specific types of attachment bonds and clarify potential buffering effects on adolescent mental health, e.g., self-harm. For example, a high-quality attachment bond (with a parent, foster caregiver, adoptive parent, etc.) could buffer against the negative impact of a low-quality attachment bond (Dagan & Sagi-Schwartz, 2018). However, studies have mainly focused on mother-child relationships and have rarely included fathers or other potential attachment figures. Additionally, the diversity of family structures (i.e., same-sex families, multigenerational families, etc.) in which adolescents grow up (Smetana & Rote, 2019) should be taken into consideration. Unravelling the unique and incremental contribution of specific types of attachment bonds could optimise the current development of prevention and treatment strategies for adolescent mental health problems.

Third, an interesting future research avenue could be the exploration of natural within-person fluctuations across hours and days in attachment (relationship quality) and examine whether attachment and self-harm are related over time. Indeed, whereas attachment is mainly conceptualized as a stable trait (Bowlby, 1969/1973), emerging research reveals a state-like component, meaning that attachment security can change from moment-to-moment, depending on

the person someone is with, or the context someone is in (Gillath et al., 2009). These within-person fluctuations remain neglected in current research using traditional, cross-sectional, retrospective questionnaires (Bosmans et al., 2014). Moreover, research suggests an interplay between the trait and state-like component of attachment and state attachment may influence trait attachment (Cuyvers et al., 2023; Waters et al., 2019). This offers a golden opportunity for the prediction, prevention and management of self-harm.

Fourth, it is relevant to further test current ideation-to-action theories of self-harm using ESM to deepen our understanding of when self-harm thoughts develop and when these translate into behaviours. Indeed, ESM is especially suited to determine when in time specific risk and protective factors relate to self-harm thoughts, behaviours, or the transition from thoughts to behaviours, which is critical knowledge to improve daily-life prevention and intervention.

A fifth and final domain that deserves further exploration, is the role of attachment across subgroups of adolescents that are specifically vulnerable to mental health problems, e.g., self-harm. For example, adolescents from specific socioeconomic groups, clinical settings, or marginalized populations (e.g., LGTBQIA+ or multiracial youth), as these are at even greater risk for self-harm, ACEs and specifically vulnerable to attachment ruptures throughout their lifetime (Coard, 2022; Sanscartier & MacDonald, 2019).

9.8 From research to clinical practice

The findings of this PhD project are highly informative for clinicians. First, in **Chapter 4**, our results highlight the importance of clinicians specifically assessing exposure to ACEs more routinely in adolescents. In **Chapter 5** and **6**, exploring and targeting daily-life levels of loneliness can be crucial to facilitate effective prevention and treatment of mental health problems and reduce the presence and intensity of self-harm thoughts and the occurrence of self-harm behaviours. For example, Just-In-Time Adaptive Interventions (JITAIs; Coppersmith et al., 2022) – a form of Ecological Momentary Interventions (Myin-Germeys et al., 2016) that draw from evidence-based psychotherapies — can

provide promising ways to target loneliness in adolescents' daily lives. In addition, Dialectical Behaviour Therapy (DBT; Linehan et al., 2020; Miller et al., 2006) could be an appropriate treatment approach as this focuses on learning adaptive emotion regulation strategies (e.g., how to adaptively deal with intense feelings of loneliness) and has been proven to be effective in adolescents (Groves et al., 2012; Witt et al., 2021).

In **Chapter 3 to 6**, we find evidence for the importance of the parent-child attachment relationship in adolescent mental health (i.e., experience of loneliness, irritability and self-harm thoughts and behaviours). Therefore, parent-child attachment relationships may be promising intervention targets for the prevention and treatment of adolescent self-harm. For example, Attachment-Based Family Therapy interventions (Diamond, 2014) focus on resolving attachment ruptures and repairing trust and have some empirical support for suicide risk reduction in adolescents (Diamond et al., 2016).

Finally, the results from this PhD thesis can be contextualized within the Window of Tolerance model (see Figure 5; Siegel, 1999), highlighting their potential application in psycho-education and therapeutic interventions for adolescents. By adapting this model to the findings of this PhD thesis, clinicians can better help clients make sense of how they regulate intense stress and emotions, e.g., loneliness, and how this regulatory process may have been compromised by the multiple or prolonged exposure to ACEs, causing increased oscillation between hypo- and hyperarousal states (Corrigan et al., 2011). This can support clients in identifying specific moments, e.g., increased levels of loneliness, that may act as potential triggers for exceeding their window of tolerance, leading to a hyperarousal state that involves thinking about self-harm and/or actually engaging in self-harm behaviours. Furthermore, using this model can help clients understand the importance of learning new, adaptive, strategies to re-enter their window and strengthening attachment relationships as a means of expanding their window of tolerance.

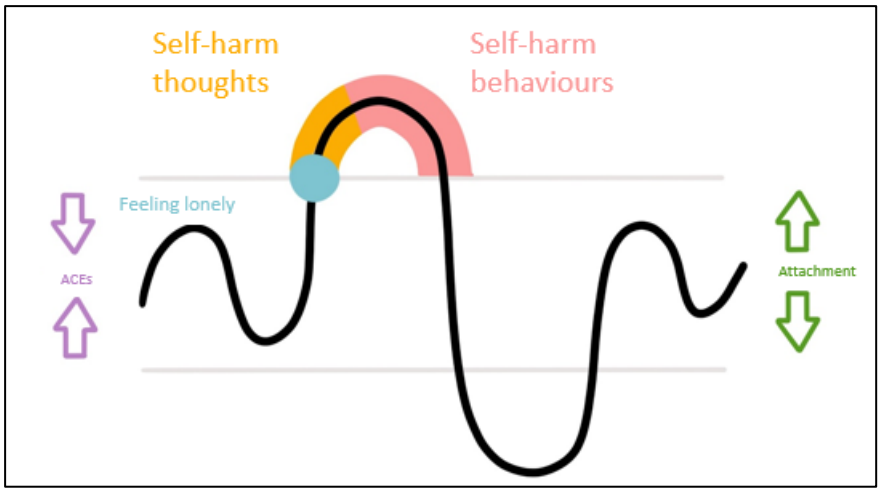


Figure 5. *Window of Tolerance model (Siegel, 1999), adapted to the results within this PhD thesis*

9.9 Tasks for society

Society plays a pivotal role in fostering, maintaining, and strengthening high-quality attachment relationships between adolescents and their parents (Tafà et al., 2022). Several critical societal actions have already been formulated in the Flemish Suicide Prevention Plan (FSPP), which aims to reduce the number of suicides by 10% by 2030 compared to 2020. However, a few additions to the FSPP can be suggested. According to the FSPP, the "Happiness Triangle" by the Flemish Institute for Healthy Living will be broadly implemented to promote resilience and the formation and maintenance of meaningful relationships so that vulnerable individuals feel happier and more supported, thus reducing the risk of suicidal thoughts and/or behaviours. Here, a programme that offers emotional and practical support for parents (or other caregivers) to help them maintain a connection with their child during adolescence may be a necessary addition that would contribute to this goal (Menashe-Grinberg et al., 2022; Meppelink et al., 2016). Such a programme could consist of lowering stress in parents and providing emotional support for parents with the goal of repairing personal attachment ruptures (e.g., Menashe-Grinberg et al., 2022) and installing self-care (e.g., Meppelink et al., 2016), as well as practical, evidence-based guidelines to support parents in raising their child (i.e., how to remain responsive and attuned to the shift in need from physical closeness to emotional availability during adolescence) (e.g., Spruijt et al., 2020). This could help parents maintain

their function as the safe haven and secure base that their child needs to find comfort, guidance, and confidence in their own ability when needed. Additionally, the FSPP aims to focus more on suicide prevention in school settings by monitoring the well-being of students and also directing education towards the development of resilience (i.e., the "Warm Schools" project by the Go for Happiness Fund). A valuable addition to this could be a preventive programme aimed at developing emotion regulation skills in young people (e.g., developing emotional literacy and regulatory skills in school). See Pedrini et al. (2022) for a systematic overview of school-based interventions aimed at improving emotion regulation skills in adolescent students. These interventions could help adolescents find the words needed to disclose their pain to their parents, which opens a way to strengthen their bond (Bastian et al., 2014). Moreover, providing appropriate resources (e.g., reimbursement of family therapy sessions aimed at strengthening attachment relationships between parents and adolescents) and contexts (e.g., events and spaces where parents and adolescents can engage in activities based on common interests) can be crucial in strengthening and restoring relationships between parents and their adolescents — an action that has not yet been included in the FSPP. Finally, the FSPP emphasises the need for continuous appropriate research, such as the FWO-funded research project SCOUT (Center for Contextual Psychiatry, KU Leuven). This research will specifically examine suicidal behaviour among young adults aged 18 to 25. However, it may be necessary to expand the age range to younger individuals in an additional project that will also use appropriate temporal models to identify specific short-term risk factors for suicidal thoughts and behaviours, and their timescales.

Furthermore, societal changes such as the increasing amount of time children spend in school and extracurricular activities, the proliferation of digital communication, and shifts in family structures can jeopardise the parent-adolescent relationship. In fact, a leading researcher in developmental psychology, Professor David Shaffer, has reviewed the literature on peer influence and concluded a systemic shift where peers have replaced parents in creating a child's sense of identity (Shaffer, 1989). This shift may result in adolescents orienting themselves towards their peers instead of their parents for learning values, norms and emotion regulatory skills, which can have

serious consequences given the inherent immaturity of peers. Although attachment bonds with peers are important, they should not undermine parental attachment relationships and their nurturing influence. Therefore, promoting a cultural shift and updating the narrative that values and prioritizes the importance of parent-child attachment, beyond childhood into adolescence, is essential. For example, media and advertising campaigns can also play a role in highlighting the significance of parent-adolescent relationships, portraying positive family dynamics, and challenging stereotypes and cultural messages that undermine the parent-adolescent bond (e.g., emphasis on peer connections) (Maté, 2010). By fostering an environment that supports and celebrates strong parent-adolescent connections, society can contribute to the emotional well-being and resilience of this vulnerable age group.

9.10 Strengths

This PhD thesis has a number of strengths. First, studies have rarely included both or differentiated between self-harm thoughts and behaviours, whilst associations may differ and have different implications for theory and practice (Branley-Bell et al., 2019). All studies included in this PhD thesis, however, were able to provide unique insights into the associations between risk/protective factors and self-harm thoughts and behaviours. Second, the methodology used within this PhD thesis is innovative. For example, we combined traditional retrospective questionnaires with innovative Experience Sampling Methodology (ESM) to assess self-harm which greatly reduced the risk of recall bias and increased ecological validity by allowing a more reliable picture of adolescents' daily reality (Myin-Germeys et al., 2018). Moreover, we have introduced a complex model (i.e., a two-part mixed effects model) in ESM research on self-harm that is especially suited to model the expected zero-inflated ESM self-harm data in the non-clinical population sample of adolescents (Farewell et al., 2017).

Finally, given that open science practices are still the exception rather than the rule in clinical and developmental psychology research (Tackett et al., 2019), we consider the extensive use of open science practices throughout this PhD thesis (i.e., the Registered Report article format, pre-/post-registration, data check-out system, open materials, and open code) a major strength. For example, all included studies are pre- or post-registered which means all hypotheses, and detailed plans for analysis were registered before collecting or analyzing the data. As such, we have assured readers that the hypotheses and methodological decisions are not biased by knowledge of the data and contributed significantly to increased transparency and replicability in psychological science (Kirtley, 2022). In fact, this PhD thesis includes the first-ever Registered Report on self-harm and is thereby pioneering the building of more robust and transparent research on self-harm.

9.11 Limitations

Despite these strengths, several limitations require discussion. First, although our study provides key insights into the role of adolescent attachment relationship quality at a trait level, emerging research suggests a state-like component of attachment which is not captured with the retrospective questionnaire we used (Fraley & Dugan, 2021; Kobak & Bosmans, 2018). This highlights the need to develop and validate appropriate ESM items to assess attachment in the daily life of adolescents, to capture all of its meaningful fluctuations as they occur naturally in adolescents' everyday lives. Second, some of the moderation analyses in **Chapter 4, 5** and **6** were underpowered and, therefore, future studies are needed to replicate these findings in larger samples. However, we consider our simulation-based power analysis to be valuable for multiple reasons. For example, whilst power calculations are still often neglected in ESM research (Trull & Ebner-Priemer, 2020), they provide much-needed transparency about which analyses are exploratory and require further confirmatory testing. Moreover, these power calculations can provide parameters that aid other researchers in conducting power analyses for similar studies.

Lastly, the ESM compliance rates were lower than would be expected from previous ESM studies (Rintala et al., 2019). There may be several reasons for this, including the short time in which ESM questionnaires were available to participants. The length of the questionnaire may also have played a role, as recent research by Eisele et al. (2020) in young adults demonstrated that questionnaire length negatively impacts compliance. Moreover, participants were also asked to complete ESM during school hours, and even though schools agreed to this, there may still have been barriers to completion of ESM questionnaires during lessons. We also did not incentivize compliance which may result in lower ESM compliance rates, but – in comparison with other ESM studies, we believe it enhanced our data quality. We, therefore, urge future researchers to use a user-centered approach aimed at increasing compliance rates in adolescent ESM studies (see Bülow et al., 2024 for a tutorial paper on the enhancement of adolescent engagement in ESM studies).

9.12 Conclusions

This PhD aimed to identify *who* is at risk for self-harm thoughts and behaviours and *when* the momentary risk for self-harm is increased among adolescents. In addition, we aimed to refine our understanding of *why* adolescents engage in self-harm behaviours. Throughout, we found it critical to evaluate and advance methodological approaches and open science aspects within this literature.

The results from the four empirical studies included in this PhD thesis show that adolescents with more adverse childhood experiences (ACEs) and low-quality attachment relationships with their parents are more at risk for self-harm thoughts and behaviours, and that momentary risk is increased when adolescents experience higher levels of loneliness. In addition, our findings suggest that adolescents use self-harm behaviours as a means to reduce their distress associated with the experience of loneliness. Finally, we were able to identify a crucial and modifiable factor that could act as a powerful tool to reduce the risk of self-harm in this young-aged group: the parent-child attachment relationship. Future research should further explore between- and within-person associations of paternal and maternal attachment relationships in adolescent self-harm thoughts and

behaviours to acquire the knowledge needed to protect these adolescents from harming themselves. In doing so, this research should transparently report measurement details and use homogeneous and standardized assessment methods to facilitate comparison across studies, scientific communication between researchers, and the building of a cumulative evidence base.

References

Achterhof, R., Kirtley, O. J., Schneider, M., Hagemann, N., Hermans, K. S., Hiekkaranta, A. P., ... & Myin-Germeys, I. (2022). Adolescents' real-time social and affective experiences of online and face-to-face interactions. *Computers in Human Behavior*, *129*, 107159.

Ainsworth, T. L., Baron, E., Brown, G. E., Cooperstein, J., & Prakash, M. (1987). Equation of state of dense nuclear matter. *Nuclear Physics A*, *464*(4), 740-768.

Ainsworth, M. D. S., Blehar, M. C., Waters, E., & Wall, S. N. (2015). *Patterns of attachment: A psychological study of the Strange Situation.* New York: Psychology Press. (Original work published 1978)

Alfò, M., & Maruotti, A. (2010). Two-part regression models for longitudinal zero-inflated count data. *Canadian Journal of Statistics*, *38*(2), 197-216.

Ammerman, B. A., & Law, K. C. (2022). Using intensive time sampling methods to capture daily suicidal ideation: a systematic review. *Journal of Affective Disorders, 299*, 108-117.

Andrews, J. L., Ahmed, S. P., & Blakemore, S. J. (2021). Navigating the social environment in adolescence: The role of social brain development. *Biological Psychiatry*, *89*(2), 109-118.

Angelakis, I., Austin, J. L., & Gooding, P. (2020). Association of childhood maltreatment with suicide behaviors among young people: a systematic review and meta-analysis. *JAMA network open*, *3*(8), e2012563-e2012563.

Baer, J. C., & Martinez, C. D. (2006). Child maltreatment and insecure attachment: A meta-analysis. *Journal of reproductive and infant psychology*, *24*(3), 187-197.

Bakermans-Kranenburg, M. J., & van IJzendoorn, M. H. (2009). The first 10,000 Adult Attachment Interviews: Distributions of adult attachment representations in clinical and non-clinical groups. *Attachment & human development*, *11*(3), 223-263.

Bamps, E., Achterhof, R., Lafit, G., Teixeira, A. M. C., Akcaoglu, Z., Hagemann, N., ... & Kirtley, O. (2022). Changes in Adolescents' Daily-Life Social Withdrawal Experiences During the COVID-19 Pandemic.

Barlow, J., Schrader-McMillan, A., Axford, N., Wrigley, Z., Sonthalia, S., Wilkinson, T., ... & Coad, J. (2016). Attachment and attachment-related outcomes in preschool children–a review of recent evidence. *Child and Adolescent Mental Health*, *21*(1), 11-20.

Bastian, B., Jetten, J., & Ferris, L. J. (2014). Pain as social glue: Shared pain increases cooperation. *Psychological science*, *25*(11), 2079-2085.

Björkenstam, E., Hjern, A., Mittendorfer-Rutz, E., Vinnerljung, B., Hallqvist, J., & Ljung, R. (2013). Multi-exposure and clustering of adverse childhood experiences, socioeconomic differences and psychotropic medication in young adults. *PLoS One, 8*(1), e53551.

Bosmans, G., Bowles, D. P., Dewitte, M., De Winter, S., & Braet, C. (2014). An experimental evaluation of the State Adult Attachment Measure: The influence of attachment primes on the content of state attachment representations. *Journal of Experimental Psychopathology*, *5*(2), 134-150.

Bosmans, G., & Kerns, K. A. (2015). Attachment in middle childhood: Progress and prospects. *New directions for child and adolescent development*, *2015*(148), 1-14.

Bowlby, J. (1969). Attachment and loss, Vol. 1.(pp.) Attachment. NY: Basic Books.

Bowlby, J. (1973). Attachment and loss. Volume II. Separation, anxiety and anger. In Attachment and loss. volume II. Separation, anxiety and anger (pp. 429-p).

Branley-Bell, D., O'Connor, D. B., Green, J. A., Ferguson, E., O'Carroll, R. E., & O'Connor, R. C. (2019). Distinguishing suicide ideation from suicide attempts: Further test of the Integrated Motivational-Volitional Model of Suicidal Behaviour. *Journal of Psychiatric Research*, *117*, 100-107.

Brennan, K. A., Clark, C. L., & Shaver, P. R. (1998). Self-report measurement of adult attachment: An integrative overview. *Attachment theory and close relationships*, *46*, 76.

Bruffaerts, R., Demyttenaere, K., Borges, G., Haro, J. M., Chiu, W. T., Hwang, I., ... & Nock, M. K. (2010). Childhood adversities as risk factors for onset and persistence of suicidal behaviour. *The British journal of psychiatry*, *197*(1), 20-27.

Brumariu, L. E., & Kerns, K. A. (2010). Parent–child attachment and internalizing symptoms in childhood and adolescence: A review of empirical findings and future directions. *Development and psychopathology*, *22*(1), 177-203.

Bülow, A., Janssen, L. H., Dietvorst, E., de Vaate, N. A. B., Hillegers, M. H., Valkenburg, P. M., & Keijsers, L. (2024). From Burden to Enjoyment: A User-Centered Approach to Engage Adolescents in Intensive Longitudinal Research.

Bunting, L., McCartan, C., Davidson, G., Grant, A., Mulholland, C., Schubotz, D., ... & Shevlin, M. (2023). The influence of adverse and positive childhood experiences on young people's mental health and experiences of self-harm and suicidal ideation. *Child Abuse & Neglect, 140,* 106159.

Calati, R., Ferrari, C., Brittner, M., Oasi, O., Olié, E., Carvalho, A. F., & Courtet, P. (2019). Suicidal thoughts and behaviors and social isolation: A narrative review of the literature. *Journal of affective disorders*, *245*, 653-667.

Carpenter, T. P., & Law, K. C. (2021). Optimizing the scientific study of suicide with open and transparent research practices. *Suicide and Life-Threatening Behavior*, *51*(1), 36-46.

Cleare, S., Wetherall, K., Clark, A., Ryan, C., Kirtley, O. J., Smith, M., & O'Connor, R. C. (2018). Adverse childhood experiences and hospital-treated self-harm. *International journal of environmental research and public health, 15*(6), 1235.

Coard, S. I. (2022). Race, discrimination, and racism as "growing points" for consideration: attachment theory and research with African American families. *Attachment & Human Development*, *24*(3), 373-383.

Coppersmith, D. D., Dempsey, W., Kleiman, E. M., Bentley, K. H., Murphy, S. A., & Nock, M. K. (2022). Just-in-time adaptive interventions for suicide prevention: Promise, challenges, and future directions. *Psychiatry*, *85*(4), 317-333.

Coppersmith, D. D., Kleiman, E. M., Glenn, C. R., Millner, A. J., & Nock, M. K. (2019). The dynamics of social support among suicide attempters: A smartphone-based daily diary study. *Behaviour research and therapy*, *120*, 103348.

Corcoran, M., & McNulty, M. (2018). Examining the role of attachment in the relationship between childhood adversity, psychological distress and subjective well-being. Child abuse & neglect, 76, 297-309.

Corrigan, F. M., Fisher, J. J., & Nutt, D. J. (2011). Autonomic dysregulation and the window of tolerance model of the effects of complex emotional trauma. *Journal of psychopharmacology*, *25*(1), 17-25.

Crowell, J. A., Fraley, R. C., & Shaver, P. R. (1999). Measurement of individual differences in adolescent and adult attachment. *Handbook of attachment: Theory, research, and clinical applications*, *2*, 635.

Csikszentmihalyi, M., & Larson, R. (1987). Validity and reliability of the experience-sampling method. *The Journal of nervous and mental disease, 175*(9), 526-536.

Cuyvers, B., Verhees, M. W., Van Ijzendoorn, M. H., Bakermans-Kranenburg, M. J., Rowe, A. C., Ceulemans, E., & Bosmans, G. (2023). The effect of attachment priming on state attachment security in middle childhood: The moderating roles of trait attachment and state attachment volatility. *The Journal of Early Adolescence*, *43*(2), 164-193.

Czyz, E. K., Horwitz, A. G., Arango, A., & King, C. A. (2019a). Short-term change and prediction of suicidal ideation among adolescents: A daily diary study following psychiatric hospitalization. *Journal of child psychology and psychiatry, 60*(7), 732-741.

Dagan, O., & Sagi-Schwartz, A. (2018). Early attachment network with mother and father: An unsettled issue. *Child Development Perspectives*, *12*(2), 115-121.

Davila, J., & Kashy, D. A. (2009). Secure base processes in couples: daily associations between support experiences and attachment security. *Journal of family psychology*, *23*(1), 76.

de Minzi, M. C. R. (2006). Loneliness and depression in middle and late childhood: The relationship to attachment and parental styles. *The Journal of genetic psychology*, *167*(2), 189-210.

Deneault, A. A., Bakermans-Kranenburg, M. J., Groh, A. M., Fearon, P. R., & Madigan, S. (2021). Child-father attachment in early childhood and behavior problems: A meta-analysis. *New Directions for Child and Adolescent Development*, *2021*(180), 43-66.

De Wolff, M. S., & Van Ijzendoorn, M. H. (1997). Sensitivity and attachment: A meta-analysis on parental antecedents of infant attachment. *Child development*, *68*(4), 571-591.

Diamond, G. M. (2014). Attachment-based family therapy interventions. *Psychotherapy*, *51*(1), 15.

Diamond, G., Russon, J., & Levy, S. (2016). Attachment-based family therapy: A review of the empirical support. *Family process*, *55*(3), 595-610.

Dixon, W. E. (2015). *Twenty studies that revolutionized child psychology*. Pearson.

Edmondson, A. J., Brennan, C. A., & House, A. O. (2016). Non-suicidal reasons for self-harm: A systematic review of self-reported accounts. *Journal of affective disorders*, *191*, 109-117.

Eisele, G., Vachon, H., Lafit, G., Kuppens, P., Houben, M., Myin-Germeys, I., & Viechtbauer, W. (2022). The effects of sampling frequency and questionnaire length on perceived burden, compliance, and careless responding in experience sampling data in a student population. *Assessment*, *29*(2), 136-151.

Farewell, V. T., Long, D. L., Tom, B. D. M., Yiu, S., & Su, L. (2017). Two-part and related regression models for longitudinal data. *Annual review of statistics and its application*, *4*, 283-315.

Farkas, B. F., Takacs, Z. K., Kollárovics, N., & Balazs, J. (2023). The prevalence of self-injury in adolescence: a systematic review and meta-analysis. *European Child & Adolescent Psychiatry*, 1-20.

Felitti, V. J., Anda, R. F., Nordenberg, D., & Williamson, D. F. (1998). Adverse childhood experiences and health outcomes in adults: The Ace study. Journal of Family and Consumer Sciences, 90(3), 31.

Flake, J. K., & Fried, E. I. (2020). Measurement Schmeasurement: Questionable Measurement Practices and How to Avoid Them. *Advances in Methods and Practices in Psychological Science, 3*(4), 456-465. https://doi.org/10.1177/2515245920952393

Fraley, R. C., & Dugan, K. A. (2021). The consistency of attachment security across time and relationships. *Attachment: The fundamental questions*, 147-153.

Fritz, J., Piccirillo, M., Cohen, Z. D., Frumkin, M., Kirtley, O. J., Moeller, J., … Bringmann, L. F. (2023, November 3). So you want to do ESM? Ten Essential Topics for Implementing the Experience Sampling Method (ESM). https://doi.org/10.31219/osf.io/fverx

Gajos, J. M., Miller, C. R., Leban, L., & Cropsey, K. L. (2022). Adverse childhood experiences and adolescent mental health: Understanding the roles of gender and teenage risk and protective factors. *Journal of affective disorders*, *314*, 303-308.

Gandhi, A., Claes, L., Bosmans, G., Baetens, I., Wilderjans, T. F., Maitra, S., ... & Luyckx, K. (2016). Non-suicidal self-injury and adolescents attachment with peers and mother: The mediating role of identity synthesis and confusion. *Journal of Child and family Studies*, *25*, 1735-1745.

Gandhi, A., Luyckx, K., Baetens, I., Kiekens, G., Sleuwaegen, E., Berens, A., Maitra, S., & Claes, L. (2018). Age of onset of non-suicidal self-injury in Dutch-speaking adolescents and emerging adults: An event history analysis of pooled data. *Comprehensive psychiatry, 80,* 170-178

Gelman, A., & Loken, E. (2013). The garden of forking paths: Why multiple comparisons can be a problem, even when there is no “fishing expedition” or “p-hacking” and the research hypothesis was posited ahead of time. *Department of Statistics, Columbia University*, *348*(1-17), 3.

Geulayov, G., Casey, D., McDonald, K. C., Foster, P., Pritchard, K., Wells, C., ... & Hawton, K. (2018). Incidence of suicide, hospital-presenting non-fatal self-harm, and community-occurring non-fatal self-harm in adolescents in England (the iceberg model of self-harm): a retrospective study. *The Lancet Psychiatry*, *5*(2), 167-174.

Gillath, O., Hart, J., Noftle, E. E., & Stockdale, G. D. (2009). Development and validation of a state adult attachment measure (SAAM). *Journal of Research in Personality*, *43*(3), 362-373.

Gillies, D., Christou, M. A., Dixon, A. C., Featherston, O. J., Rapti, I., Garcia-Anguita, A., ... & Christou, P. A. (2018). Prevalence and characteristics of self-harm in adolescents: meta-analyses of community-based studies 1990–2015. *Journal of the American Academy of Child & Adolescent Psychiatry*, *57*(10), 733-741.

Glassman, L. H., Weierich, M. R., Hooley, J. M., Deliberto, T. L., & Nock, M. K. (2007). Child maltreatment, non-suicidal self-injury, and the mediating role of self-criticism. *Behaviour research and therapy, 45*(10), 2483-2490.

Glazebrook, K., Townsend, E., & Sayal, K. (2016). Do coping strategies mediate the relationship between parental attachment and self-harm in young people?. *Archives of Suicide Research*, *20*(2), 205-218.

Gonzalez, O., MacKinnon, D. P., & Muniz, F. B. (2021). Extrinsic convergent validity evidence to prevent jingle and jangle fallacies. *Multivariate Behavioral Research, 56*(1), 3-19.

Goossens, L. (2018). Loneliness in adolescence: Insights from Cacioppo's evolutionary model. *Child Development Perspectives*, *12*(4), 230-234.

Grossmann, K., & Grossmann, K. E. (2020). Essentials when studying child-father attachment: A fundamental view on safe haven and secure base phenomena. *Attachment & Human Development, 22*(1), 9-14.

Groves, S., Backer, H. S., Van den Bosch, W., & Miller, A. (2012). Dialectical behaviour therapy with adolescents. *Child and adolescent mental health*, *17*(2), 65-75.

Grusec, J. E., & Davidov, M. (2021). *Socializing children*. Cambridge University Press.

Hawkley, L. C., & Cacioppo, J. T. (2010). Loneliness matters: A theoretical and empirical review of consequences and mechanisms. *Annals of behavioral medicine*, *40*(2), 218-227.

Hawton, K., Saunders, K. E., & O'Connor, R. C. (2012). Self-harm and suicide in adolescents. *The lancet, 379*(9834), 2373-2382.

Henry, C. S., Sheffield Morris, A., & Harrist, A. W. (2015). Family resilience: Moving into the third wave. *Family Relations*, *64*(1), 22-43.

HM Government, 2018. A Connected Society: A Strategy for Tackling Loneliness – Laying the Foundations for Change. Department for Digital, Culture, Media and Sport, London. https://www.gov.uk/government/publications/a-connected-society-astrategy- for-tackling-loneliness. (Accessed 9 May 2021).

Horstmann, K. T., & Ziegler, M. (2020). Assessing personality states: What to consider when constructing personality state measures. *European Journal of Personality, 34*(6), 1037-1059.

Hughes, K., Bellis, M. A., Hardcastle, K. A., Sethi, D., Butchart, A., Mikton, C., ... & Dunne, M. P. (2017). The effect of multiple adverse childhood experiences on health: a systematic review and meta-analysis. *The Lancet public health, 2*(8), e356-e366.

Husky, M., Swendsen, J., Ionita, A., Jaussent, I., Genty, C., & Courtet, P. (2017). Predictors of daily life suicidal ideation in adults recently discharged after a serious suicide attempt: A pilot study. Psychiatry research, 256, 79-84.

Izadi-Mazidi, M., Yaghubi, H., Mohammadkhani, P., & Hassanabadi, H. (2019). Assessing the functions of non-suicidal self-injury: factor analysis of functional assessment of self-mutilation among adolescents. *Iranian journal of psychiatry*, *14*(3), 184.

Jacobucci, R., McClure, K., & Ammerman, B. A. (2023). Comparing the role of perceived burdensomeness and thwarted belongingness in prospectively predicting active suicidal ideation. *Suicide and Life-Threatening Behavior, 53*(2), 198-206.

Joiner, T. (2005). *Why people die by suicide*. Harvard University Press.

Kalmakis, K. A., & Chandler, G. E. (2015). Health consequences of adverse childhood experiences: A systematic review. Journal of the American Association of Nurse Practitioners, 27(8), 457-465.

Kapur, N., Cooper, J., O'Connor, R. C., & Hawton, K. (2013). Non-suicidal self-injury v. attempted suicide: new diagnosis or false dichotomy?. *The British Journal of Psychiatry*, *202*(5), 326-328.

Kaurin, A., Dombrovski, A. Y., Hallquist, M. N., & Wright, A. G. (2022). Momentary interpersonal processes of suicidal surges in borderline personality disorder. *Psychological medicine*, *52*(13), 2702-2712.

Keijsers, L., Branje, S. J., VanderValk, I. E., & Meeus, W. (2010). Reciprocal effects between parental solicitation, parental control, adolescent disclosure, and adolescent delinquency. *Journal of Research on Adolescence, 20*(1), 88-113.

Kerns, K. A., Mathews, B. L., Koehn, A. J., Williams, C. T., & Siener-Ciesla, S. (2015). Assessing both safe haven and secure base support in parent–child relationships. *Attachment & human development*, *17*(4), 337-353.

Kessler, R. C., Petukhova, M., Sampson, N. A., Zaslavsky, A. M., & Wittchen, H. U. (2012). Twelve-month and lifetime prevalence and lifetime morbid risk of anxiety and mood disorders in the United States. *International journal of methods in psychiatric research*, *21*(3), 169-184.

Kidger, J., Heron, J., Lewis, G., Evans, J., & Gunnell, D. (2012). Adolescent self-harm and suicidal thoughts in the ALSPAC cohort: a self-report survey in England. *BMC psychiatry*, *12*, 1-12.

Kiekens, G., Hasking, P., Boyes, M., Claes, L., Mortier, P., Auerbach, R. P., Cuijpers, P., Demyttenaere, K., Green, J. G., Kessler, R. C., Myin-Germeys, I., Nock, M. K., & Bruffaerts, R. (2018). The associations between non-suicidal self-injury and first onset suicidal thoughts and behaviors. *Journal of affective disorders, 239,* 171-179.

Kiekens, G., Hasking, P., Bruffaerts, R., Alonso, J., Auerbach, R. P., Bantjes, J., ... & Kessler, R. C. (2023). Non-suicidal self-injury among first-year college students and its association with mental disorders: results from the World Mental Health International College Student (WMH-ICS) initiative. *Psychological medicine*, *53*(3), 875-886.

Kiekens, G., Robinson, K., Tatnell, R., & Kirtley, O. J. (2021). Opening the black box of daily life in nonsuicidal self-injury research: with great opportunity comes great responsibility. *JMIR mental health, 8*(11), e30915.

Kirtley, O. J., Lafit, G., Achterhof, R., Hiekkaranta, A. P., & Myin-Germeys, I. (2021). Making the black box transparent: A template and tutorial for registration of studies using experience-sampling methods. *Advances in Methods and Practices in Psychological Science, 4*(1), 2515245920924686.

Kleiman, E. M., Turner, B. J., Fedor, S., Beale, E. E., Huffman, J. C., & Nock, M. K. (2017). Examination of real-time fluctuations in suicidal ideation and its risk factors: Results from two ecological momentary assessment studies. *Journal of abnormal psychology, 126*(6), 726.

Kleindienst, N., Bohus, M., Ludäscher, P., Limberger, M. F., Kuenkele, K., Ebner-Priemer, U. W., ... & Schmahl, C. (2008). Motives for nonsuicidal self-injury among women with borderline personality disorder. *The Journal of nervous and mental disease*, *196*(3), 230-236.

Klonsky, E. D., & May, A. M. (2015). The three-step theory (3ST): A new theory of suicide rooted in the "ideation-to-action" framework. *International Journal of Cognitive Therapy*, *8*(2), 114-129.

Kobak, R., & Bosmans, G. (2019). Attachment and psychopathology: A dynamic model of the insecure cycle. *Current opinion in psychology*, *25*, 76.

Koenig, J., Klier, J., Parzer, P., Santangelo, P., Resch, F., Ebner-Priemer, U., & Kaess, M. (2021). High-frequency ecological momentary assessment of emotional and interpersonal states preceding and following self-injury in female adolescents. *European child & adolescent psychiatry*, *30*, 1299-1308.

Lasgaard, M., Goossens, L., Bramsen, R. H., Trillingsgaard, T., & Elklit, A. (2011). Different sources of loneliness are associated with different forms of psychopathology in adolescence. *Journal of Research in Personality*, *45*(2), 233-237.

Laye-Gindhu, A., & Schonert-Reichl, K. A. (2005). Nonsuicidal self-harm among community adolescents: Understanding the "whats" and "whys" of self-harm. *Journal of youth and Adolescence*, *34*, 447-457.

Lee, S.L., Pearce, E., Ajnakina, O., Johnson, S., Lewis, G., Mann, F., Pitman, A., Solmi, F., Sommerlad, A., Steptoe, A., Tymoszuk, U., 2021. The association between loneliness and depressive symptoms among adults aged 50 years and older: a 12- year population-based cohort study. The Lancet Psychiatry 8 (1), 48–57.

Lim, K. S., Wong, C. H., McIntyre, R. S., Wang, J., Zhang, Z., Tran, B. X., ... & Ho, R. C. (2019). Global lifetime and 12-month prevalence of suicidal behavior, deliberate self-harm and non-suicidal self-injury in children and adolescents between 1989 and 2018: a meta-analysis. *International journal of environmental research and public health*, *16*(22), 4581.

Linehan, M. M. (2020). *Dialectical behavior therapy in clinical practice*. Guilford Publications.

Lionetti, F., Pastore, M., & Barone, L. (2015). Attachment in institutionalized children: A review and meta-analysis. *Child abuse & neglect*, *42*, 135-145.

Madge, N., Hewitt, A., Hawton, K., Wilde, E. J. D., Corcoran, P., Fekete, S., ... & Ystgaard, M. (2008). Deliberate self-harm within an international community sample of young people: comparative findings from the Child & Adolescent Self-harm in Europe (CASE) Study. *Journal of child Psychology and Psychiatry*, *49*(6), 667-677.

Maté, G. (2010). Holding on to our kids in a peer culture. *Education Canada*, *50*(1), 61-63.

McClelland, H., Evans, J. J., Nowland, R., Ferguson, E., & O'Connor, R. C. (2020). Loneliness as a predictor of suicidal ideation and behaviour: a systematic review and meta-analysis of prospective studies. *Journal of affective disorders*, *274*, 880-896.

McClelland, H., Evans, J. J., & O'Connor, R. C. (2021). Exploring the role of loneliness in relation to self-injurious thoughts and behaviour in the context of the integrated motivational-volitional model. *Journal of psychiatric research, 141,* 309-317.

Menashe-Grinberg, A., Shneor, S., Meiri, G., & Atzaba-Poria, N. (2022). Improving the parent–child relationship and child adjustment through parental reflective functioning group intervention. *Attachment & human development*, *24*(2), 208-228.

Meppelink, R., de Bruin, E. I., Wanders-Mulder, F. H., Vennik, C. J., & Bögels, S. M. (2016). Mindful parenting training in child psychiatric settings: heightened parental mindfulness reduces parents' and children's psychopathology. *Mindfulness*, *7*, 680-689.

Mestdagh, M., & Dejonckheere, E. (2021). Ambulatory assessment in psychopathology research: Current achievements and future ambitions. *Current Opinion in Psychology*, *41*, 1-8.

Mikulincer, M., Shaver, P. R., & Pereg, D. (2003). Attachment theory and affect regulation: The dynamics, development, and cognitive consequences of attachment-related strategies. *Motivation and emotion*, *27*, 77-102.

Miller, A. L., Rathus, J. H., & Linehan, M. M. (2006). *Dialectical behavior therapy with suicidal adolescents*. Guilford Press.

Moccia, L., Janiri, D., Pepe, M., Dattoli, L., Molinaro, M., De Martin, V., ... & Di Nicola, M. (2020). Affective temperament, attachment style, and the psychological impact of the COVID-19 outbreak: an early report on the Italian general population. *Brain, behavior, and immunity*, *87*, 75-79.

Moore, K. A., & N Ramirez, A. (2016). Adverse childhood experience and adolescent well-being: Do protective factors matter?. Child Indicators Research, 9, 299-316.

Mortier, P., Cuijpers, P., Kiekens, G., Auerbach, R. P., Demyttenaere, K., Green, J. G., Kessler, R. C., Nock, M. K., & Bruffaerts, R. (2018). The prevalence of suicidal thoughts and behaviours among college students: a meta-analysis. *Psychological medicine, 48*(4), 554-565.

Muehlenkamp, J. J., Claes, L., Havertape, L., & Plener, P. L. (2012). International prevalence of adolescent non-suicidal self-injury and deliberate self-harm. *Child and adolescent psychiatry and mental health*, *6*, 1-9.

Munafò, M. R., Nosek, B. A., Bishop, D. V., Button, K. S., Chambers, C. D., Percie du Sert, N., ... & Ioannidis, J. (2017). A manifesto for reproducible science. *Nature human behaviour*, *1*(1), 1-9.

Myin-Germeys, I., Kasanova, Z., Vaessen, T., Vachon, H., Kirtley, O., Viechtbauer, W., & Reininghaus, U. (2018). Experience sampling methodology in mental health research: new insights and technical developments. *World Psychiatry*, *17*(2), 123-132.

Narayan, A. J., Lieberman, A. F., & Masten, A. S. (2021). Intergenerational transmission and prevention of adverse childhood experiences (ACEs). *Clinical psychology review*, *85*, 101997.

National Institute for Health and Care Excellence. (2011). Self-harm (NICE guideline). https://www.nice.org.uk/guidance

Nock, M. K. (2009). Why do people hurt themselves? New insights into the nature and functions of self-injury. *Current directions in psychological science*, *18*(2), 78-83.

Nock, M. K., Green, J. G., Hwang, I., McLaughlin, K. A., Sampson, N. A., Zaslavsky, A. M., & Kessler, R. C. (2013). Prevalence, correlates, and treatment of lifetime suicidal behavior among adolescents: Results from the National Comorbidity Survey Replication Adolescent Supplement. *JAMA Psychiatry, 70*(3), 300-310

Nock, M. K., & Prinstein, M. J. (2004). A functional approach to the assessment of self-mutilative behavior. *Journal of consulting and clinical psychology*, *72*(5), 885.

Nosek, B. A., Hardwicke, T. E., Moshontz, H., Allard, A., Corker, K. S., Dreber, A., ... & Vazire, S. (2022). Replicability, robustness, and reproducibility in psychological science. *Annual review of psychology*, *73*, 719-748.

Novak, M. A. (2003). Self-injurious behavior in rhesus monkeys: new insights into its etiology, physiology, and treatment. *American Journal of Primatology: Official Journal of the American Society of Primatologists, 59*(1), 3-19.

O'Connor, R. C., Rasmussen, S., Miles, J., & Hawton, K. (2009). Self-harm in adolescents: self-report survey in schools in Scotland. *The british journal of psychiatry*, *194*(1), 68-72.

O'Connor, R. C. (2011). Towards an integrated motivational–volitional model of suicidal behaviour. International handbook of suicide prevention: *Research, policy and practice, 1,* 181-98.

O'Connor, R. C., & Kirtley, O. J. (2018). The integrated motivational–volitional model of suicidal behaviour. *Philosophical Transactions of the Royal Society B: Biological Sciences, 373*(1754), 20170268.

Orben, A., Tomova, L., & Blakemore, S. J. (2020). The effects of social deprivation on adolescent development and mental health. *The Lancet Child & Adolescent Health*, *4*(8), 634-640.

Palm, G. (2014). Attachment theory and fathers: Moving from "being there" to "being with". *Journal of Family Theory & Review*, *6*(4), 282-297.

Pedrini, L., Meloni, S., Lanfredi, M., & Rossi, R. (2022). School-based interventions to improve emotional regulation skills in adolescent students: A systematic review. *Journal of Adolescence*, *94*(8), 1051-1067.

Raby, K. L., Fraley, R. C., & Roisman, G. I. (2021). Categorical or dimensional measures of attachment. *Attachment: The fundamental questions*, *70*, 70-77.

Rasmussen, S., Hawton, K., Philpott-Morgan, S., & O'Connor, R. C. (2016). Why do adolescents self-harm?. *Crisis*.

Rintala, A., Wampers, M., Myin-Germeys, I., & Viechtbauer, W. (2019). Response compliance and predictors thereof in studies using the experience sampling method. *Psychological assessment*, *31*(2), 226.

Sachs-Ericsson, N. J., Rushing, N. C., Stanley, I. H., & Sheffler, J. (2016). In my end is my beginning: Developmental trajectories of adverse childhood experiences to late-life suicide. *Aging & mental health, 20*(2), 139-165.

Sahle, B. W., Reavley, N. J., Li, W., Morgan, A. J., Yap, M. B. H., Reupert, A., & Jorm, A. F. (2021). The association between adverse childhood experiences and common mental disorders and suicidality: an umbrella review of systematic reviews and meta-analyses. *European child & adolescent psychiatry, 1-11*.

Sanscartier, S., & MacDonald, G. (2019). Healing through community connection? Modeling links between attachment avoidance, connectedness to the LGBTQ+ community, and internalized heterosexism. *Journal of Counseling Psychology*, *66*(5), 564.

Santangelo, P. S., Koenig, J., Funke, V., Parzer, P., Resch, F., Ebner-Priemer, U. W., & Kaess, M. (2017). Ecological momentary assessment of affective and interpersonal instability in adolescent non-suicidal self-injury. *Journal of abnormal child psychology, 45*, 1429-1438.

Santens, T., Claes, L., Diamond, G. S., & Bosmans, G. (2018). Depressive symptoms and self-harm among youngsters referred to child welfare: The role of trust in caregiver support and communication. *Child abuse & neglect*, *77*, 155-167.

Saul, J., Valle, L. A., Mercy, J. A., Turner, S., Kaufmann, R., & Popovic , T. (2014, March 28). CDC Grand Rounds: Creating a Healthier Future Through Prevention of Child Maltreatment. MMWR Morb Mortal Wkly Rep., 63(12), 260–263.

Sawyer, S. M., Azzopardi, P. S., Wickremarathne, D., & Patton, G. C. (2018). The age of adolescence. *The lancet child & adolescent health*, *2*(3), 223-228.

Sedano-Capdevila, A., Porras-Segovia, A., Bello, H. J., Baca-Garcia, E., & Barrigon, M. L. (2021). Use of ecological momentary assessment to study suicidal thoughts and behavior: a systematic review. *Current psychiatry reports, 23*(7), 41.

Sels, L., Homan, S., Reis, H., Horn, A. B., Scholz, U., Kowatsch, T., & Kleim, B. (2022). Testing the role of perceived responsiveness in suicidal ideation: an experience sampling study in psychiatric inpatients.

Sheinbaum, T., Kwapil, T. R., Ballespí, S., Mitjavila, M., Chun, C. A., Silvia, P. J., & Barrantes-Vidal, N. (2015). Attachment style predicts affect, cognitive appraisals, and social functioning in daily life. *Frontiers in psychology*, *6*, 296.

Shpigel, M. S., Diamond, G. M., & Diamond, G. S. (2012). Changes in parenting behaviors, attachment, depressive symptoms, and suicidal ideation in attachment-based family therapy for depressive and suicidal adolescents. *Journal of Marital and Family Therapy*, *38*, 271-283.

Siegel, D. J. (1999). The developing mind (Vol. 296). Guilford Press New York.

Smetana, J. G., & Rote, W. M. (2019). Adolescent–parent relationships: Progress, processes, and prospects. *Annual Review of Developmental Psychology*, *1*, 41-68.

Solmi, M., Radua, J., Olivola, M., Croce, E., Soardo, L., Salazar de Pablo, G., ... & Fusar-Poli, P. (2022). Age at onset of mental disorders worldwide: large-scale meta-analysis of 192 epidemiological studies. *Molecular psychiatry*, *27*(1), 281-295.

Souza, K., Sosu, E. M., Thomson, S., & Rasmussen, S. (2024). A systematic review of the studies testing the integrated motivational-volitional model of suicidal behaviour. *Health psychology review*, 1-25.

Spirito, A., & Esposito-Smythers, C. (2006). Attempted and completed suicide in adolescence. *Annu. Rev. Clin. Psychol.*, *2*, 237-266.

Spruijt, A. M., Dekker, M. C., Ziermans, T. B., & Swaab, H. (2020). Educating parents to improve parent–child interactions: Fostering the development of attentional control and executive functioning. *British Journal of Educational Psychology*, *90*, 158-175.

Steinberg, L., & Morris, A. S. (2001). Adolescent development. *Annual review of psychology*, *52*(1), 83-110.

Swannell, S. V., Martin, G. E., Page, A., Hasking, P., & St John, N. J. (2014). Prevalence of nonsuicidal self-injury in nonclinical samples: Systematic review, meta-analysis and meta-regression. *Suicide and Life-Threatening Behavior*, *44*(3), 273-303.

Tackett, J. L., Brandes, C. M., King, K. M., & Markon, K. E. (2019). Psychology's replication crisis and clinical psychological science. *Annual review of clinical psychology*, *15*, 579-604.

Tafà, M., Bracaglia, F., Inguscio, L., & Carone, N. (2022). What Decides the Well-Being of the Relationship between Parents and Adolescents. *International Journal of Environmental Research and Public Health*, *20*(1), 383.

Torquati, J. C., & Raffaelli, M. (2004). Daily experiences of emotions and social contexts of securely and insecurely attached young adults. *Journal of Adolescent Research*, *19*(6), 740-758.

Trull, T. J., & Ebner-Priemer, U. W. (2020). Ambulatory assessment in psychopathology research: A review of recommended reporting guidelines and current practices. *Journal of Abnormal Psychology*, *129*(1), 56.

Vancayseele, N., Van Hevele, E., & Portzky, G. DE EPIDEMIOLOGIE VAN SUÏCIDEPOGINGEN IN VLAANDEREN (2022).

van Heeringen K. Stress–Diathesis Model of Suicidal Behavior. In: The Neurobiological Basis of Suicide. CRC Press/Taylor & Francis, Boca Raton (FL); 2012. PMID: 23035289.

Van Meter, A. R., Knowles, E. A., & Mintz, E. H. (2023). Systematic review and meta-analysis: international prevalence of suicidal ideation and attempt in youth. *Journal of the American Academy of Child & Adolescent Psychiatry*, *62*(9), 973-986.

Van Orden, K. A., Witte, T. K., Cukrowicz, K. C., Braithwaite, S. R., Selby, E. A., & Joiner Jr, T. E. (2010). The interpersonal theory of suicide. *Psychological review, 117*(2), 575.

Veer, I. M., Riepenhausen, A., Zerban, M., Wackerhagen, C., Puhlmann, L. M., Engen, H., ... & Kalisch, R. (2021). Psycho-social factors associated with mental resilience in the Corona lockdown. *Translational psychiatry*, *11*(1), 67.

Venta, A. (2020). Attachment facilitates acculturative learning and adversity moderates: Validating the theory of epistemic trust in a natural experiment. Child Psychiatry & Human Development, 51(3), 471-477.

Waters, T. E., Facompré, C. R., Van de Walle, M., Dujardin, A., De Winter, S., Heylen, J., ... & Bosmans, G. (2019). Stability and change in secure base script knowledge during middle childhood and early adolescence: A 3-year longitudinal study. *Developmental Psychology*, *55*(11), 2379.

WHO (2020). World Health Organization: WHO announces COVID-19 outbreak a pandemic. http://www.euro.WHO.int/en/health-topics/health-emergencies/coronavirus-covid-19/news/news/2020/3/whoannounces-covid-19-outbreak-a-pandemic

Williams, M. (2014). *Cry of pain: understanding suicide and the suicidal mind*. Hachette UK.

Witt, K. G., Hetrick, S. E., Rajaram, G., Hazell, P., Salisbury, T. L. T., Townsend, E., & Hawton, K. (2021). Interventions for self-harm in children and adolescents. *Cochrane database of systematic reviews*, (3).

World Health Organization. (2021). Suicide worldwide in 2019: Global health estimates. https://www.who.int/publications/i/item/978 9240026643

Zetterqvist, M. (2015). The DSM-5 diagnosis of nonsuicidal self-injury disorder: a review of the empirical literature. *Child and adolescent psychiatry and mental health*, *9*, 1-13.

Zortea, T. C., Gray, C. M., & O'Connor, R. C. (2021). The relationship between adult attachment and suicidal thoughts and behaviors: A systematic review. *Archives of suicide research*, *25*(1), 38-73.

Supplementary Materials

Supplementary materials for **Chapter 3** are available online: https://osf.io/8eu9y/

Supplementary materials for **Chapter 4** are available online: https://osf.io/uq5ba/

Supplementary materials for **Chapter 5** are available online: https://osf.io/wdkxz/

Supplementary materials for **Chapter 6** are available online: https://osf.io/yqxp7/

Supplementary materials for **Chapter 7** are available online: https://osf.io/dxvsh/

Scientific Acknowledgements

I am deeply grateful for every contribution that made the SIGMA project possible. In particular, I would like to thank the entire SIGMA team for their exceptional effort in designing and setting up the study, collecting the data, and managing the project. Special thanks to Prof. Inez Myin-Germeys, Prof. Olivia Kirtley, Silke Apers, Martine van Nierop, Martien Wampers, Tessa Biesemans, Jolien Bynens, Aleksandra Lecei, Noëmi Hagemann, Karlijn Hermans, Anu Hiekkaranta, Zeynep Akcaoglu, Robin Achterhof, Eva Bamps, and the SIGMA master students. I would also like to thank Ginette Lafit and Kristof Vansteenlandt for their assistance in analysing these longitudinal data. Moreover, I want to thank all the adolescents, parents, teachers, school personnel and all organisations involved in the SIGMA project. Finally, I extend my gratitude to the Research Foundation Flanders for funding this project through the Odysseus Grant (FWO G08416N) to Prof. Inez Myin-Germeys, and through other grants funded to co-authors that can be found via the published and preprinted versions of the studies.

Conflict of Interest Statement

The authors, including the doctoral candidate, have no conflicts of interests to disclose.

Personal Contribution

I became a core member of the SIGMA team in 2019 which means I was not involved in the set up and data collection for the first wave of the SIGMA study (described in **Chapter 3 to 6**), but I was for all of the other waves of the SIGMA study (including the covid wave described in **Chapter 4**). This includes planning and administering the project, preparing the protocol and study materials, contacting and recruiting schools and individuals participants, collecting in-person and online retrospective and Experience Sampling data across Flanders, providing education packages to schools, creating online content, and writing newsletters and reports. All research articles, including the systematic review in **Chapter 7**, was first-authored by myself, except for the editorial paper in **Chapter 8** which I co-authored. For **Chapter 3 to 6**, I conceptualized the study with my supervisors OJK and IMG, wrote the paper and conducted all the analyses. For **Chapter 4**, I collected part of the data. For **Chapter 7**, I searched, screened, and synthesized all the results in collaboration with the co-authors. For **Chapter 8**, I contributed to the writing of the manuscript.

Professional Career

Julie Janssens (born August 10, 1993) grew up as the youngest daughter in a family in Pellenberg, near Leuven. Surrounded by three male engineers and a household marked by daily discussions and, at times, heated conflicts, she developed an insatiable desire to understand the underlying mechanisms of conflict and authentic connection within and between individuals. Consequently, studying Clinical Psychology and completing a four-year Family Therapy course were natural choices for her.

After obtaining her Master's degree in Psychology with magna cum laude honours, she built clinical expertise in a private practice, where she encountered an impossible paradox in treating adolescents thinking about and engaging in self-harm. The more these young individuals, their parents, and therapeutic protocols tried to convince her to treat these adolescents individually, the stronger she felt that this approach neglected the underlying core need of these young individuals. Julie could not but understand the self-harm of these adolescents as their way to communicate their unmet need to be seen, heard and loved by their most important attachment figures: their parents. Realizing that more than 700,000 lives are lost to suicide every year and that rates among adolescents are rising, she felt inadequate as a therapist. In fact, despite significant advances in mental health knowledge over the past 50 years, effective prevention and treatment of self-harm seemed elusive. This realization drove her to pursue a PhD at the Center for Contextual Psychiatry (CCP) to explore what could potentially be a crucial, and tangible, protective factor for self-harm: the parent-child attachment relationship.

Upon arriving at the CCP, Julie brought a contextual view on mental health processes and research in general, and extended current theoretical frameworks used to understand and respond to adolescent self-harm. During her PhD journey, she built a unique combination of expertise in research on attachment, self-harm and Experience Sampling Methodology (ESM) enabling her to empirically demonstrate *the power of attachment* in this PhD thesis, and to do so with great integrity. Julie is known for her high level of transparency in personal, clinical and research contexts.

Within a PhD context, this is illustrated in the advanced skills she mastered in Open Science practices, e.g., pioneering the most challenging Open Science practice by publishing the first-ever Registered Report on self-harm, and in her guidance of other researchers to implement Open Science practices (e.g., workshops, talks and co-authoring an editorial on the possibilities of Open Science in suicide research). Throughout her PhD, Julie enjoyed translating research to a broad audience including adolescents, schools and clinicians, both online and in-person, increasing societal impact through public engagement, such as writing blog posts, collaborating with researchers across the world and presenting at (inter)national conferences. After completing her PhD, Julie will remain a strong advocate for adolescent mental health, bridging the critical gap between research and clinical practice.

List of Publications

All publications indicated with * are chapters within this thesis.

***Janssens, J. J**., Myin-Germeys, I., Lafit, G., Achterhof, R., Hagemann, N., Hermans, K. S., Hiekkaranta, A. P., Lecei, A. & Kirtley, O. J. (2022). Lifetime and current self-harm thoughts and behaviors and their relationship to parent and peer attachment. Crisis: The Journal of Crisis Intervention and Suicide Prevention. Registered Report.

***Janssens, J. J.,** Achterhof, R., Lafit, G., Bamps, E., Hagemann, N., Hiekkaranta, A. P., Hermans, K. S. F. M., Lecei, A., Myin-Germeys, I. & Kirtley, O. J. (2021). The Impact of COVID-19 on Adolescents' Daily Lives: The Role of Parent–Child Relationship Quality. Journal of Research on Adolescence, 31(3), 623-644. Preregistered on the Open Science Framework.

*Kirtley, O. J., **Janssens, J. J**., & Kaurin, A. (2022). Open science in suicide research is open for business. Crisis.

Pre-prints:

Bamps, E., Achterhof, R., Lafit, G., Teixeira, A. M. C., Akcaoglu, Z., Hagemann, N., Hermans, K. S. F. M., Hiekkaranta, A. P., **Janssens, J. J.,** Lecei, A., Myin-Germeys, I. & Kirtley, O. (2022). Changes in Adolescents' Daily-Life Social Withdrawal Experiences During the COVID-19 Pandemic. Preregistered on the Open Science Framework.

Achterhof, R., Myin-Germeys, I., Bamps, E., Hagemann, N., Hermans, K., Hiekkaranta, A. P., **Janssens, J. J.,** Lecei, A. & Kirtley, O. (2021). COVID-19-related changes in adolescents' daily-life social interactions and psychopathology symptoms. Preregistered on the Open Science Framework.

***Janssens, J. J.,** Kiekens, G., Jaeken, M., & Kirtley, O. J. (2023). A systematic review of interpersonal processes and their measurement within experience sampling studies of self-injurious thoughts and behaviours.

***Janssens, J. J.,** Lafit, G., De Corte, E., Achterhof, R., Hagemann, N., Hermans K. S. F. M., Hiekkaranta, A. P., Lecei, A., Myin-Germeys, I., & Kirtley, O. J. (2023). Associations between adverse childhood experiences, parent-child and peer attachment relationships, and daily-life self-harm in adolescents.

***Janssens, J. J.,** Lafit, G., Simsa, B., Bosmans, G., Achterhof, R., Hagemann, N., Myin-Germeys, I., & Kirtley, O. J. (2023). The role of parent-child attachment in the association between loneliness and self-harm thoughts and behaviours in daily life.

Hiekkaranta, A. P., Derks, K., Achterhof, R., Bamps, E., Hagemann, N., **Janssens, J. J**, Myin-Germeys, I., & Kirtley, O. (2023). Psychopathology and ruminating, savoring, and sharing in the daily lives of adolescents during the COVID-19 pandemic.

Hiekkaranta, A. P., Myin-Germeys, I., Achterhof, R., Bamps, E., Hagemann, N., **Janssens, J. J.,** Akcaoglu, Z., Lafit, G., & Kirtley, O. (2023). Adolescents' future orientation and anticipatory emotion regulation in daily life during the COVID-19 pandemic: An experience sampling study.

Lachowicz, A., Houben, M., Vaessen, T., Lafit, G., Achterhof, R., Akcaoglu, Z., Bamps, E., Hagemann, N., Hiekkaranta, A. P., **Janssens, J. J**., Lecei, A., Kirtley, O., & Myin-Germeys, I. (2023).

Delayed Affective Recovery from Stress is Linked to Current but not Future Subclinical Anxiety Symptoms in Youth: an Experience Sampling Study.

Ackaoglu, Z., Achterhof, R., Vaessen, T., **Janssens, J. J.,** Wampers, M., Bamps, E., Lafit, G., Kirtley, O. J., & Myin-Germeys, I. (2024) Sex differences in subclinical psychotic experiences: the role of daily-life social interactions

Personal Acknowledgements

Dankwoord