A Temporal Network Analysis of Risk Factors for Suicide

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Abstract

Suicide is a major public health concern in New Zealand, with the number of lives lost due to suicide increasing almost every year. The factors influencing a person's decision to take their own life are numerous and often complex. Some of these factors are dynamic, fluctuating over short periods of time and ultimately altering a person's risk for suicide. Network analysis is a novel statistical technique that can be used to explore complex causal associations in systems of variables, such as risk factors for suicide. The present study used temporal network analysis to explore the associations between dynamic risk factors for suicide over time. Data collection involved ecological momentary assessment, where a general community sample of 39 adult participants completed a brief survey five times per day for ten days, resulting in 1420 completed surveys. Each survey assessed participants' momentary experience of suicidal ideation, depressed mood, hopelessness, social support, self-esteem, thwarted belongingness, perceived burdensomeness, anhedonia, worthlessness, alcohol intoxication, and fatigue. All variables fluctuated from measurement to measurement at least some of the time, highlighting the dynamic nature of suicide risk. Temporal, contemporaneous, and between-persons networks of the 11 measured variables were estimated using temporal network analysis. In the temporal network, hopelessness was the only variable that predicted an increase in suicidal ideation at the subsequent measurement. Multiple nodes were estimated to be positively associated with suicidal ideation in the contemporaneous network, including depressed mood, thwarted belongingness, perceived burdensomeness, and worthlessness, while self-esteem was negatively associated with suicidal ideation in this network. In the between-persons network, hopelessness was the only variable with a significant association with suicidal ideation. The results of this study highlight the importance of continuously assessing changes in suicide risk factors given their dynamic

nature. Hopelessness may be an especially important risk factor to assess given its temporal association with increased suicidal ideation. Regarding future research opportunities, experimental N=1 network studies about the effectiveness of personalised interventions based on node centrality are an important next step in determining whether individualised networks have a place in personalised treatment for suicidality.

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Chapter One: Current Understanding of Suicide

Every year hundreds of New Zealanders take their own life, many more attempt to do so, and countless more have suicidal thoughts. Since 2018, there has been a slight decrease in the number of suicides that occur in New Zealand annually (Te Whatu Ora, 2022). In the year to June 2022, 538 people died by suicide, equating to a rate of 10.2 suicide deaths per 100,000 New Zealanders (Te Whatu Ora, 2022). In the same period, more than 9,000 people were hospitalised for attempting suicide or engaging in intentional self-harm in New Zealand (Ministry of Health, 2022).

In New Zealand, particular demographic characteristics are associated with a higher likelihood of suicide than others. For example, when comparing the suicide rates of different genders, we see a pronounced difference in the number and rate of suicides of males and females. For every female suicide in the year to June 2022, there were 2.9 male suicides (Te Whatu Ora, 2022). The rate of male suicides is also nearly three times that of females, with a rate of 14.9 suicides per 100,000 males compared to 5.5 suicides per 100,000 females (Te Whatu Ora, 2022). While a suicide rate ratio of one female suicide to three male suicides is typical for high-income countries such as New Zealand, a report by the World Health Organization (2019) states that globally males have a suicide rate 1.8 times higher than that of females. There are numerous explanations proposed for why males tend to have higher suicide rates than females, such as males being more impulsive, using means of suicide that are more lethal, and engaging in help-seeking behaviour less often than females (Sher, 2020). The suicide rate of gender diverse individuals is not reported in New Zealand statistics, so this is unable to be compared to the rates

above. However, a recent nationwide study reported that 37% of trans and non-binary participants had a lifetime suicide attempt (Veale et al., 2019).

Suicide rates in New Zealand also vary by age group, with particular age groups having higher rates of suicide. The highest suicide rates in New Zealand are among young adults. In the year to June 2022, the age group with the highest suicide rate in New Zealand was those aged 20 to 24 years, with a rate of 21.4 suicides per 100,000 (Te Whatu Ora, 2022). Worldwide suicide is the fourth leading causes of death for 15 to 29 year olds (World Health Organisation, 2021). A few other age brackets across the lifespan also have particularly high suicide rates, including adults aged 35 to 39 and 55 to 59 as well as older adults aged over 85. Adults in the 35 to 39 year old age bracket died by suicide at a rate of 14.4 per 100,000 in the year to June 2022, while the rate was 13.7 per 100,000 for those aged 55 to 59. Older adults aged over 85 years reported the fourth highest suicide rate out of all age brackets for the same period, with a rate of 10.7 suicides per 100,000 (Te Whatu Ora, 2022).

Within New Zealand, there are disparities between the suicide rates of different ethnic groups, too. Māori people have the highest suicide rate, with 15.9 suicides per 100,000, while the suicide rate for Pacific Islander people is 9.9 per 100,000 and for Asian people is 3.8 per 100,000 (Te Whatu Ora, 2022). The suicide rate of other ethnic groups in New Zealand, including New Zealand European/Pākehā people, sits at 10.1 suicides per 100,000 people (Te Whatu Ora, 2022). The reasons for the difference in suicide rates of Māori and non-Māori are poorly understood. One explanation postulated by Beautrais and Fergusson (2006) is that Māori are comparatively disadvantaged in New Zealand, as evidenced by the over-representation of Māori in health, welfare, and justice statistics. Another related explanation posited by Beautrais and Fergusson

(2006) is that the difference is due to factors which are unique to Māori and other indigenous populations, such as the impact of colonisation.

Impact of Suicide

Suicide can have many impacts, the most obvious of which is the loss of a person's life. In 2005 it was estimated that 19,218 years of life were lost when 460 people died by suicide (O'Dea & Tucker, 2005). At that time, the average number of years of life lost for males was 40.8 years and for females was 44.9 years (O'Dea & Tucker, 2005). With the current number of suicides per year being even higher, the number of years of life lost due to suicide will be even more today.

It is imperative that we try to prevent suicide from occurring to reduce loss of life and also to reduce the wide range of effects that each suicide can have. A single suicide can have far-reaching impacts, with ramifications being felt by relatives, friends, colleagues, mental health professionals, and even impacting the economy. Shneidman (1972) estimated that for each suicide that occurred, six people were bereaved, based on the size of an average immediate family at the time. However, current empirical estimates of the number of people bereaved by suicide are much higher, taking into account the many relationships that exist outside of a person's immediate family. In Cerel et al.'s (2019) study of adults in the United States of America, 46.7% of the 1702 participants reported that they knew someone who had died by suicide. Extrapolation by Cerel et al. (2019) suggests that for each suicide in the United States of America, an estimated 135 people are bereaved (i.e., they knew the person who died). In another study in the United States of America, more than half of the 1432 participants knew of another person's suicide, and 36% of all participants reported experiencing great distress following a

person's suicide (Feigelman et al., 2018). Individuals who know someone who has died by suicide on average express higher levels of suicidal ideation, depression, and anxiety than individuals who have not been exposed to suicide (Cerel et al., 2016).

Though there are no empirical estimates for how many people in New Zealand are exposed to each suicide that occurs or how many experience distress relating to this exposure, recent research suggests many people *know of* someone who has died by suicide. Holman and Williams' (2020) study of New Zealand youth aged 18 to 24 found 55% of the 100 participants personally knew a young person who had died by suicide. Given Cerel et al.'s (2019) and Feigelman et al.'s (2018) estimates of how many people are exposed to suicide and experience subsequent distress, and that over 500 suicides occur in New Zealand each year (Te Whatu Ora, 2022), it is plausible that thousands of New Zealanders experience some degree of bereavement-related distress following the suicide of someone they know.

Suicide-bereaved people also face difficulties at work following the suicide. Individuals who have been bereaved by suicide report poor occupational functioning, with grief impacting their productivity and motivation in their place of work or study (Pitman et al., 2018). Research suggests that these individuals are also significantly more likely to quit their job or a course following the suicide, when compared to individuals bereaved by other causes (Pitman et al., 2016, 2018). A consequence of absenteeism and staff turnover following a person's suicide is that the country's economy suffers a loss too. In New Zealand, the most recent estimates for the economic cost of suicide suggest that a loss of more than NZD200 million occurs due to lost productivity of the people who died by suicide, and a further NZD5 million loss results from service-related costs following the suicide, such as police and coronial involvement (O'Dea & Tucker, 2005).

Suicide also has a profound effect on mental health professionals such as psychologists, psychiatrists, counsellors, and social workers. Though not all people who are experiencing suicidal thoughts or behaviours make contact with a mental health service, it is estimated that many do, with Luoma et al. (2002) reporting around a third of people who die by suicide have had contact with a mental health service in the 12 months prior to their death, and a fifth have had contact in the last month. Some of these individuals may have been current clients of mental health services at the time of their suicide, and thus a number of mental health professionals experience losing a client to suicide. In Australia, around a third of surveyed psychologists reported losing a client due to suicide, and three-quarters reported working with a client who had attempted suicide (Finlayson & Simmonds, 2018; Trimble et al., 2000). As a result of experiencing client suicide, mental health professionals may feel sadness, shock, and guilt, and may also perceive themselves as incompetent (Finlayson & Simmonds, 2018). A client's suicide can have further impacts on the behaviour of practitioners, with some reporting an increased focus on identifying suicide risk, a reluctance to take on clients who are suicidal, or doubtfulness of their competence to work with such clients (Finlayson & Simmonds, 2018).

As well as the direct impacts that suicide can have on individuals who personally know someone who has died by suicide, indirect exposure to suicide through media can also impact individuals. Literature about suicide frequently links news media about suicide to increased suicidality (i.e., increased suicidal ideation or suicidal behaviour; Fink et al., 2018; Pirkis et al., 2020; Pirkis & Blood, 2010; Stack, 2005). Celebrity suicides in particular often garner a lot of media attention, and sometimes news reports of celebrity suicides describe the location and method of the suicide in detail. This is problematic, with some research suggesting that following the suicide of a celebrity, there is an increase in suicides using the same method (Fink et al.,

2018; Pirkis et al., 2020). The World Health Organization (2008) released guidelines for media reports about suicide specifying that media professionals should avoid detailing the location and the method of suicide in order to reduce copycat suicides. In 2008, many New Zealand media reports about suicide did not meet these guidelines, with a third of such reports detailing the method of suicide (Thom et al., 2012). Since this time, New Zealand has developed its own best practice guidelines for media reports about suicide (Ministry of Health, 2011). However, there are no known published analyses of how the details included in media reports about suicide have changed since the implementation of these guidelines, and how this may have impacted rates of suicide in New Zealand.

An international example of the impact of inappropriate reporting about suicide has been demonstrated in the way the media reported the suicide of comedian Robin Williams in August 2014, and the increase in suicide that followed. Carmichael and Whitley's (2019) thematic analysis of news reports about Robin Williams' suicide showed that more than a quarter used language that romanticised his suicide by implying that it was a heroic act, and nearly half provided explicit details about the method of suicide he used. Studies in both the United States of America and in Australia have shown that there was an increase in the number of suicides in the months following Robin Williams death that used the same method of suicide as he did (Fink et al., 2018; Pirkis et al., 2020).

Prevention of Suicide

With the impact of each person's suicide being felt widely, preventing future suicides is of utmost importance. In recent years the Ministry of Health (2019) released their Suicide Prevention Strategy for 2019 to 2029, which aims to reduce New Zealand's suicide rate and

increase the general wellbeing of the population. The suicide prevention continuum in this document includes promoting wellbeing, responding to suicidal distress and behaviour, and providing support after a suicide (Ministry of Health, 2019). The document acknowledges that suicide prevention is likely to be complex, as multitudinous factors influence whether a person is at risk of suicide, each of which impacts individuals in varying ways. Suicide prevention tends to focus on reducing these factors which put an individual at increased likelihood of suicide, which are known as risk factors (Ministry of Health, 2019).

At a community level, suicide prevention efforts in New Zealand have involved suicide prevention campaigns and changing access to means of lethal suicide methods. Suicide prevention campaigns in New Zealand have thus far focused on increasing conversations about suicide in our communities, with the aim of reducing stigma and encouraging people to seek help. One such campaign was the "Start The Conversation Today" campaign by Lifeline Aotearoa in 2013 which involved a series of six videos that were played on television nationally (Ftanou et al., 2017). In addition, campaigns targeting populations with high suicide rates in New Zealand have also been developed, such as the Mates in Construction campaign which aims to connect construction workers to support and raise awareness of suicide (Mates in Construction New Zealand, n.d.). There is no known published research about the effectiveness of these campaigns in preventing suicide in New Zealand.

Regarding the community level suicide prevention approach of changing access to means, one example of this was the introduction of new firearms legislation in 1992, restricting who was able to access firearms (Beautrais, 2000; Beautrais, Fergusson, et al., 2006). Following this, suicide by firearm reduced by 46% (a statistically significant decrease), but the overall number of suicides by any method did not significantly decrease (Beautrais, Fergusson, et al.,

2006). This may have been because suicide by firearm made up a small number of the total annual suicides that occurred at that time. Another possibility is that individuals who planned to take their life by firearm may have substituted another equally lethal method of suicide (Beautrais, 2000).

At an individual level, suicide prevention typically involves engagement with a health service in some way. Many individuals who die by suicide are engaged with a health service in the months prior to their death. Chiang et al. (2021) found that almost 60% of the people who died by suicide in New Zealand between 2013 and 2015 had contact with a primary health service (e.g., a general practitioner) in the six months prior to their death, while 46.5% had contact with a secondary health service (i.e., any specialist health service, including mental health services as well as others). In addition, when compared to the general population, a higher proportion of individuals who die by suicide have had contact with health services in the 24 months prior to their death, with 80% contacting a primary health service and 65% contacting a secondary health service, compared to the general population rates of 75% and 40%, respectively. This makes health services a crucial point of contact for suicide prevention efforts at an individual level.

Within health services, effective suicide interventions may involve a combination of pharmacological treatment (i.e., medication), psychological treatment (e.g., cognitive behavioural therapy or dialectical behavioural therapy), and safety planning interventions among others (Ali et al., 2021; Ferguson et al., 2022; Fox et al., 2020). However, if someone is acutely suicidal, in that they are imminently going to try to take their life, the Ministry of Health recommends inpatient admission (Ministry of Health, 2003). This is not an effective long-term solution as people who are hospitalised due to self-injury or high suicide risk may attempt

suicide after being released from hospital. In one New Zealand-based study, being hospitalised for a suicide attempt or non-fatal self-injury was associated with elevated risk for suicide or suicide attempt within the following twelve months, with a relative risk of 105.4 and 175.7 respectively when compared to the general New Zealand population (K. R. Conner et al., 2003). Continued or increased suicide risk following hospitalisation is documented in multiple studies in New Zealand as well as overseas (Gibb et al., 2005; Howson et al., 2008; Large et al., 2011), with one study in Denmark demonstrating that 7% of male suicides and 6% of female suicides occurred within a week following discharge from an inpatient service (Madsen et al., 2020).

In addition to contact with a health service, helpline services can support suicide prevention efforts at an individual level by providing 24/7 access to support from trained volunteers or mental health professionals. One helpline in New Zealand, Lifeline, receives over 30,000 counselling calls each year, with around 8% of callers indicating they are having suicidal ideation, and 2% stating they are planning to suicide (Shepherd et al., 2022). Research suggests that suicide crisis helplines can potentially reduce an individual's distress in the short-term, potentially reducing their risk of suicide (Assing Hvidt et al., 2016).

Risk Assessment and Prediction

Knowledge of whether an individual is at increased risk of suicide and the reasons for why this is the case can help us to take action to prevent suicide from occurring at an individual level. One way to gather information about an individual's risk of suicide is to complete a comprehensive suicide risk assessment. The Ministry of Health (2003) have proposed best practice guidelines for suicide risk assessment in emergency departments and acute mental health service settings. These guidelines specify that mental health clinicians should obtain information

from a client about any diagnosed mental health problems, factors driving their suicidality, interpersonal problems, and patterns of dysfunctional thinking, as well as assessing factors associated with increased short-term and long-term risk of suicide like hopelessness and depression (Ministry of Health, 2003).

The Ministry of Health (2003) guidelines also specify that clinicians should identify or describe what category of risk the individual best matches, from no risk through to very high risk, and use this to guide how they manage the suicidal person's care (Ministry of Health, 2003). An individual's suicide risk is somewhat arbitrarily categorised as being low, moderate, or high, based on clinical judgement of the information gathered during the risk assessment (Ministry of Health, 2003). However, whether or not someone will attempt suicide cannot be predicted with perfect accuracy, in part due to the low base rate of suicide (Ministry of Health, 1998) and it has been demonstrated that the categorisation of suicide risk by health professionals has poor predictive validity, sensitivity, and specificity in predicting who will take their life (Pisani et al., 2016). Research suggests that predicting future suicides in this way produces many false positives – individuals are deemed at risk of suicide but do not go on to engage in suicidal behaviour – and false negatives – individuals are not deemed at risk of suicide but go on to engage in suicidal behaviour (Berman & Silverman, 2014; Schiepek et al., 2011). To exemplify this, in one of the earliest studies exploring the prospective accuracy of suicide prediction, of 4200 participants, the model that was used correctly identified 35 of the 63 individuals who went on to take their life, while falsely identifying 1206 individuals who did not take their life although the model predicted they would (Pokorny, 1983). That is, the sensitivity of the model was 56% and the specificity was 74% (Pokorny, 1983). More recent research has demonstrated slightly improved sensitivity and specificity using machine learning approaches, such as

Machado et al. (2022) whose model had 75% sensitivity and 89% specificity in predicting suicide attempts in a sample of about 40,000 people in the United States of America.

Despite recommendation from professional bodies in New Zealand as well as internationally (Carter et al., 2016; National Institute for Health and Care Excellence, 2022), risk categorisation continues to be used in New Zealand health services. This has important implications for individuals who, as a result of incorrect risk categorisation, may then either receive treatment they do not need or be unable to access timely interventions (Fortune & Hetrick, 2022). Instead of focusing on categorising someone as being low or high risk of suicide, it has been suggested that risk assessment should focus primarily on identifying changeable risk factors and employing effective interventions, ideally tailored to the individual's needs (Carter & Spittal, 2018). Knowledge of the reasons for why a person is suicidal enables mental health professionals to direct their limited resources towards addressing the specific risk factors the person is experiencing, taking action to change these factors, and thus hopefully overall minimising the likelihood that the individual will die by suicide.

Historical Theories of Suicide

Risk prediction and prevention may be best accomplished if it is guided by accurate theories about the causes of suicide, rather than being based solely on either statistical prediction or clinical judgement. For centuries people have theorised about why someone decides to take their own life, with each theory postulating a different variable or group of variables to be the reason for why someone becomes suicidal. For example, in the 19th century Durkheim (2006, first published in 1897) proposed a sociological theory of suicide, describing that suicide was due to changes in two social conditions – integration and regulation. Integration relates to the

degree to which a society interacts, has shared beliefs, and is devoted to common goals, while regulation describes the control that society has over an individual (Johnson, 1965). According to Durkheim's theory, if either of these two variables were low or high, rather than moderate, suicide was more likely to occur (Johnson, 1965). However, Durkheim's theory focused only on social factors, neglecting to incorporate individual psychological variables which can lead to suicidality.

In contrast to Durkheim, Baumeister's (1990) escape theory of suicide focused on a psychological explanation for suicide. The cause of suicide in this theory can be summarised as an escape from self (Baumeister, 1990). It involves a decision tree, with six key principles outlined by Baumeister (1990). First, either a failure or setback occurs, or a person has unrealistic expectations of themselves (usually both). This is then attributed to negative aspects of the self (principle two), such that the individual blames themselves for the undesired outcome. The third principle, a high level of self-awareness, leads to further negative effects (principle four) such as feelings of low mood, embarrassment, or guilt. These negative feelings lead an individual to experience a state of cognitive numbness (principle five) in an attempt to escape the discomfort caused by the negative feelings, and it is during this state of numbness that the individual experiences reduced inhibitions (principle six). When the individual has reduced inhibitions, they are theorised to be more likely to engage in suicidal behaviour. To help explain why suicide is rare despite these principles being fairly common in life, the escape theory of suicide states that at any point in the decision tree, the suicidal path may not be chosen, resulting in suicide not occurring (Baumeister, 1990). Baumeister states that his theory is intended to explain only *some* suicides, not all, claiming that it "would be naïve to propose that all suicides result from a single psychological process" (Baumeister, 1990, p.90).

Shneidman's (1993) psychache theory is another well-known historical theory of suicide. This theory describes suicide as a means of escaping psychache, which is the label Shneidman (1993) gives to psychological pain caused by unmet needs. The needs described in this theory include achievement, autonomy, shame-avoidance, and nurturance, among others. If a person's psychache surpasses their personal threshold, the individual will try to escape this aversive state by engaging in suicidal behaviour (Gunn & Lester, 2015). Shneidman builds on previous theories by acknowledging the impact society can have on a person, as well as the internal individual factors that may be implicated in suicide, stating that a person will likely attempt suicide when, alongside psychache, they experience press and perturbation – the pressure of society, and the experience of inner turmoil or mental health problem (Gunn & Lester, 2015).

Ideation to Action Theories of Suicide

Thus far theories of suicide like those detailed above have been narrow in focus, theorising about a specific motivating factor or process (O'Connor, 2011) or conflating the reasons for why a person might have thoughts of suicide with why they then go on to act on these thoughts (Klonsky & May, 2014). As a result, these theories fail to explain whether the theorised variables cause suicidal ideation, suicidal behaviour, or both (Klonsky & May, 2014). This is in stark contrast with recent empirical literature, which describes variables such as hopelessness as being associated with suicidal ideation, but much less so with suicidal behaviour (Klonsky & May, 2014). The reverse is true for other variables, like lack of social support, which instead shows a stronger association with suicidal behaviour than with suicidal ideation (Pompili et al., 2014). Historical theories fail to account for these differences in associations, and in turn such theories are unable to explain why only a handful of individuals with these factors will

express suicidal behaviour or die by suicide compared to the number that will experience suicidal ideation (Klonsky & May, 2014).

With the 21st century came the development of a second wave of theories of suicide: the ideation to action theories. These include the interpersonal psychological theory (Joiner, 2005), the integrated motivational-volitional model (O'Connor, 2011), and the three step theory (Klonsky & May, 2015). Each of these theories attempts to explain why an individual will develop suicidal thoughts and then progress from having suicidal thoughts to expressing suicidal behaviour. The theories are described below, along with a discussion of empirical literature that has explored the associations postulated in these theories.

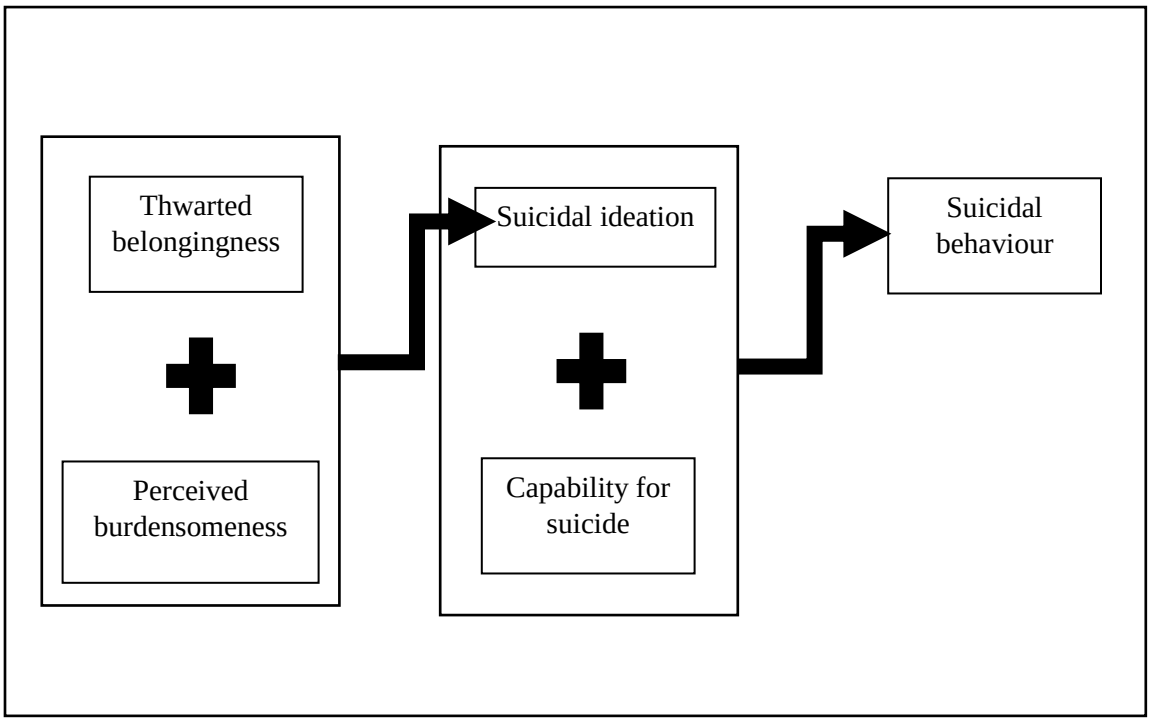
Interpersonal Psychological Theory

Joiner (2005) first detailed the interpersonal psychological theory of suicide in his book, "Why People Die by Suicide." He postulated that, for an individual to be able to die by suicide, they need to have both the desire to die and have acquired the practical capability to do so. An individual's desire to die purportedly arises as a result of two fundamental needs not being met: feeling like one belongs and is cared about, and that one is effective with others (Joiner, 2005). These needs fail to be met when an individual's relationships are unstable and infrequent, and when they perceive themselves to be permanently incompetent and ineffective to the point of burdening others (Joiner, 2005). This experience of thwarted belongingness and perceived burdensomeness results in the development of suicidal ideation, with suicide appearing attractive. Joiner (2005) notes that the concepts of thwarted belongingness and perceived burdensomeness are not static: an individual may vacillate between feeling like a burden and not feeling this way, and the same may occur with feelings of belonging.

What drives an individual to attempt suicide once experiencing suicidal ideation is an acquired capability for suicide (Joiner, 2005). Individuals with the capability for suicide are described by Joiner as being fearless of inflicting high levels of pain on themselves and as being tolerant of this pain. Many methods of suicide involve a degree of pain, thus individuals who are fearful or intolerant of pain are theorised to be unlikely to have the capability to take their life. See Figure 1 below for a summary of this theory.

Figure 1

The Interpersonal Psychological Theory of Suicide



To date there has been mixed support for the hypothesised mechanisms of the interpersonal psychological theory of suicide. The findings of Hallensleben et al. (2019) provide some support for the association of perceived burdensomeness and thwarted belongingness with suicidal ideation. They found these variables to have a significant positive association with one

another cross-sectionally in a sample of inpatients with depression. However, when testing which variables prospectively predicted suicidal ideation, the authors found that perceived burdensomeness predicted future suicidal ideation when controlling for lagged suicidal ideation, while thwarted belongingness did not, thus only providing partial support for the interpersonal psychological theory of suicide. Rogers and Joiner (2019) found a similar result, with perceived burdensomeness but not thwarted belongingness being associated with suicidal ideation at subsequent measurements.

Very few studies to date have tested the theory's hypothesis for the transition from ideation to attempt – presence of acquired capability. To test this relationship, Wolford-Clevenger et al. (2020) collected data daily for 90 days from a sample of 206 college students with a history of suicidal ideation. Capability for suicide was measured by fearlessness of death and perceived pain tolerance while suicidal behaviour was measured by whether a participant had attempted suicide previously, due to there being very few suicide attempts during the study. The authors found that acquired capability for suicide was not significantly associated with previous suicidal behaviour, providing some opposition to the mechanism for transition from ideation to attempt that is hypothesised by this theory. Further to this, a systematic review by Ma et al. (2016) found that only around half of the reviewed studies that test whether there was an effect of acquired capability on suicide attempt found a statistically significant effect. Additionally, Ma et al. (2016) reported that acquired capability for suicide was significantly associated with suicidal ideation in a number of the reviewed studies, and thus this variable was not specific to predicting suicide attempts, as the interpersonal psychological theory postulates.

Integrated Motivational-Volitional Model

O'Connor's (2011) integrated motivational-volitional model of suicide describes how suicidal ideation progresses to suicidal behaviour as a result of the interplay between numerous psychological factors. There are three phases of this model: the pre-motivational phase, motivational phase, and volitional phase (see Figure 2). Within each of these phases, O'Connor (2011) proposes there are factors that facilitate or obstruct the transition from one phase to another, termed threat to self moderators, motivational moderators, and volitional moderators, depending on the phase they operate in. The three phases of this theory and the specific moderators are described below.

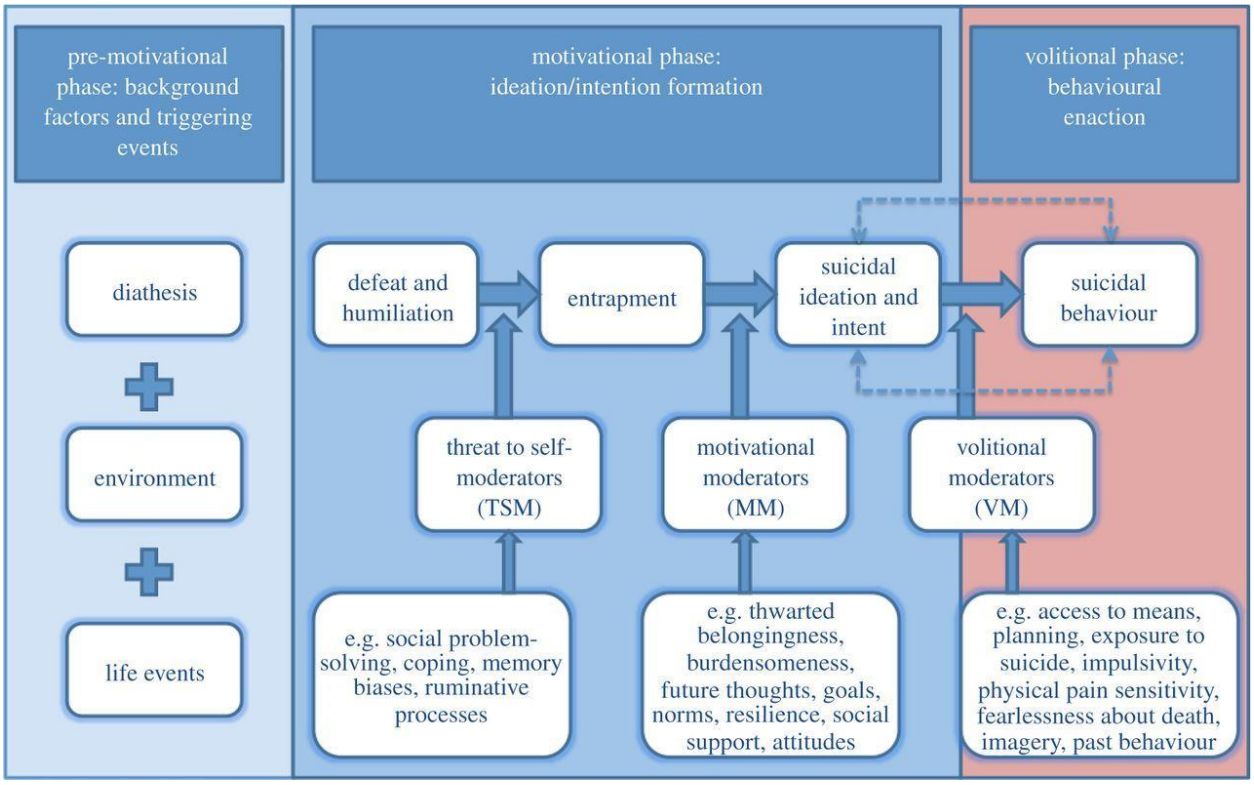
The first phase in O'Connor's (2011) integrated motivational-volitional model of suicide is the pre-motivational phase. Background factors such as deprivation, as well as triggering life events like a relationship ending or the death of someone close activate an individual's underlying vulnerability for suicide. This underlying vulnerability is conferred by individual differences, such as level of socially prescribed perfectionism, for example.

O'Connor (2011) titles the second phase of this model as the motivational phase, where failure to meet the perceived demands or unrealistic expectations from others signals defeat or humiliation to an individual. In turn this triggers a feeling of entrapment. Entrapment describes the state where suicide is seen as the primary solution to the problems being experienced by the individual. State-specific moderators of this process include memory biases and rumination processes, which lead to increased feelings of defeat and humiliation, and in turn, entrapment. An individual who is experiencing feelings of entrapment then begins to have thoughts of suicide, with this considered to be a solution to the problem at hand. Much like in Joiner's

interpersonal psychological theory of suicide, feelings of perceived burdensomeness and thwarted belongingness also precipitate these thoughts of suicide.

Figure 2

The Integrated Motivational-Volitional Model of Suicide



Note. From "The integrated motivational–volitional model of suicidal behaviour," by R. C. O'Connor and O. J. Kirtley, 2018, *Philosophical Transactions of the Royal Society B: Biological Sciences, 373*, p.2. (https://doi.org/10.1098/rstb.2017.0268) CC BY 4.0

The volitional phase is the final part of this model, as described by O'Connor (2011). This phase describes how an individual progresses from having thoughts of suicide to acting on these, expressing suicidal behaviour. Factors such as acquired capability, access to means, a

suicide plan, and impulsivity increase the likelihood that a person will engage in suicidal behaviour.

This model has received attention, being tested by a number of researchers in recent years. One such study testing the relationships of the integrated motivational-volitional model is that by Wetherall et al. (2018). The authors included a sample of 3508 participants aged between 18 and 34 years from the Scottish Wellbeing Study. The participants were categorised into one of three groups: those with no suicidal history, those with lifetime suicidal ideation, and those with lifetime suicide attempt. The motivational and volitional phase variables were then compared across these three groups. Wetherall and colleagues found that participants with a history of suicidal ideation or suicide attempt expressed higher levels of motivational and volitional phase factors than individuals with no suicidal history. Individuals with a history of ideation or attempt expressed more defeat, perceived burdensomeness, and acquired capability, for example. Furthermore, volitional phase factors differentiated between individuals with a history of suicidal ideation and those with a history of suicide attempt. Participants who had attempted suicide expressed higher levels of impulsivity and acquired capability than participants with a history of suicidal ideation. The results of Wetherall et al. are consistent with the mechanisms of the transition from ideation to action that are proposed in O'Connor's (2011) integrated motivational-volitional model.

Further support comes from Branley-Bell et al. (2019), who report relationships consistent with Wetherall et al.'s. Motivational and volitional phase factors significantly differed between participants with no suicidal history, and those who had a history of ideation or attempt. For example, those with suicidal histories expressed higher levels of hopelessness, entrapment, defeat, and perceived burdensomeness (Branley-Bell et al., 2019). Additionally, just like in

Wetherall et al.'s study, participants who had a history of suicide attempt expressed higher levels of volitional phase factors compared to those with a history of suicidal ideation (Branley-Bell et al., 2019). This supports the hypothesis of the integrated motivational-volitional model that volitional phase factors distinguish between those with ideation and those who attempt suicide.

Three Step Theory

Klonsky and May's (2015) three step theory is the most recent ideation-to-action theory of suicide described in this chapter. This theory explains how the variables of pain, hopelessness, connectedness, and capability for suicide can lead to suicidal ideation and behaviour. Figure 3 below shows a summary of the three step theory.

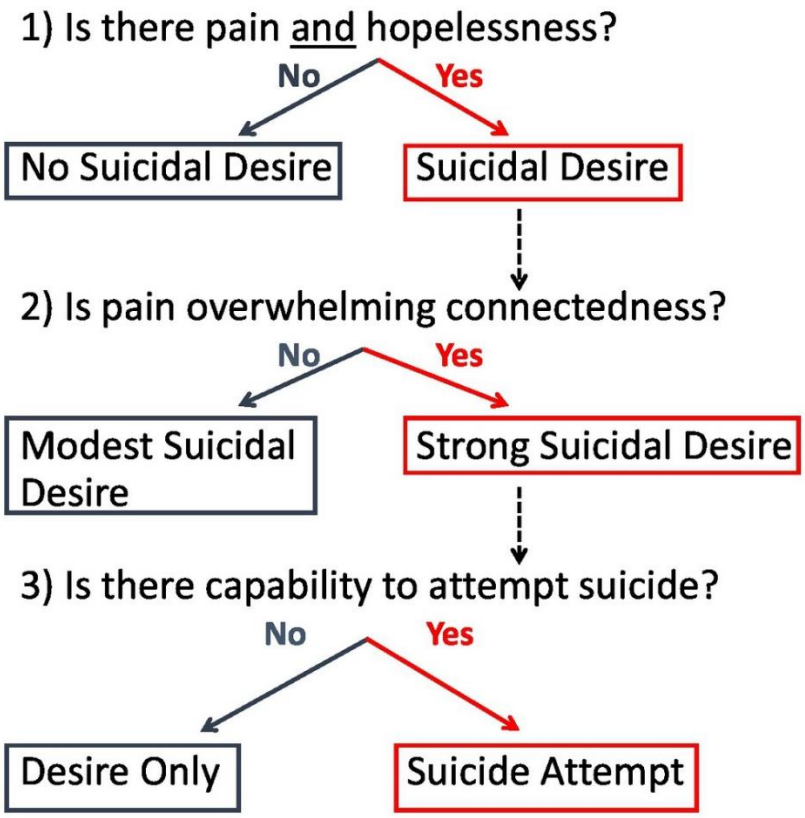
Klonsky and May (2015) state that the first step of the three step theory involves pain and hopelessness. If an individual experiences pain day in and day out, whether that pain be psychological, emotional, or otherwise, from a behavioural conditioning perspective the individual is being punished for living. This is postulated to decrease the individual's desire to be alive. Examples of painful experiences, thoughts, or feelings that might lead to the experience of suicidal ideation include social isolation, negative self-perceptions, perceived burdensomeness, and physical pain. When this pain is coupled with hopelessness, a feeling that the situation cannot and will not improve, then the individual will experience thoughts of suicide.

The second step of this theory by Klonsky and May (2015) describes how the strength of suicidal ideation experienced by an individual can be determined by their connectedness. Connectedness in this theory includes connections to people, jobs, roles, interests, or other things that provide a person with a sense of purpose or meaning. Klonsky and May (2015) note that a lack of connectedness is not necessary for suicidal ideation to develop, but connectedness may

protect against strong suicidal ideation if it is present. If a person has a high level of connectedness, their suicidal ideation will be moderate when they are in pain, such that they would occasionally have thoughts of killing themselves. If a person experiences a low level of connectedness when they are in pain, their ideation will become strong, and they may express increased desire to take their life.

Figure 3

The Three Step Theory of Suicide



Note. From "The three-step theory (3ST): A new theory of suicide rooted in the "ideation-to-action" framework," by E. D. Klonsky, M. C. Pachkowski, A. Shahnaz, and A. M. May, 2021, *Preventative Medicine, 152*, p.2. (https://doi.org/10.1016/j.ypmed.2021.106549) Copyright © 2021 by Elsevier. Reprinted with permission.

Step three of this theory describes the transition from ideation to attempt (Klonsky & May, 2015). Once an individual has strong thoughts of suicide, whether this individual has the capability to attempt suicide determines whether they will act on these thoughts or not. In this theory, capability for suicide is divided into three types: dispositional, acquired, and practical. Dispositional capability for suicide includes genetic variables such as how sensitive to pain an individual is. For example, an individual with a low pain threshold would be unlikely to be able to attempt suicide using a method that induces pain. Acquired capability for suicide is similar to that described in the interpersonal psychological theory of suicide. This term describes an individual's habituation to pain and the idea of death, which result in an increased likelihood of suicide attempt. The last type is practical capability. This describes factors which make a suicide attempt easier to do, such as the knowledge of and access to lethal suicide means. If an individual is knowledgeable about how to use a particular method to suicide, and has the means to practically utilise this method, they are at increased likelihood of doing so. When an individual's dispositional, acquired, and practical capacities for suicide are high, they progress from ideating suicide to attempting suicide.

Klonsky and May (2015) tested the three steps of their theory in sample of American adults, and found their results to be consistent with each of the three steps of the theory. In support of step one, pain and hopelessness were each associated with increased suicidal ideation, and the interaction of pain and hopelessness significantly predicted suicidal ideation. In relation to the second step, Klonsky and May (2015) found the interaction of pain-hopelessness and connection to be statistically significant. The authors also reported that level of connectedness was more strongly associated with suicidal ideation in the group of participants who expressed high pain and high hopelessness, compared to the other participant subgroups. Additionally,

consistent with step three of the theory, the authors found that dispositional, acquired, and practical capacity for suicide each were able to differentiate between participants with a history of suicidal ideation versus history of suicide attempt, such that individuals who had attempted suicide had significantly higher capacity for suicide.

The results of research by Tsai et al. (2020) also provide support for the premises of the three step theory. The authors found that the interaction of pain and hopelessness was associated with significantly higher levels of suicidal ideation, much like that found by Klonsky and May (2015). This finding was statistically significant for both males and females, and across two adult age groups (Tsai et al., 2020). In further support of the theory, Tsai et al. (2020) found that individuals with low connectedness and high pain and hopelessness tended to express significantly stronger suicidal ideation than individuals that had high levels of connectedness. Findings of research by Dhingra et al. (2019) were also similar.

Though ideation to action theories have overcome some of the issues associated with the historical theories of suicide, by differentiating between which variables are associated with suicidal ideation and which are associated with suicidal behaviour, they come with their own limitations. Notably, the empirical evidence supporting these theories is largely correlational, coming from observational research rather than experimental studies, such that we cannot definitively determine which variable was the cause and which was the effect, nor can we rule out confounding variables. Research exploring the temporal dynamics of specific suicide risk factors and their temporal effect on suicidal ideation or behaviour would take us one step closer to understanding what causes suicidality, possibly providing stronger evidence for the premises of ideation to action theories described above.

Chapter Two: Suicide as a Complex Dynamic System

The ideation to action theories discussed in the previous chapter conceptualise suicide as being the result of multiple factors that increase suicide risk through a range of mediating and moderating effects. However, these theories assume the presence of only unidirectional effects, with some risk factors affecting or moderating others, which then go on to affect the probability of suicide risk. In reality, these risk factors could be causally connected to one another in more complex ways than the theories above describe. As such, it may be useful to conceptualise suicide risk as a complex, dynamic (i.e., changeable) system of variables. In this chapter, cross-sectional and longitudinal research about dynamic risk factors for suicide is discussed first. Following this there is a discussion of research that has measured how specific suicide risk factors change over time, and how these changes impact suicidal ideation.

Risk Factors for Suicide: Evidence From Cross-Sectional and Longitudinal Studies

The reasons for why people experience suicidal thoughts or behaviour are complex, with numerous risk factors contributing to this experience. Risk factors for suicide can be categorised as either static or dynamic. A static risk factor is one that is stable over time, contributing to an individual's baseline risk for suicide (Bryan & Rudd, 2016). Demographic characteristics such as gender and ethnicity are considered static risk factors, as are historical experiences and events such as having a family history of suicide. In contrast, dynamic risk factors for suicide are variables that fluctuate over time, contributing to variations in a person's baseline suicide risk by increasing or decreasing it (Bryan & Rudd, 2016). Dynamic risk factors may be acute, fluctuating over short periods of time such as minutes or hours, or they may be stable over longer periods but still considered amenable to change. An example of a dynamic risk factor that is acutely dynamic is a person's mood, because this can change over very short periods of time. In

contrast, socioeconomic status is a stable dynamic risk factor, as in principle it can be changed but is likely to be stable over longer periods of time.

When it comes to preventing suicide, dynamic risk factors are particularly important to consider, and therefore were the focus of the present study. As dynamic risk factors can be changed, if we decrease (or increase) the dynamic risk factors an individual experiences then it is likely their overall suicide risk would change too. If we can identify which factors increase a person's risk of suicide, we may be able to direct our efforts towards specifically targeting these factors in interventions, reducing them, and possibly preventing suicide in a more precise, effective way than we are currently able to. Additionally, researching dynamic suicide risk factors that have theoretical underpinnings as well as those that do not may help us to build new theories of suicide, or to refine those described in the previous chapter, improving our current understanding of how suicidality develops and progresses. In turn this may further our understanding about which risk factors may be especially effective therapeutic targets, fostering more effective suicide prevention.

The dynamic risk factors for suicide that were included in this study were depressed mood, worthlessness, anhedonia, fatigue, alcohol intoxication, hopelessness, perceived burdensomeness, thwarted belongingness, self-esteem, and social support. These risk factors were considered likely to be acutely dynamic and were either involved in ideation to action theories of suicide or had empirical evidence supporting their association with suicidal ideation or their impact on the probability of suicide. The empirical associations and theoretical relevance of the risk factors included in this study are discussed below.

Depression

Depression is an extremely common mental health problem, with an estimated 300 million people experiencing depression worldwide (World Health Organisation, 2018). In New Zealand, approximately 14% of adults have had a diagnosis of depression at some point in their life (Mental Health Foundation, 2014). Having a diagnosis of depression increases the risk that an individual will experience thoughts of suicide, with one of the criteria for a diagnosis of major depressive disorder in the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) being the presence of recurrent suicide attempts or thoughts of suicide (American Psychiatric Association, 2013). A meta-analysis of cross-sectional and cohort studies about suicide attempts among individuals with depression estimated 31% of individuals with depression attempt suicide at some point in their life (Dong et al., 2019), suggesting there may be an association between depression and suicide attempts since this rate is much higher than the prevalence of suicide attempts in the general population. Furthermore, longitudinal research by Aaltonen et al. (2019) suggests that severe depression is a long-term predictor of suicide death, while a systematic review by Hawton et al. (2013) suggests that greater severity of depression is associated with greater suicide risk. Examining the relationship between suicidality and individual symptoms of depression may enable us to better understand why someone with depression is at increased risk of suicide. Research about depression and suicidality typically focuses on depression symptomology as a whole, with few studies exploring how individual symptoms of depression are associated with suicidality (Crowe et al., 2019). However, thus far the limited research available suggests that individual symptoms of depression such as depressed mood, anhedonia, worthlessness, and fatigue are each likely to be dynamic and have an association with either suicidal ideation or behaviour.

Depressed mood. Depressed mood is one of the symptoms required to make a diagnosis of major depressive disorder according to DSM-5 criteria (American Psychiatric Association, 2013). Individuals experiencing suicidal ideation report higher levels of depressed mood than individuals with no suicidality, and individuals who have recently attempted suicide report even lower mood than those experiencing suicidal ideation with no suicide attempts (Cameron et al., 2017). Recent research has also evidenced that depressed mood is temporally associated with changes in suicidal ideation (Kyron et al., 2019).

Anhedonia. Anhedonia is a term used to describe a loss of interest or pleasure in activities (American Psychiatric Association, 2013). A meta-analysis by Ducasse et al. (2018) found anhedonia to be significantly higher among individuals experiencing suicidal ideation compared to individuals without suicidal ideation, with a medium effect size. In a sample of psychiatric outpatients in New York, anhedonia was positively associated with suicidal ideation cross-sectionally, and also prospectively at one month follow-up, even when controlling for other symptoms of depression (Hawes et al., 2018). Furthermore, research suggests that a recent change in anhedonia is significantly associated with level of suicidal ideation, independent of static state or trait anhedonia level (Yang et al., 2020).

Worthlessness. There is a modest number of studies exploring the relationship between worthlessness and suicidality, most of which are cross-sectional. Feelings of worthlessness have been demonstrated to be significantly associated with concurrent suicidal ideation (Nock et al., 2010). Cross-sectional research by Bolton et al. (2008) in the United States of America found that feelings of worthlessness were significantly correlated with suicide attempts too, with this relationship existing for both men and women. Longitudinal research supports this relationship,

finding that worthlessness was significantly associated with a suicide attempt three years later (Bolton et al., 2010; Wakefield & Schmitz, 2016).

Fatigue. Fatigue, the feeling of tiredness or a lack of energy, is the sixth symptom of major depression listed in the DSM-5 (American Psychiatric Association, 2013). It is described as often being the problem a person presents to health services with, over other symptoms of depression (American Psychiatric Association, 2013), with 78% of individuals with depression in one study reporting moderate fatigue or higher (Vaccarino et al., 2008). Feeling tired has been shown to be associated with higher levels of suicidal ideation in multiple samples, including psychiatric patients in the United States of America (Nadorff et al., 2014), elderly with a diagnosis of depression (Lynch et al., 1999), and young adults aged 18 to 35 (E. M. Kleiman et al., 2018). Lynch et al., (1999) suggest that fatigue may lead to suicidal ideation through limiting an individual's cognitive, emotional, and physical capacity, reducing their ability to problem solve.

Alcohol Intoxication

Acute alcohol intoxication is a dynamic risk factor for suicide, with alcohol found in the blood of many people who die by suicide (Cherpitel et al., 2004; K. R. Conner et al., 2013). In New Zealand, 37% of the people who took their own life in the year to June 2020 had alcohol in their blood at the time of their death (Ministry of Justice, 2021). Furthermore, between 2007 and 2020, 26.6% of the people who died by suicide in New Zealand had a blood alcohol concentration over the legal limit of 50mg alcohol per 100ml of blood (Crossin et al., 2022). Alcohol is implicated in a high proportion of suicide attempts too, with a review of studies between 1991 and 2001 finding acute alcohol intoxication to be involved in 10% to 73% of suicide attempts (Cherpitel et al., 2004). Meta-analyses suggest there is a dose-response between

acute alcohol use and suicide attempt, with low levels of acute alcohol use associated with low odds of a suicide attempt and high levels of acute alcohol use associated with high odds of suicide attempt (Borges et al., 2017). Furthermore, a recent study demonstrated that many individuals who were acutely intoxicated experienced transient suicidal ideation (Robins et al., 2021). Acute alcohol intoxication may be implicated in suicide through reducing inhibitions that would usually stop a person from hurting themselves (Cherpitel et al., 2004).

Hopelessness

A person who feels hopeless has a negative expectation of themself and the future (Beck et al., 1974) and is at increased risk of suicide. In their longitudinal study, Kuo et al. (2004) reported that participants who had high levels of hopelessness at baseline were 11 times more likely to die by suicide during the 13-year study. Hopelessness is also predictive of future suicidal ideation, with high levels of hopelessness being associated with increased thoughts of suicide just hours later (Hallensleben et al., 2019), as well as over longer periods such as weeks or months (Roeder & Cole, 2019; Sueki, 2020).

Hopelessness plays a key role in Klonsky and May's (2015) three step theory of suicide. In the first step of this theory, an individual will experience suicidal ideation if they feel hopeless about their situation and are experiencing pain (Klonsky & May, 2015).

Self-esteem

Research suggests individuals with low self-esteem are at increased risk of suicide. A meta-analysis of longitudinal studies about self-esteem among adolescents and young adults showed that individuals aged 12 to 26 who had attempted suicide tended to have significantly lower self-esteem than those who had not attempted suicide (Soto-Sanz et al., 2019). This is

similar to results of a New Zealand longitudinal cohort study by Fergusson et al. (2003). In their study, low self-esteem at age 15 was significantly associated with suicidal ideation and suicide attempt by the age of 21. Furthermore, logistic regression analyses by Wild et al. (2004) estimate that individuals with low self-esteem are significantly more likely to attempt suicide or to have thoughts of suicide compared to individuals with high self-esteem.

To date there has been little research about how dynamic and changeable self-esteem is over short periods of time, with self-esteem long being thought of as a stable trait. However, there is some evidence that this may not be the case, with self-esteem instead showing within-person fluctuations over short periods of time. Knowles et al.'s (2007) research focused on the self-esteem of individuals with bipolar disorder, with participants completing survey measurements of self-esteem twice a day for a period of one week. The authors used within-person standard deviations to measure how dynamic self-esteem was for each participant. In Knowles et al.'s (2007) study, on average the self-esteem of participants with bipolar disorder fluctuated by 3.84 within-person standard deviations between measurements, while the self-esteem of participants without bipolar disorder fluctuated by 1.98 within-person standard deviations. This highlights that an individual's self-esteem can vary substantially throughout the day. At present there is no known published research on how these small fluctuations in self-esteem specifically relate to suicide. If self-esteem is acutely dynamic, showing some change over short periods of time, and it has an association with suicidal ideation, it is plausible that the changes in self-esteem are associated with changes in suicidal ideation too.

Self-esteem is involved in Klonsky and May's (2015) three step theory of suicide, although not explicitly. The theory postulates that individuals who feel pain have a decreased desire to be alive, leading to suicidal ideation, and that this pain can be physical, psychological,

emotional, or otherwise. Klonsky and May (2015) describe having a negative self-perception as being a painful experience. As one aspect of self-perception is self-esteem (Harter, 2012), low self-esteem might also be considered a painful experience that can lead to thoughts of suicide.

Social Support

Social support can be described as the interactions between people that lead a person to perceive that they are supported, cared for, and loved. A person's perception of social support is dynamic, fluctuating over time in response to the interactions they engage in (Coppersmith et al., 2019). Low levels of perceived social support are associated with increased risk of suicide, while high levels of perceived social support tend to protect against suicide risk (E. M. Kleiman & Liu, 2013). Researchers exploring the association between social support and suicidality report a significant negative association between perceived social support and thoughts of suicide, such that perceiving more social support is associated with having less suicidal ideation (Richie et al., 2019). Additionally, individuals who attempt suicide multiple times tend to report lower levels of social support than individuals who attempt suicide for the first time (Liu et al., 2017), suggesting that individuals with less social support might be more likely to attempt suicide multiple times. Longitudinal research also suggests social support is implicated in suicide risk. In Teismann et al.'s (2016) study, among participants who reported suicidal ideation at baseline, having high social support at baseline was a significant predictor of having no thoughts of suicide 17 months later.

Social support is implicated in the second step of Klonsky and May's (2015) three step theory of suicide, which involves connectedness, with individuals who feel connected theorised to be less likely to experience suicidal ideation. This connection can be to jobs, roles, interests,

and people (Klonsky & May, 2015). If someone has a high level of social support, they likely feel connected to the people supporting them, such that they would be less likely to experience strong suicidal ideation. Social support is also involved in the integrated motivational-volitional model of suicide by O'Connor (2011). In the motivational phase of this theory, lack of social support increases the likelihood that feelings of entrapment will lead to suicidal ideation (O'Connor, 2011).

Perceived Burdensomeness

Individuals who perceive they are a burden to others tend to experience more suicidal ideation, with cross-sectional research finding perceived burdensomeness has a significant positive association with thoughts of suicide (Duffy et al., 2020) and suicide attempts (Hill & Pettit, 2014). Research suggests there is also a temporal association between feeling like a burden and having thoughts of suicide, with high levels of perceived burdensomeness at one measurement having a positive association with suicidal ideation at the subsequent measurement (Hallensleben et al., 2019; E. M. Kleiman et al., 2017).

Due to a dearth of longitudinal research about the relationship between perceived burdensomeness and suicidal ideation and attempt, it is unclear whether perceived burdensomeness prospectively predicts suicidality (Hill & Pettit, 2014). In research by Hains et al. (2019), among participants receiving cognitive behavioural therapy for suicide prevention, a decrease in perceived burdensomeness was significantly associated with decreased suicide risk as measured by a clinician during a semi-structured interview. In the same study, changes in perceived burdensomeness fully mediated the effects of changes in depression and hopelessness on suicide risk (Hains et al., 2019).

Further evidence of the implication of perceived burdensomeness in suicide risk comes from a recent randomised controlled trial by Short et al. (2019). The authors tested whether an intervention targeting perceived burdensomeness and thwarted belongingness was able to reduce suicidal ideation compared to a control group. The authors found that individuals who received the intervention had reduced feelings of burdensomeness and thwarted belongingness following the intervention. Additionally, the results of temporal mediation analyses showed that condition (intervention versus control) had an indirect effect on suicidality, through reduced perceived burdensomeness. Short et al. (2019) conclude that these results demonstrate that perceived burdensomeness may have a causal role in determining suicidality.

Perceived burdensomeness is implicated in all three ideation to action theories of suicide. In Joiner's (2005) interpersonal psychological theory of suicide, it is theorised that feeling like a burden on others leads to thoughts of suicide. Additionally, in O'Connor's (2011) integrated motivational-volitional model of suicide, perceived burdensomeness is said to increase the likelihood that feelings of entrapment will lead to suicidal ideation in the motivational phase. Perceived burdensomeness is also implicated in Klonsky and May's (2015) three step theory of suicide, being described as a painful experience that can lead to suicidal ideation.

Thwarted Belongingness

Thwarted belongingness describes the feelings of loneliness and isolation that arise when a person's need to belong is unmet (Van Orden et al., 2010). Thwarted belongingness has been shown to fluctuate over short periods of time (Hallensleben et al., 2019), such that it can be considered dynamic and changeable. Cross-sectionally, thwarted belongingness shows a positive association with suicidal ideation (Roeder & Cole, 2019), such that individuals with high levels

of thwarted belongingness tend to concurrently experience more thoughts of suicide. This relationship has been found in samples from primary care, community, and school populations (Ma et al., 2016). Temporally, thwarted belongingness has been shown to predict future suicidal ideation in samples of adolescents and young adults (Roeder & Cole, 2019).

There is mixed evidence of the relationship between thwarted belongingness and suicidal ideation cross-sectionally, with a systematic review by Ma et al. (2016) finding more studies reporting non-significant effects of thwarted belongingness on suicidal ideation than significant effects. This is similarly the case for studies reporting on the effect of thwarted belongingness on suicide attempts (Ma et al., 2016).

Like perceived burdensomeness, thwarted belongingness is implicated in all three ideation to action theories of suicide. In Joiner's (2005) interpersonal psychological theory of suicide, if an individual feels as though they do not belong, they are likely to develop thoughts of suicide. Thwarted belongingness is also postulated to increase the likelihood that feelings of entrapment will lead to suicidal ideation in the motivational phase of O'Connor's (2011) integrated motivational-volitional model of suicide. Thwarted belongness is implicated in Klonsky and May's (2015) three step theory of suicide too, being described as a painful experience that can lead to suicidal ideation.

The Temporal Nature of Suicide Risk

Although risk factors for suicide have been studied for decades, with some research being about the longitudinal association between suicide risk factors and suicidal ideation, to date little research has focused on how suicide risk factors fluctuate over short periods of time, and how these short-term changes impact suicidal ideation. A meta-analysis of fifty years of longitudinal

suicide risk research found less than 1% of the effects analysed had a measurement interval of a month or less (Franklin et al., 2017), showing there is a lack of research about whether risk factors for suicide are predictive of suicidal ideation and behaviour in the *short term*, over periods of hours or days. To explore the acutely dynamic nature of suicide risk, collecting data through ecological momentary assessments may be particularly useful.

What is Ecological Momentary Assessment?

Ecological momentary assessment describes research methods that aim to measure variables of interest multiple times across a period of days or weeks (Davidson et al., 2016). Each assessment measures a participant's current state in that participant's own real-world environment (Shiffman et al., 2008). The assessment of current states reduces participant recall bias, while the real-world nature of data collection enables generalisation to life outside of a laboratory, increasing ecological validity (Shiffman et al., 2008). Ecological momentary assessment has been used to study many different psychological phenomena. For example, there have been ecological momentary assessment studies of mood and anxiety disorders, substance use behaviour, self-esteem, and pain (Shiffman et al., 2008). Once data has been collected, it is analysed to estimate how the variables of interest are related to one another over time, and how much they fluctuate over time. If we were to collect data on suicidal ideation and risk factors for suicide such as depression and hopelessness, we could measure how much each variable varies from measurement to measurement, whether the variables are significantly associated with one another within a single time point, and whether the risk factors at one time point are significantly predictive of suicidal ideation at a subsequent time point. Although ecological momentary assessment research is not as conclusive as an experiment for establishing causal effects, it does provide a stronger *indication* of causality than a cross-sectional study would. If a causal

relationship exists between two variables, one of the variables should temporally precede the other (Epskamp, van Borkulo, et al., 2018) and ecological momentary assessment research is able to establish whether a temporal relationship is present or not.

The use of ecological momentary assessment to study aspects of suicide has gained a lot of traction in recent years. Researchers have acknowledged that this method could make substantial contributions to our understanding of theories of suicide (Davidson et al., 2016), providing fine-grained detail about the moment to moment relationships between risk factors for suicide, and how suicidal ideation develops, as well as information about which risk factors may be indicators of imminent risk. Collecting data in this way may also have further implications for suicide risk assessment and intervention in mental health services (Davidson et al., 2016). The real-time data collected about suicidal ideation and suicide risk factors could ultimately enable practitioners to have up-to-date information about a client's experience, and in turn enable the distribution of timely interventions tailored to the current needs of the client.

Ecological momentary assessment research also enhances the transparency of participant self-disclosure. Participants in research that is conducted via computers or smartphones may be more likely to disclose that they are experiencing suicidal ideation – not because they are more likely to experience suicidal ideation during this sort of research, but because they are more willing to self-disclose when they are experiencing such thoughts. Studies have shown that when assessing symptoms of depression in participants with major depressive disorder, on average the participants report more severe symptoms in ecological momentary assessments than they do on paper versions of the same survey (Torous et al., 2015). Specifically, this result was seen for the measurement of suicidal ideation among individuals with depression. No participants reported suicidal ideation on either of the two paper versions of Torous et al.'s (2015) questionnaire

which were administered at the start and end of the study, whereas 69% of the same participants reported some suicidal ideation in at least one of the 90 ecological momentary assessments administered vis smartphone. Torous et al. (2015) conclude that this suggests that individuals with major depressive disorder may report more severe symptoms of depression, including suicidal ideation, through real-time smartphone measurements compared to what they might report to clinical providers, who often use one-off paper assessments. This may be due to the participant's preference for anonymity, with smartphone measurements providing more privacy than physically handing in a paper survey.

Torous et al.'s (2015) research suggests ecological momentary assessments may be highly sensitive to symptoms of depression such as suicidal ideation, resulting in increased detection of such symptoms. When using ecological momentary assessment to research suicidal ideation and suicide risk specifically, it is expected that the measurements will be sensitive to these variables, such that many participants will disclose their experience of suicidal ideation. As such, ecological momentary assessment is a viable option for examining how suicidal ideation and risk factors for suicide fluctuate over time and how they are associated with one another from measurement to measurement.

Suicide Ecological Momentary Assessment Literature

At present only a small number of researchers have used ecological momentary assessment to examine the temporal nature of suicide and its risk factors. The focus of these studies has been to explore how much suicidal ideation and suicide risk factors fluctuated over short periods of time, and whether particular risk factors were predictive of future suicidal

ideation. The key results of ecological momentary assessments focusing on these areas are described below.

Variability of Suicidal Ideation. Thus far only a couple of ecological momentary assessment studies of suicide have explored whether suicidal ideation varies over short periods of time. One such study is that by Kleiman and colleagues (2017), who conducted two ecological momentary assessment studies to find out how suicidal ideation fluctuated over time. The self-reported suicidal ideation score (range of 0 to 12) varied for nearly all participants in Kleiman et al.'s (2017) first study, with an average root mean square successive difference (RMSSD) of 2.28 for suicidal ideation and a RMSSD range of 0.00 to 4.54. RMSSD measures an item's variability from measurement to measurement, with a higher RMSSD indicating more variability (E. M. Kleiman et al., 2017). The authors also found that participants who had a high mean level of suicidal ideation showed greater variability around the mean than individuals with lower mean ideation. Kleiman and colleagues (2017) replicated the above study with a second participant group consisting of 36 adult psychiatric inpatients who had been admitted to hospital due to high suicidal ideation or a recent suicide attempt. The results of this second study were very similar to the first.

The results of recent research by Hallensleben et al. (2019) provide further support for the findings of Kleiman et al. (2017) that suicidal ideation fluctuates over short periods of time. Assessments in Hallensleben et al.'s (2019) study were completed ten times a day between 8am and 7.50pm, with a minimum interval of 30 minutes between the assessments. All survey items were rated on a scale from 1 (not at all) to 5 (extremely), with two survey items being used to measure each construct. Hallensleben and colleagues (2019) used mean squared successive difference (MSSD) scores to describe variability. MSSD is similar to RMSSD in that a higher

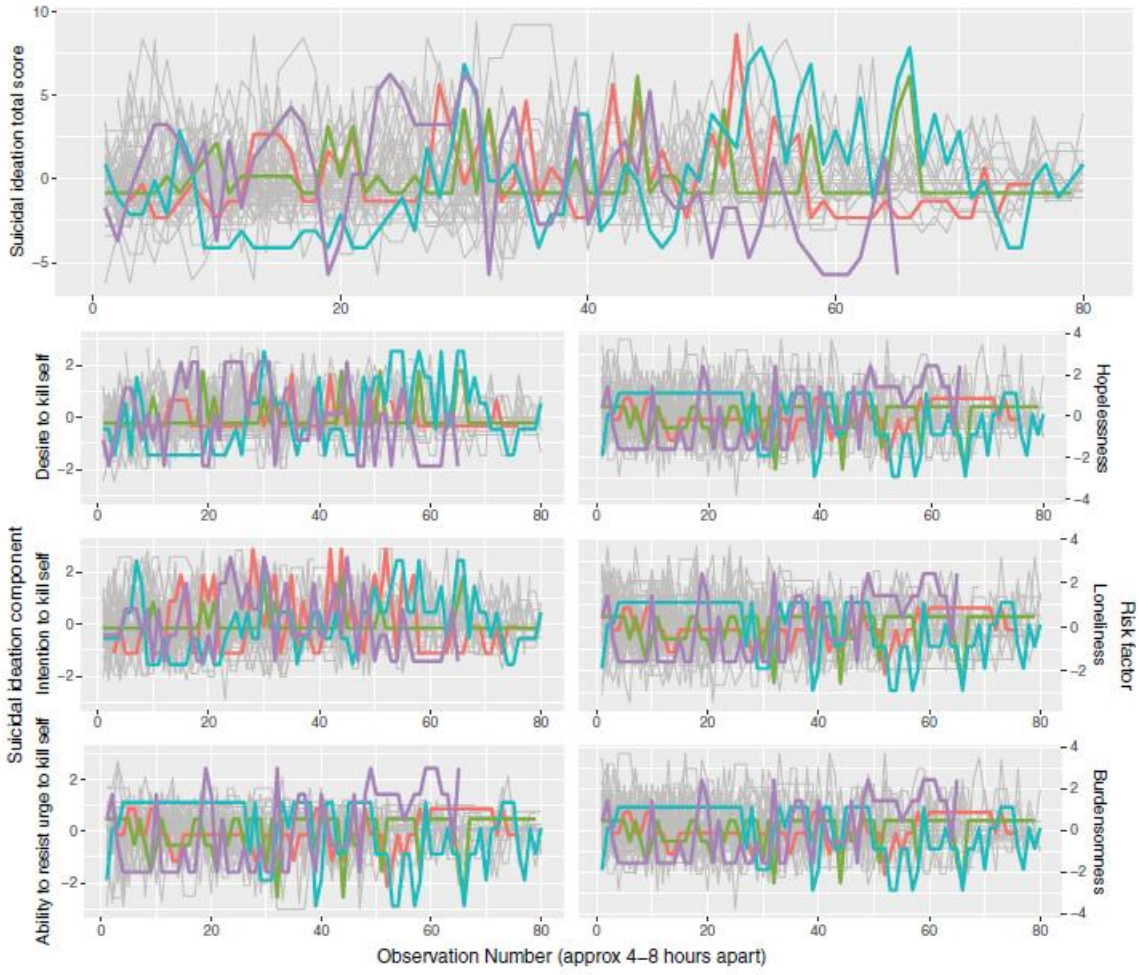
score represents higher variability from measurement to measurement (Hallensleben et al., 2019). The authors found that both passive and active suicidal ideation varied between assessments, with MSSD scores ranging from 0 to 12.83, and a mean MSSD of 2.10 for active ideation and 2.02 for passive ideation. These findings suggest that suicidal ideation varies over short periods of time, from 30 minutes to a few hours.

Variability of Risk Factors. Another aim of ecological momentary assessments about suicide has been to find out whether risk factors for suicide fluctuate over short periods of time. In Kleiman et al.'s (2017) study, the risk factors hopelessness, perceived burdensomeness, and loneliness each varied greatly from assessment to assessment. Each of these risk factors was measured with a scale ranging from 0 to 4. In this study, hopelessness, perceived burdensomeness, and loneliness had an average RMSSD of 1.17, 1.16, and 1.23 respectively, and had RMSSD ranges from 0.00 to 3.00. When scores were graphed over time, each risk factor showed a saw-tooth pattern, exemplifying how changeable the risk factors for suicide can be (see Figure 4).

Another risk factor for suicide that has been assessed using ecological momentary assessment is social support. Coppersmith et al. (2019) found that the level of social support perceived by participants fluctuated between measurements, which were completed once per day using a smartphone survey. Raw social support scores ranged between 1 and 5 in this study. The mean RMSSD was 0.98, with a range of 0.22 to 2.14, suggesting some variability from day to day.

Figure 4

Fluctuation of Variables Over Time



Note. These plots show how different variables fluctuated over time. The variables were group mean-centred. Coloured lines were used to exemplify the plot of individual participants. From "Examination of real-time fluctuations in suicidal ideation and its risk factors: Results from two ecological momentary assessment studies.," by E. M. Kleiman, B. J. Turner, S. Fedor, E. E. Beale, J. C. Huffman, and M. K. Nock, 2017, *Journal of Abnormal Psychology, 126*(6), p.6. (https://doi.org/10.1037/abn0000273) Copyright © 2017 by American Psychological Association. Reprinted with permission.

The results of Kleiman et al. (2017) and Coppersmith et al. (2019) suggest that risk factors for suicide such as hopelessness, perceived burdensomeness, loneliness, and social support fluctuate over small periods of time, with each of these variables showing variability across a few hours or day to day. An implication of this is that the measurement of risk factors over long periods of time with large intervals between measurements, as is common in longitudinal psychological research (Franklin et al., 2017), may in reality not be able to accurately encapsulate how dynamic these variables are. Such studies likely miss the nuanced fluctuations that these variables show over periods of just a few hours. This highlights the importance of conducting research using ecological momentary assessments, to enable us to further determine just how variable risk factors for suicide might be. Such knowledge could be used to inform how we assess and monitor suicide risk over time.

Temporal Relationships. The third way that ecological momentary assessments of suicide have been used is to explore whether high levels of risk factors are predictive of suicidal ideation within the same measurement or at the subsequent one. In Kleiman et al.'s (2017) first study, hierarchical linear modelling showed that within a single measurement the risk factors hopelessness, perceived burdensomeness, and loneliness were each significantly positively associated with suicidal ideation. However, only hopelessness and perceived burdensomeness significantly predicted increased suicidal ideation at the subsequent assessment. The authors found that when controlling for lagged suicidal ideation, none of these associations were significant.

It is important to note here that without controlling for lagged suicidal ideation (i.e., suicidal ideation at the previous measurement) it would be impossible to rule out whether an effect is occurring in the opposite direction to what is observed because suicidal ideation at one

measurement could affect suicide risk factors within the same measurement as well as suicidal ideation at the subsequent measurement. In addition, if lagged suicidal ideation is not controlled for, there could be any number of stable individual difference variables that affect both a risk factor at one measurement and suicidal ideation at the subsequent measurement. By controlling for lagged suicidal ideation, these stable individual difference variables are unable affect the estimated relationship between a risk factor at one measurement and suicidal ideation at the subsequent measurement. Therefore, if there was a significant relationship between a risk factor and suicidal ideation when controlling for lagged suicidal ideation, we could rule out a few alternative explanations for this relationship, giving us more confidence in a potentially causal temporal relationship between the two variables.

Further evidence of the temporal relationship between suicide risk factors and suicidal ideation comes from Coppersmith et al. (2019), who found similar results to Kleiman et al. (2017) when studying the variability of social support and whether it could predict suicidal ideation. In Coppersmith et al.'s (2019) study, social support was significantly negatively associated with suicidal ideation within the same measurement, and the subsequent measurement too. However, when suicidal ideation at the same measurement was controlled for, these relationships were no longer significant. This was similarly the case for perceived burdensomeness, thwarted belongingness, and sadness as well. Each of these risk factors was significantly associated with increased suicidal ideation at the same measurement and the subsequent measurement, but not when lagged ideation was controlled for.

The most recent ecological momentary assessment study exploring whether risk factors for suicide are able to predict suicidal ideation is that by Hallensleben et al. (2019). In their study, the risk factors perceived burdensomeness, thwarted belongingness, hopelessness, and

depressiveness were each significantly positively associated with passive and active suicidal ideation within the same measurement. Hopelessness and perceived burdensomeness were found to predict passive suicidal ideation at the subsequent measurement when controlling for lagged suicidal ideation, while thwarted belongingness and depressiveness did not. A similar result was seen for the prediction of subsequent active suicidal ideation, with hopelessness and perceived burdensomeness significantly positively associated with future active suicidal ideation when controlling for lagged suicidal ideation. Taken together, the studies by Kleiman et al. (2017), Coppersmith et al. (2019), and Hallensleben et al. (2019) show that high levels of risk factors such as perceived burdensomeness and hopelessness are associated with increased suicidal ideation within the same assessment, and they may also have *some* ability to predict future ideation, though as of yet this is unclear. The results support the literature discussed earlier in this chapter, that described similar relationships found in cross-sectional and longitudinal studies.

Ecological momentary assessment research brings us one step closer to understanding whether suicide risk factors may have a causal effect on suicidal ideation. With further research in this domain, we may glean more information about whether risk factors for suicide are predictive of suicidality or if these variables are simply correlated with suicidality.

Chapter Three: A Network Approach to Understanding Suicide Risk

While the previous chapter exemplified the idea that suicide risk factors can vary and affect one another dynamically, the focus of this chapter is to explain a popular analysis method for studying such dynamic systems – network analysis. Suicide risk is complex, and the methods of research and analysis commonly used in psychology have rendered these complexities difficult to investigate. In recent years, the novel data analysis method of network analysis has been used to study the complex interplay of variables and how associations between variables change over time. Historically network analysis has been used to analyse connections people have with one another and connections between cells in the brain (L. Bringmann et al., 2019).

In the field of clinical psychology, network analysis gained attraction in the late 2000s as a method of analysing data about psychopathology when Borsboom (2008) conceptualised psychopathology as networks of complex, causal associations between symptoms. Since then, network analysis has been applied to networks of symptoms of various disorders, such as depression and anxiety (for example, see Beard et al., 2016; L. F. Bringmann et al., 2014; Cramer et al., 2016; Heeren et al., 2018). A small number of studies have shown that network analysis may be able to encapsulate the complex dynamic and temporal nature of suicide risk factors, too (Brown et al., 2021; de Beurs et al., 2019, 2017; Holman & Williams, 2022; Rath et al., 2019; Schönfelder et al., 2021; Shiratori et al., 2014; Simons et al., 2019). This chapter will provide an overview of what network analysis is and what it can tell us about suicide risk. It will also include a review of research that has used this method of analysis to explore variables associated with suicide.

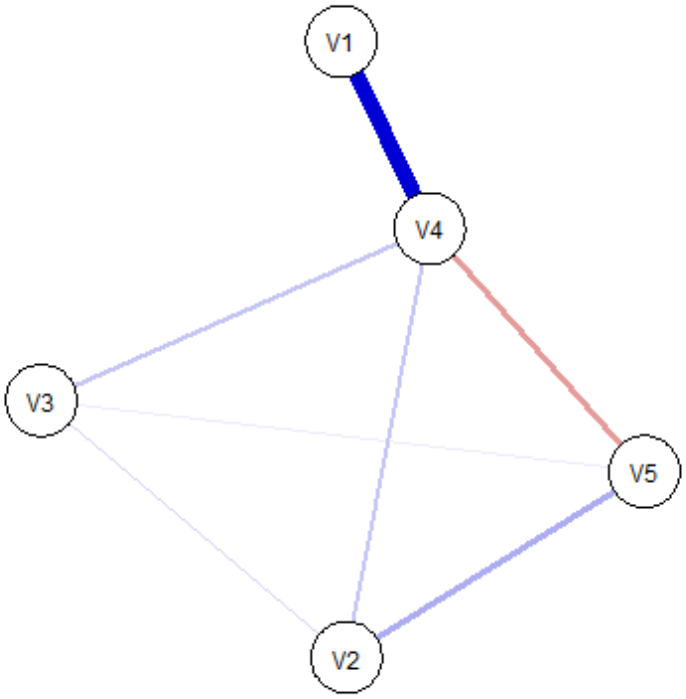
What is Network Analysis?

Network analysis is a type of statistical analysis that can be used to explore complex associations between variables, such as risk factors for suicide. The output of this analysis is a visual network structure of the associations between variables and the strength and direction of these associations. This output makes the complexity of the associations visually accessible and understandable. Each variable (e.g., a risk factor for suicide) is depicted by a circle, known as a *node*, and these nodes are joined by lines called *edges*. Thicker, more opaque edges represent stronger associations between two nodes. Negative associations are depicted by a red edge, and positive associations by a blue edge.

Networks can be estimated using cross-sectional data or temporal data. In a network estimated using cross-sectional data, such as that in Figure 5 below, the edges are undirected, as it is unknown what the temporal direction of a causal effect is, given the data is collected within a single time point. Typically, cross-sectional networks are estimated using partial correlations. Each edge in this type of network represents an association that exists between two nodes after controlling for all other nodes in the network, such that the relationship is not due to the presence of another node and the nodes are not conditionally independent (Epskamp & Fried, 2018). If it is assumed that all third variables affecting nodes in the network have been included in the analysis, a partial correlation between two nodes could suggest that one of the variables causes the other, that there is a reciprocal relationship between the variables, or that both variables cause a third variable present in the network (Epskamp & Fried, 2018). As these partial correlations are *potentially* indicative of causality, a cross-sectional network can be useful for generating hypotheses about relationships that can then be tested in experimental studies or temporal networks.

Figure 5

Cross-sectional Network Example



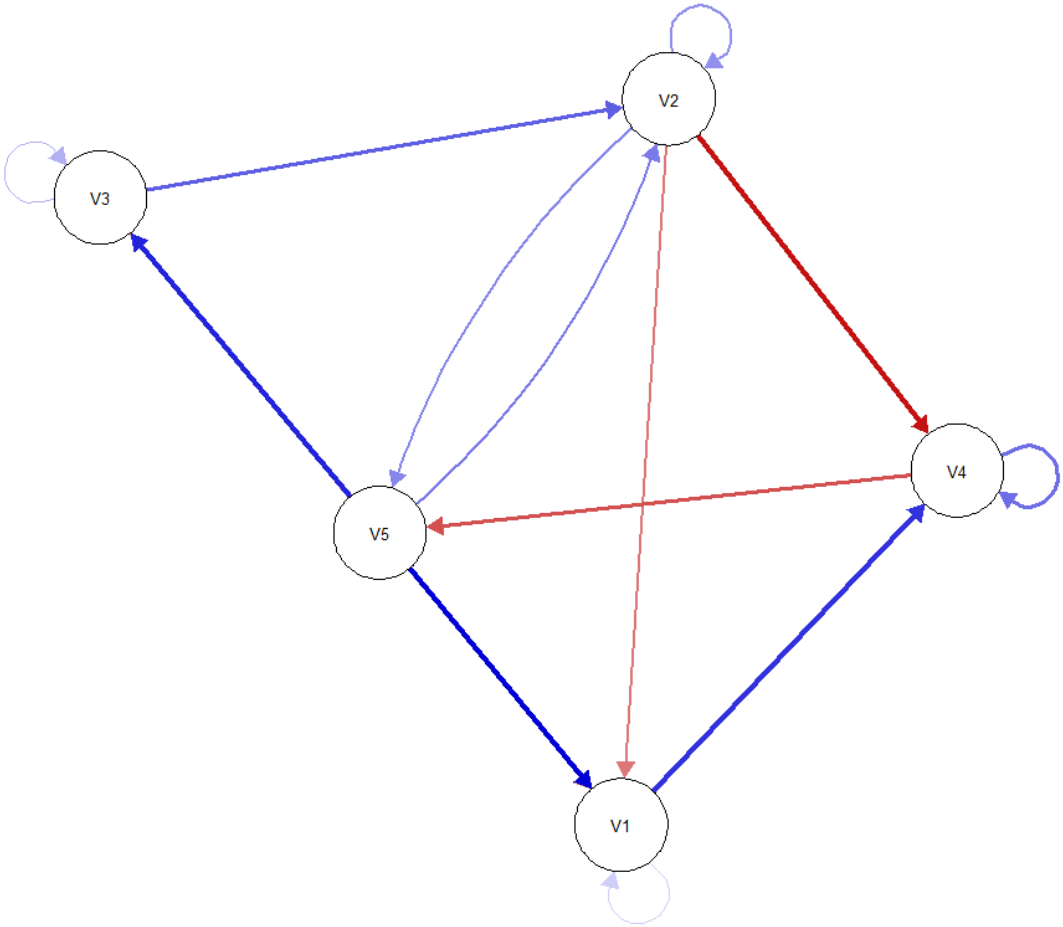
A network estimated using temporal data (i.e., data collected at multiple time points) is different to a network produced using cross-sectional data. Temporal data networks are estimated using vector autoregression modelling, which regresses each variable on itself at the previous time point, resulting in a vector of lagged regression coefficients (fixed effects; Rath et al., 2019). When using multilevel vector autoregressive modelling, the vector autoregression coefficients can vary between individuals (random effects; Rath et al., 2019). Both autoregressive and cross-lagged effects between variables are then visualised in the temporal network (Epskamp, van Borkulo, et al., 2018). An autoregressive effect is depicted when a variable at one time point is predicted by itself at the previous time point, and a cross-lagged

effect is depicted when a variable at one time point is predicted by a different variable at the previous time point when controlling for the autoregressive effects (Epskamp, van Borkulo, et al., 2018).

Three types of network structures can be estimated using temporal data: a temporal network (Figure 6), contemporaneous network, and between-persons network. Each of these networks will be described in detail below.

Figure 6

A Temporal Network Example



A temporal network, such as that shown in Figure 6, shows how each node predicts the other nodes over time (Epskamp, van Borkulo, et al., 2018). The nodes V1, V2, V3, V4, and V5 could represent variables such risk factors for suicide. In a temporal network an edge between two nodes represents a cross-lagged effect, where a variable at one time point is predicted by another variable at the previous time point. Unlike the cross-sectional network, the edges in a temporal network are directed, having an arrowhead pointing from one node to another. The direction of this arrowhead represents the temporal direction of the relationship. For example, in Figure 6 one of the edges points from V1 to V4. This suggests that V1 at one measurement predicts a change in V4 at the next measurement, and as this edge is blue, a positive association, it depicts that an increase in V1 results in an increase in V4 over time. As the cause (V1) temporally precedes the effect (V4), and all other variables in the network are controlled for in the analysis, the presence of an edge between these two nodes in a temporal network is said to be indicative of a potentially causal relationship, unless there is a time-varying confounding variable not included in the network.

In addition to these cross-lagged effects, some nodes in a temporal network will have an autoregressive effect, shown by an arrow on a node that loops back onto itself, such as that seen on V1. This autoregression suggests that V1 at one time point is predicted by itself at the previous time point. The estimation of autoregressive effects helps to cope with a possible assumption violation, as using data with short intervals between measurements, as is typically used for this analysis, can violate the statistical assumption of independent consecutive responses. For example, a person who feels depressed at one measurement is likely to still feel this way (to a degree) at the subsequent measurement if the measurement interval is only a few hours long. Controlling for autoregressive effects also enables us to produce more credible

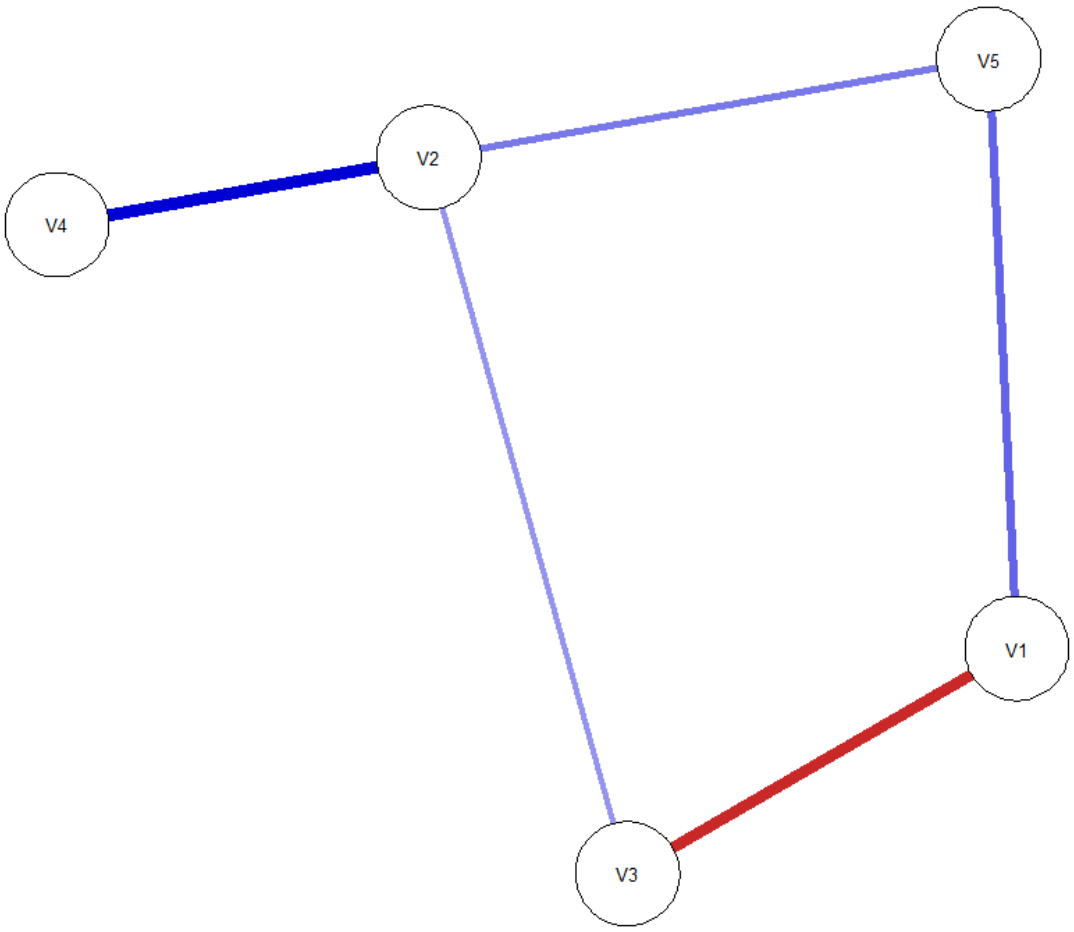
estimates of causal effects, because a temporal relationship between two variables cannot be the result of the lagged dependent variable. For example, in Figure 6, the temporal relationship between V1 and V4 cannot be due to lagged V4 affecting both variables, as this has been controlled for in the autoregression shown on V4.

There may be instances when a temporal relationship between nodes is not detected due to having measurement intervals that are too long, or too short. When using ecological momentary assessment to collect data, assessments are often completed a few hours apart. This would not be able to capture a causal relationship that occurs between variables within seconds or minutes, as the effect of the independent variable on the dependent variable would occur within the same measurement interval rather than in the following one. Thus, such a relationship would not be apparent in a temporal network (Epskamp, van Borkulo, et al., 2018). However, it would be depicted in a contemporaneous network.

In temporal vector autoregression models the residuals are permitted to be correlated, meaning that nodes within the same time point may have correlations with one another that cannot be explained by the temporal network (Epskamp, van Borkulo, et al., 2018). Using these residuals, a contemporaneous network (Epskamp, Waldorp, et al., 2018) can be estimated. The contemporaneous network shown in Figure 7 depicts associations between nodes within the same measurement, after controlling for the effects depicted in the temporal and between-persons networks (Epskamp, van Borkulo, et al., 2018). As the associations are present within the same time point, edges are undirected in a contemporaneous network (Epskamp, van Borkulo, et al., 2018).

Figure 7

A Contemporaneous Network Example



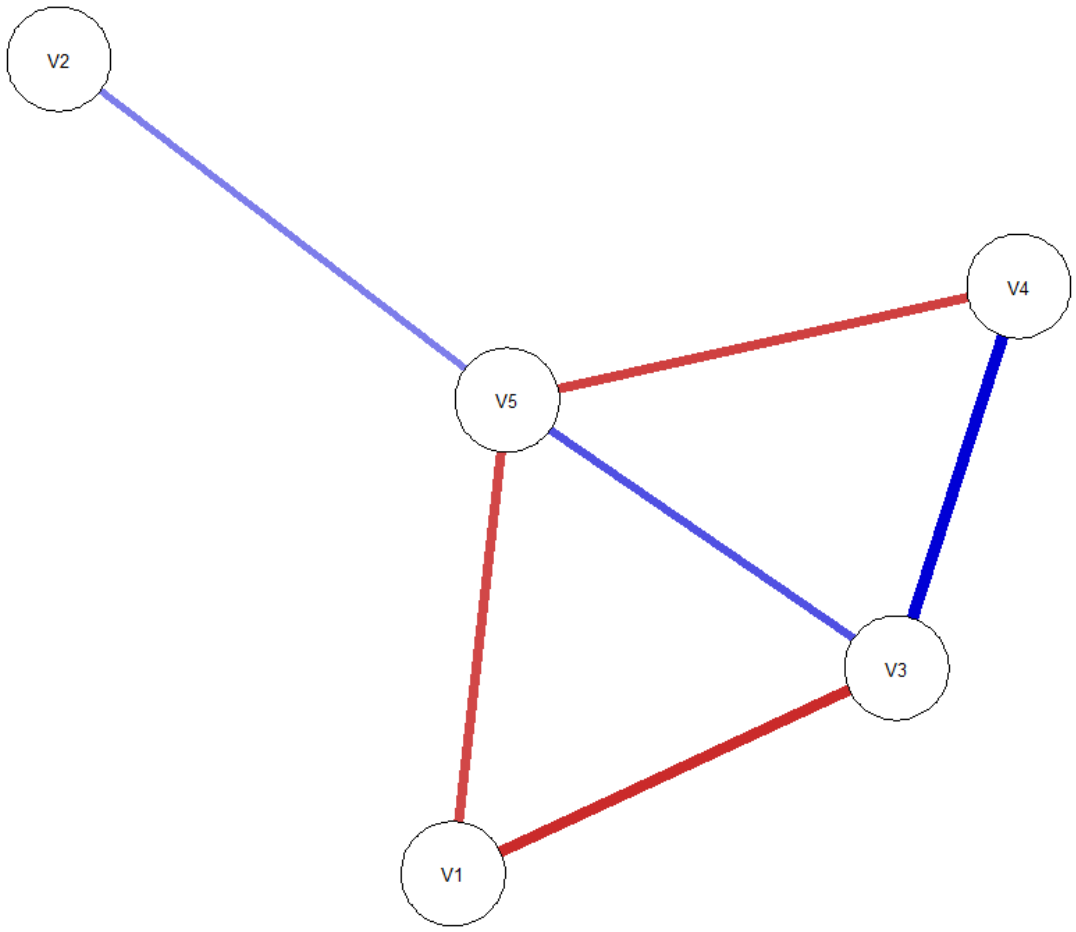
Despite being undirected, edges in a contemporaneous network may still indicate potentially causal relationships (Epskamp, van Borkulo, et al., 2018). An edge in a contemporaneous network depicts the partial correlation that exists between a pair of nodes at one time point after controlling for all other variables in the network within the same time point and the previous one, (Epskamp, van Borkulo, et al., 2018). In Figure 7, the blue edge between V2 and V5 would suggest an increase in V2 is associated with an increase in V5 within the same

measurement (or vice versa). Using two risk factors for suicide as a further example, there might be a causal effect of alcohol intoxication on low mood. This effect might occur over a shorter period than the measurement interval used to measure these factors, and low mood at one time point might still be experienced at the next time point given the short intervals between measurements. In this case a temporal network would show an autoregression on low mood (i.e., low mood at one time point is predicted by itself at the previous time point), but it would likely not show an edge between low mood and alcohol intoxication, because the effect of the independent variable (e.g., alcohol intoxication) on the dependent variable (e.g., low mood) would occur within the same measurement interval. Instead, if the relationship between alcohol intoxication and low mood existed, it might be visible in a contemporaneous network, due to this network depicting relationships between nodes in the same measurement. However, there could also be alternative explanations for this relationship, which would have to be tested in follow-up research.

The third type of network that can be estimated if temporal data has been collected from multiple participants is a between-persons network (Epskamp, Waldorp, et al., 2018). Figure 8 depicts an example of a between-persons network. When collecting temporal data, each participant will have their own mean level of each variable over time (Rath et al., 2019). In the between-persons network these personal mean scores are correlated across persons (Rath et al., 2019). A blue edge, such as that seen between V2 and V5 in Figure 8 would suggest participants with a high mean level of V2 tend to have a high mean level of V5 (and vice versa). In contrast, a red edge, such as that between V1 and V5, would suggest that participants with a high mean level of V1 tend to have a low mean level of V5 (and vice versa).

Figure 8

A Between-Persons Network Example



Between-persons networks are sometimes assumed to be the same as cross-sectional networks. However, cross-sectional networks may include temporal, contemporaneous and between-persons variance, such that it is impossible to distinguish between these effects in a cross-sectional network. In contrast, a between-persons network contains only the between-persons variance, with the temporal and contemporaneous variance being depicted in their respective networks.

In addition to producing a visual network graph, network analysis produces a centrality plot that enables us to quantify how *central* each node is to each of the three networks. Centrality measures how connected a node is to the other nodes in the network (Fonseca-Pedrero, 2018). If we assume that the connections between nodes are indicative of causality, when a particular node has strong connections to many other nodes and is therefore highly central to the network, it may be the case that this node has a causal effect on each of the nodes it is connected to. Continuing with this assumption, if we activated (i.e., increased or decreased) a node which had high centrality due to its effects on many other variables, in turn it would activate those nodes it is connected to, which would then cause changes in the nodes that those nodes are connected to, such that activating a single central node could create change throughout the entire network. Using a network of risk factors for suicide as an example, depressed mood might be the most central risk factor to the network, having an effect on many other risk factors such as alcohol intoxication, hopelessness, and perceived burdensomeness, each of which might be connected to further risk factors. If the depressed mood node is activated, such that there is an increase (or decrease) in level of depressed mood, then the risk factors connected to the depressed mood node would also be activated, and the risk factors connected to those would likely be activated as well. Thus, by activating the central variable in the network, change across the whole network may occur, due to the potentially causal influence each node has on those it is connected to.

Multiple types of centrality exist, such as closeness and betweenness centrality. Closeness centrality measures how strongly a node is indirectly associated with other nodes, using the inverse of the sum of the shortest paths between one node and all others (Epskamp, Maris, et al., 2018). Betweenness centrality measures the number of shortest paths between two nodes that a particular node of interest is included in (Epskamp, Maris, et al., 2018). There is

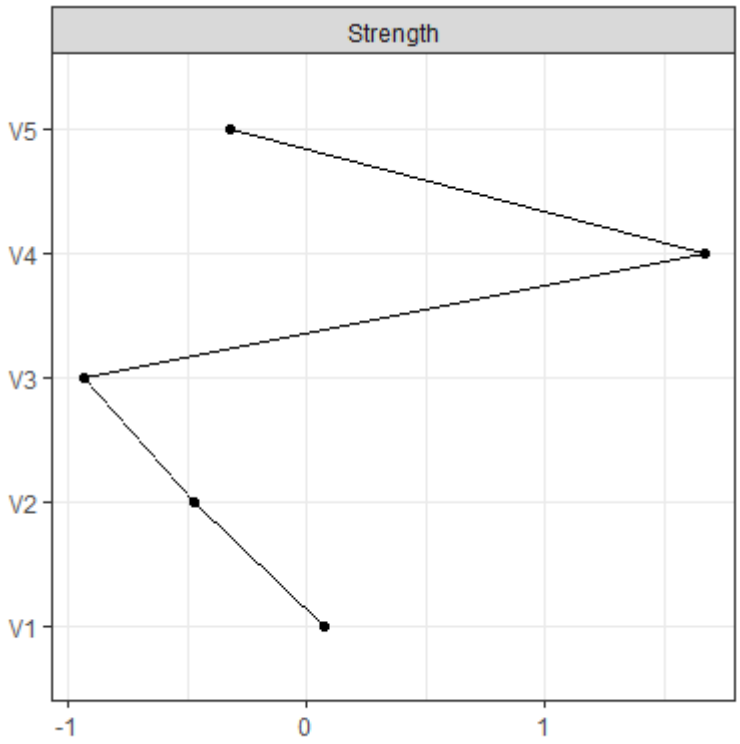
much debate about the suitability of closeness and betweenness centrality for use with psychological networks. Measures of centrality were designed for use in social networks, where edges depict observable relationships between people, rather than associations between psychological constructs like those depicted by edges in psychological networks (L. Bringmann et al., 2019). As such, there are concerns about the reliability of measures of centrality, with some psychological network analyses suggesting closeness and betweenness centrality in particular are unstable measures, shown by wide confidence intervals and inconsistencies between similar datasets (L. Bringmann et al., 2019). However, if the assumption of causality between connected nodes holds true, centrality estimates could provide useful information about which nodes may be useful intervention targets, for example, which could then go on to be tested in experimental research. As such, a measure of centrality will be included in the current study. This will provide others the ground on which to generate hypotheses for further research about centrality measures.

The type of centrality that will be used in this research is *strength centrality*. The strength centrality of a node is measured by summing the strength of the direct associations that node has (Epskamp, Maris, et al., 2018). Say that in a hypothetical network the edge weight between V1—V2 is 0.1 and the edge weight between V1—V3 is 0.3. The strength centrality of V1 would thus be 0.1 + 0.3 = 0.4. Strength centrality can then be plotted using *z* scores. Using *z* scores rather than raw scores enables us to compare how much each node's strength centrality differs from the mean. Figure 9 shows an example of a centrality plot, with the nodes listed on the Y axis, and *z* score on the X axis. In this plot, each node's *z* score represents how many standard deviations above or below the mean level of centrality that node's centrality is. Node V3's centrality, for example, is nearly one standard deviation below the mean strength centrality of all nodes in the

network. This suggests node V3 has low strength centrality compared to the other nodes in the network. In contrast, the strength centrality of node V4 is more than one standard deviation above the mean strength centrality of all nodes in the network, suggesting it has comparatively higher strength centrality.

Figure 9

Strength Centrality Plot Example



Note. This centrality plot corresponds to the cross-sectional network example in Figure 5.

In a temporal network, two types of strength centrality are estimated: in-strength and out-strength centrality. In-strength centrality refers to the summed strength of associations directed towards a particular node, and out-strength refers to the summed strength of associations directed away from a particular node (Jones et al., 2021). As an example, in relation to the temporal

network depicted earlier in Figure 6, the in-strength centrality for node V5 would be calculated by summing the strength of the edges pointing towards V5, which come from V2 and V4. The out-strength of V5 would be calculated by summing the strength of the edges pointing away from V5, which go towards V1, V2, and V3. As above, the in-strength and out-strength centrality for each node are plotted as *z* scores.

What Can Network Analysis Tell Us About Suicide Risk?

Network analysis has provided researchers with an alternative way of understanding psychopathology and, more recently, suicide risk. Traditionally psychopathology has been conceptualised from the latent variable viewpoint (Humphry & McGrane, 2010). Particular sets of symptoms are usually observed together and typically we would assume that this observation is due to the effect of an underlying latent variable. For example, from this perspective, the presence of a latent variable such as anxiety could be said to lead to the presence of observable symptoms which we would associate with that disorder (Borsboom & Cramer, 2013). That is to say, if a latent variable 'anxiety' exists and individuals have differing levels of this variable, then individuals with high levels of the variable will likely develop observable symptoms such as excessive worry and irritability. In contrast, the network perspective postulates that psychopathology can be understood as a system of variables, each of which causally influences the others. From this perspective, each symptom of a disorder would arise as a result of another symptom being experienced, such that when excessive worry is experienced, irritability is then activated, and in turn this might activate other symptoms. This activation results in a causal network of symptoms that mutually influence one another, and it is this network that we would call 'anxiety.'

Network analysis has been applied to symptoms of numerous disorders, including anxiety, depression, and eating disorders (Cramer et al., 2016; Forrest et al., 2018; Heeren et al., 2018). These networks have shown what the most central symptoms are for a particular disorder, how each symptom is uniquely related to other symptoms of the disorder, and what symptoms are comorbid across multiple disorders. For example, network analyses of symptoms of anorexia nervosa have shown the most central variables to be desiring weight loss, restraint, weight and shape preoccupation, shape over-valuation, and fear of weight gain (Forrest et al., 2018). Additional network research has demonstrated that many significant cross-sectional network associations exist between symptoms of anorexia nervosa, with positive partial correlations estimated between weight dissatisfaction and the desire to lose weight, and between binging and vomiting (Elliott et al., 2020). Such studies have also evidenced that some symptoms of anorexia nervosa are comorbid symptoms of anxiety and depression, with variables such as feeling worthless and having a negative reaction to weighing oneself being bridge symptoms between the clusters of symptoms for these disorders (Elliott et al., 2020).

In recent years, researchers such as O'Connor and Portzky (2018) have called for network analysis to be applied to studies of suicide. From the network perspective, suicide risk can be conceptualised as a system of variables (i.e., risk factors) that causally influence one another to produce a network of variables which together create 'suicide risk.' If an individual experiences an increase in a risk factor, such as depressed mood for example, this may lead to further activation of risk factors in the network, resulting in increased (or decreased) risk for suicide. This may be especially true for risk factors that are central to the network. It is plausible that when the most central risk factors are activated, the many risk factors associated with these

central risk factors may also be activated, resulting in network-wide activation and a change in overall suicide risk.

Applying network analysis to risk factors for suicide may increase our understanding of the complexity of associations between such factors. Many factors are cited in empirical literature as being associated with suicidal ideation, but traditional methods of analysis are unable to tell us exactly *how* these risk factors are associated with ideation and other risk factors. Network analysis makes these complex associations visually accessible, enabling a better understanding of how these variables might mutually influence one another. For example, a cross-sectional network analysis of 18 risk and protective factors for suicide by Holman and Williams (2022) found feeling depressed had the strongest direct association with suicidal ideation. Feeling depressed was directly associated with ten other variables in the network, including perceived burdensomeness, feeling anxious, feeling hopeless, self-esteem, substance abuse, and resilience, and each of these had further associations with other variables too. This network exemplified how complex the associations between risk and protective factors are likely to be, and how network analysis can be used to visualise such complex associations. However, this was a cross-sectional network, and thus it is unable to identify the temporal relationships risk factors may have with suicidal ideation.

Network analysis also enables us to explore which risk factors are central to suicide risk. Knowledge about which risk factors are central has potential implications for the creation of personalised interventions to reduce suicide risk. Nodes that have the highest centrality in a network are those which influence many other nodes, with this influence potentially being causal. Thus, a central node is plausibly a powerful target for intervention. By changing the central node, the nodes connected to this central one might also be activated and changed. For

example, if depressed mood was the most central node in a network of risk factors for suicide, such that it had strong connections with many other nodes, an intervention targeting depressed mood specifically might also reduce the level of other risk factors that are directly associated with this risk factor. This could stimulate network-wide change and reduce overall suicide risk. Targeting central risk factors may therefore be effective at reducing suicide risk, compared to targeting factors that are not as connected to other nodes. To be able to create targeted interventions, we first need to find out which risk factors are most central by conducting network analyses of suicide risk factors. Completing these analyses at a group level would tell us which nodes are most central, helping to establish *potentially* useful intervention targets in a general sense, whereas network analyses at an individual level (i.e., N=1 network studies) would enable us to figure out which nodes are central for an individual so that we could devise personalised interventions for that individual, which in theory would be more effective than a general, non-personalised intervention. While as of yet there are no published N=1 network studies of suicide risk factors, the centrality of various risk factors for suicide at a group level has been estimated in a small number of cross-sectional studies so far. For example, Holman and Williams' (2022) cross-sectional network analysis of risk and protective factors for suicide found feeling depressed, feeling hopeless, perceived burdensomeness, self-esteem, and social support to be most central. Other researchers such as Shiratori et al. (2014) report physical illness, depression, and economic hardship to be central factors in a cross-sectional network of events precipitating suicides in Japan. To gain a clearer picture of which risk factors are most central to suicide risk, more network analyses of suicide risk factors are required.

Using network analysis to study suicide risk may be of further benefit in that it could provide evidence in support or opposition of theories of suicide, such as the interpersonal

psychological theory (Joiner, 2005), integrated motivational-volitional model (O'Connor, 2011), or three step theory (Klonsky & May, 2015). Networks of variables from these theories would provide information about how these variables interact with one another and how they relate to suicidal ideation. For example, a temporal network of variables included in the interpersonal psychological theory of suicide might include perceived burdensomeness, thwarted belongingness, and capability for suicide, as well as suicidal ideation and behaviour. If such a network contained the temporal associations implied by the theory, it would provide further support for the main premises of the theory (depending on what other associations were depicted in the network too). A cross-sectional network study by Schönfelder et al. (2021) has exemplified how networks might be used in this way, with their network estimation demonstrating that thwarted belongingness and perceived burdensomeness have significant partial correlations with both suicidal ideation and suicidal behaviour. This finding only partially supports the interpersonal psychological theory of suicide, as according to the theory, thwarted belongingness and perceived burdensomeness cause only suicidal ideation, not suicidal behaviour.

Conducting network analyses of risk factors with a theoretical underpinning as well as additional risk factors that thus far only have empirical support rather than theoretical would enable researchers to refine existing theories or potentially develop new ones. For example, de Beurs et al. (2019) conducted a cross-sectional network analysis of 17 theoretical constructs from the interpersonal psychological theory and integrated motivational-volitional model as well as depression, stress, mental wellbeing. A relative importance analysis found depression to be one of the most important statistical predictors of suicidal ideation, along with internal entrapment and perceived burdensomeness. Depression showed a strong direct association with suicidal

ideation, as did stress and mental imagery. Because cross-sectional network analysis uses partial correlations in the network estimation, these results suggest that risk factors outside of those included in the theories analysed by de Beurs et al. (2019) may contribute uniquely to the development of suicidal ideation. Understanding how risk factors are associated with suicidal ideation in a network has the potential to increase our knowledge about how suicidal ideation might develop, thus it provides some ground on which to refine theories of suicide. This is beneficial because these theories can in turn be used to inform effective interventions for suicide that address suicidal risk early on (de Beurs et al., 2019).

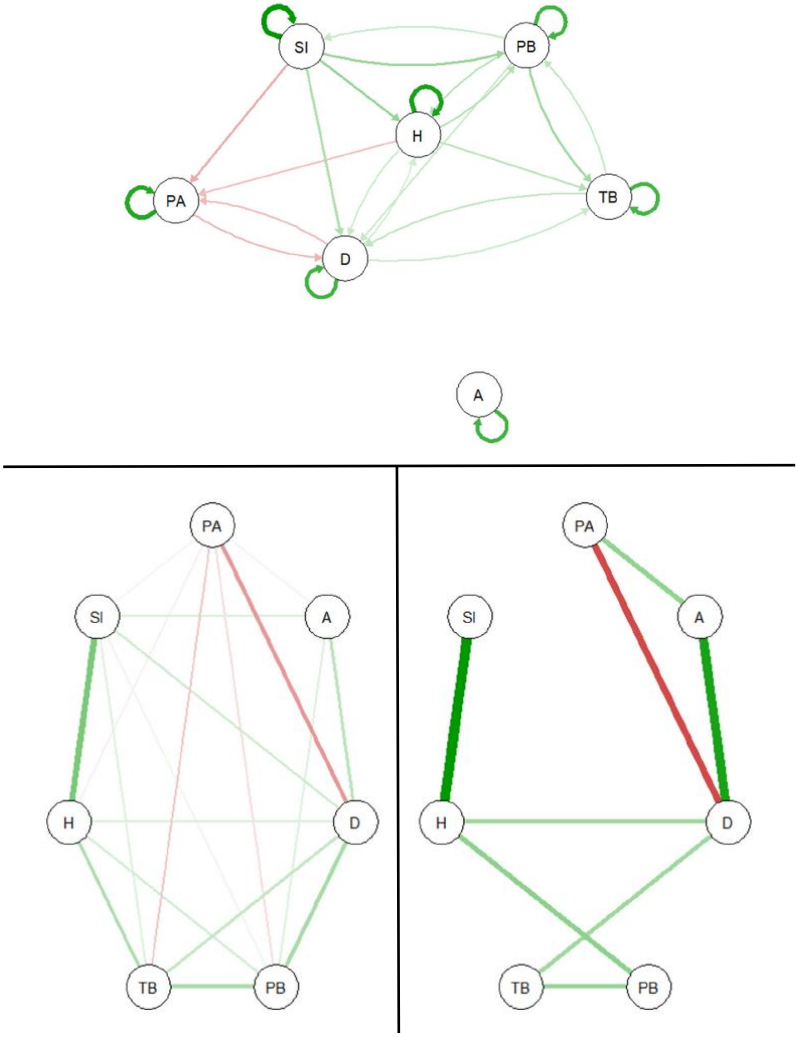
Existing Suicide Temporal Network Analysis Literature

Estimating a temporal network of suicide risk factors using data collected through ecological momentary assessments would enable us to study the short-term dynamics of suicide risk factors and suicidal ideation. Almost all published suicide network analyses have used cross-sectional data (e.g., de Beurs et al., 2019, 2017; Holman & Williams, 2022; Shiratori et al., 2014; Simons et al., 2019), with the exception of Rath et al. (2019) who used ecological momentary assessment data to estimate temporal, contemporaneous, and between-persons networks. This data has been analysed in multiple studies, including Forkmann et al. (2018) and Hallensleben et al. (2019). Using a smartphone app, 74 psychiatric inpatient participants completed six days of surveys with ten assessment prompts sent each day, measuring suicidal ideation, perceived burdensomeness, thwarted belongingness, depression, hopelessness, positive affect, and anxiety. Overall, the compliance rate for assessments was high, with 89.7% of the assessments being completed, totalling 4295 assessments.

The networks estimated by Rath et al. (2019) are pictured in Figure 10. The temporal network showed that suicidal ideation at one measurement was predicted by perceived burdensomeness at the previous measurement. Unless there is a time-varying confounding variable that affects both suicidal ideation and perceived burdensomeness, the presence of a relationship between these nodes in the temporal network is suggestive of a causal relationship. This is because the temporal network demonstrates that the cause temporally precedes the effect, and also controls for both stable interindividual differences (these are extracted in the between-persons network) and the effect of all other nodes in the network. Therefore, the presence of an edge in a temporal network provides us with stronger evidence of a causal relationship than that suggested by cross-sectional research where numerous individual differences might confound variables, and the direction of the causal effect might be in the opposite direction to that hypothesised. In Rath et al.'s contemporaneous network, hopelessness had the strongest positive association with suicidal ideation. If a causal relationship exists between hopelessness and suicidal ideation, this association being present in the contemporaneous network and not the temporal network could suggest the effect might occur over a shorter period of time than the measurement interval allowed for. The between-persons network estimated a strong association between suicidal ideation and hopelessness. This meant participants who reported high hopelessness tended to report high suicidal ideation on average. Many other associations were estimated in the networks, as can be seen in Figure 10. Rath et al.'s (2019) research demonstrates the applicability of temporal network analysis to suicide risk factors, and the resulting novel information about the temporal, contemporaneous, and between-persons relationships between risk factors for suicide and suicidal ideation.

Figure 10

Rath et al.'s (2019) Temporal (top), Contemporaneous (bottom left), and Between-Persons (bottom right) Networks



Note. Green edges represent positive associations and red edges represent negative associations. From "Modelling suicide ideation from beep to beep: Application of network analysis to ecological momentary assessment data," by D. Rath, D. de Beurs, N. Hallensleben, L. Spangenberg, H. Glaesmer, and T. Forkmann, 2019, *Internet Interventions, 18*, p.5. (https://doi.org/10.1016/j.invent.2019.100292) CC BY NC ND.

In addition to providing a visual understanding of how complex the associations between risk factors for suicide can be, Rath and colleagues' (2019) network analyses provide further insight into the theorised mechanisms of suicidal ideation development. By including variables such as perceived burdensomeness and thwarted belongingness, Rath et al. were able to explore whether the temporal relationships proposed in the interpersonal theory of suicide were supported. In the estimated temporal network, perceived burdensomeness predicted suicidal ideation at the subsequent measurement while thwarted belongingness did not. This does not support the interpersonal psychological theory of suicide, which postulates both variables must be present for suicidal ideation to develop (Joiner, 2005). However, as the contemporaneous network estimated positive associations between suicidal ideation and both perceived burdensomeness and thwarted belongingness, it is possible these effects simply occur over shorter periods than that which the measurement interval allowed for, and hence they were not apparent in the temporal network. Alternatively, this study may have been underpowered to detect small effects in the temporal network, and this could have resulted in these effects not being detected.

Rath et al.'s (2019) temporal network analysis of suicide risk factors is the first study of this nature. To further increase our understanding of the complexity of the relationships between risk factors for suicide and suicidal ideation, and how these variables fluctuate over time, the present study builds upon Rath et al.'s research by conducting a temporal network analysis of a larger group of risk factors for suicide, with some differences.

Chapter Four: The Present Study

Research Aims

The primary aim of this research was to explore how dynamic risk factors for suicide were associated over short periods of time, and which of these risk factors were directly associated with suicidal ideation in temporal, contemporaneous, and between-persons networks. This was the second known study to apply temporal network analysis to risk factors for suicide. The one study that previously explored this (Rath et al., 2019) did not include some common risk factors for suicide that have empirical (and theoretical) associations with suicidal ideation, suicide attempts, or suicide death, such as acute alcohol intoxication, social support, and self-esteem. This previous study also only included one symptom of depression – depressed mood – yet there are a few additional symptoms of depression that are directly empirically associated with suicide, such as anhedonia, worthlessness, and fatigue. Including these symptoms of depression in the present study's network analyses of suicide risk factors increases our understanding of the role these symptoms play in altering suicide risk.

This research utilised an ecological momentary assessment design to collect data about risk factors for suicide. Network analysis was then used to analyse the temporal, contemporaneous and between-persons relationships that exist between these risk factors. The risk factors included in this study were those that could be considered dynamic and changeable over short periods of time. These risk factors were depressed mood, worthlessness, fatigue, anhedonia, hopelessness, perceived burdensomeness, thwarted belongingness, acute alcohol intoxication, self-esteem, and social support. The risk factors chosen for this study were well-supported by theoretical and empirical literature. A summary of some of the empirical support for the association of these factors with increased likelihood of suicidal ideation, suicide attempt,

and suicide death is listed in Table 1 below. A more detailed review of the literature supporting these associations was provided in Chapter Two.

Table 1

Empirical Research Supporting the Association Between Suicide Risk Factors and Suicidal Ideation, Suicide Attempt, and Suicide Death

Variable	Suicidal ideation	Suicide attempt	Suicide death
Depression			
Depressed mood		Cameron et al. (2017)	Aaltonen et al. (2019)
Worthlessness		Wakefield and Schmitz (2016)	
Fatigue	Ribeiro et al. (2012)		
Anhedonia	Ducasse et al. (2018)		
Alcohol intoxication		Cherpitel et al. (2004)	
Hopelessness	Hallensleben et al. (2019)		
	Roeder & Cole (2019)		
	Sueki (2020)		
	Wolfe et al. (2019)		
Perceived burdensomeness	Duffy et al. (2020)	Hill & Pettit (2014)	
	Hallensleben et al. (2019)		
	Hill & Pettit (2014)		
	Kleiman et al. (2017)		

Table 1 continued

Variable	Suicidal ideation	Suicide attempt	Suicide death
Thwarted belongingness	Hallensleben et al. (2019) Kleiman et al. (2017) Ma et al. (2016) Roeder & Cole (2019)	Ma et al. (2016)	
Social support	Richie et al. (2019) Teismann et al. (2016)	Liu et al. (2017)	
Self-esteem	Fergusson et al. (2003) Wild et al. (2004)	Delam & Bazrafshan (2019) Fergusson et al. (2003) Soto-Sanz et al. (2019) Wild et al. (2004)	

Note. This is not an exhaustive list of relevant literature. The research cited here includes that which was described in Chapter Two.

Most of the risk factors included in the network analyses in the present study are implicated in one or more of the prominent ideation to action theories of suicide, including the interpersonal psychological theory of suicide (Joiner, 2005), integrated motivational-volitional model of suicide (O'Connor, 2011), and the three step theory of suicide (Klonsky & May, 2015). The theoretical involvement of each risk factor included in the present study was briefly described earlier in this thesis. The ideation to action theories were used to inform the inclusion of some of the dynamic suicide risk factors for suicide in the network analyses. Subsequently,

the results of this study are compared to the theoretical literature about suicide risk in the Discussion section, providing support or opposition to their premises. The risk factors in the present study and the theories they are involved in are listed in Table 2 below.

Table 2

Theoretical Involvement of Risk Factors Included in the Present Study

Interpersonal psychological theory of suicide	Integrated motivational-volitional model of suicide	Three step theory of suicide
Perceived burdensomeness	Perceived burdensomeness	Perceived burdensomeness
Thwarted belongingness	Thwarted belongingness	Thwarted belongingness
	Social support	Social support
		Hopelessness
		Self-esteem

Note. There are additional variables associated with each of these theories that are not listed here as they are not included in the present study.

Hypotheses

The present study had seven hypotheses that were preregistered on the Open Science Framework at https://osf.io/w2e8x. These hypotheses were based on Rath et al.'s (2019) and Holman and Williams' (2022) findings. These findings are briefly described alongside each of the hypotheses below.

H1. In the temporal network, depressed mood will be positively associated with suicidal ideation at the subsequent time point.

Holman and Williams (2022) found that feeling depressed had the strongest direct positive association with thoughts of suicide in their cross-sectional network analysis. The present study will investigate whether this is similarly the case in a temporal network including these nodes.

H2. In the temporal network, perceived burdensomeness will be positively associated with suicidal ideation at the subsequent time point.

Rath et al. (2019) found that perceived burdensomeness was directly, positively associated with thoughts of suicide in the temporal network they estimated. This relationship is also theorised in the interpersonal psychological theory of suicide (Joiner, 2005) and the integrated motivational-volitional model (O'Connor, 2011), where perceived burdensomeness is purported to result in an increased level of suicidal ideation.

H3. In the temporal network, thwarted belongingness will be positively associated with suicidal ideation at the subsequent time point.

The interpersonal psychological theory of suicide (Joiner, 2005) and the integrated motivational-volitional model (O'Connor, 2011) both claim that thwarted belongingness is associated with increased levels of suicidal ideation. However, in Rath et al.'s (2019) temporal network, thwarted belongingness was *not* directly associated with thoughts of suicide. Ecological momentary assessment literature about suicide risk reports similar results, finding thwarted belongingness at one measurement to not have a significant association with suicidal ideation at the subsequent measurement (Hallensleben et al., 2019; E. M. Kleiman et al., 2017). Given this conflict between theory and empirical findings, the present study includes a hypothesis about the temporal relationship between thwarted belongingness and suicidal ideation.

H4. In the temporal network, hopelessness will be positively associated with suicidal ideation at the subsequent time point.

H5. In the contemporaneous network, hopelessness will be positively associated with suicidal ideation.

In Rath and colleagues' (2019) estimated temporal network, hopelessness did not have a direct association with suicidal ideation. However, in the contemporaneous network, hopelessness was directly associated with increased thoughts of suicide. I hypothesise that a relationship between hopelessness and suicidal ideation will be estimated in both the temporal and contemporaneous networks in the present study.

H6. In the between-persons network, hopelessness will be positively associated with suicidal ideation.

Rath et al.'s (2019) between-persons network showed that participants with high levels of hopelessness tended to report high levels of suicidal ideation on average. This finding aligns with Klonsky and May's (2015) three step theory of suicide, which theorises that high levels of hopelessness lead to an individual experiencing thoughts of suicide.

H7. In the between-persons network, self-esteem will be negatively associated with suicidal ideation.

Holman and Williams (2022) found that self-esteem had a direct negative association with thoughts of suicide in their cross-sectional network analysis. Rath et al.'s (2019) temporal network analysis did not include a measure of self-esteem. Self-esteem is involved in Klonsky

and May's (2015) three step theory of suicide, whereby a painful experience, such as low self-esteem, leads to increased suicidal ideation.

Research Questions

In addition to having specific hypotheses, this research had four research questions which were also preregistered. These are listed below. The results associated with these questions may provide the basis for hypothesis-testing in future research.

RQ1. To what degree does suicidal ideation fluctuate from measurement to measurement?

RQ2. To what degree do risk factors for suicide fluctuate from measurement to measurement?

RQ3. What nodes are directly associated with increased suicidal ideation in each network (temporal, contemporaneous, and between-persons)?

RQ4. What nodes have the highest strength centrality in each network (temporal, contemporaneous, and between-persons)?

Preregistration

Preregistration describes a process where research questions and analysis plans are defined prior to conducting research (Nosek et al., 2018). One goal of preregistration is to enable researchers to transparently evaluate how capable a test is of falsifying a prediction (Lakens, 2019). A preregistration is usually posted to an online repository (Nosek et al., 2018), such as the Open Science Framework, where it is timestamped and available for other researchers to view.

This is intended to promote the transparency, reproducibility, and replicability of research (Kirtley et al., 2021).

In recent years preregistration has grown in popularity in the field of psychology as a way to increase the reproducibility of psychological research. It is well-known that sometimes researchers explore different combinations of analyses to find those which produce statistically significant results, and only these results are then reported – a process also known as "*p*-hacking" (Head et al., 2015; Simmons et al., 2011). Another questionable research practice is hypothesising after the results are known, or "HARKing" (Kerr, 1998). Preregistering data collection and analysis plans before research is conducted may protect against *p*-hacking and HARKing by providing researchers with fewer opportunities to selectively report findings that appear unduly favourable (Nosek et al., 2018). Preregistration thus provides consumers of research with more confidence that the results are not simply the outcome of altering hypotheses or analyses to find the effects that are statistically significant as it enables other researchers to check whether published analyses differ from preregistered analyses. Preregistration is especially valuable in the context of ecological momentary assessment research as this research design requires a researcher to make many more choices compared to traditional research designs (Kirtley et al., 2021), and thus it presents more possibilities for "researcher degrees of freedom" (Simmons et al., 2011).

The present study has been preregistered on the Open Science Framework at https://osf.io/w2e8x. Kirtley et al.'s (2020) preregistration template for ecological momentary assessment research was used to guide the preregistration for this study. The preregistration included a plan for data collection, the specific hypotheses that were to be tested, and the statistical analyses that were to be used to test these hypotheses. It also included an R (R Core

Team, 2021) script to show how these analyses would likely be conducted. The analysis script that was used to produce the statistical output reported in this thesis is a slightly modified version of the preregistered script. Preregistration is a novel feature of this research, setting it apart from previous temporal network literature about suicide, such as Rath et al. (2019), which was not preregistered.

Chapter Five: Method

Participants and Procedure

This study had an ecological momentary assessment design. An online survey was used to collect data from a sample of participants repeatedly over time, with five identical surveys sent every day for a period of ten consecutive days. To be eligible to participate in this study, individuals needed to be aged 18 years or over and live in New Zealand. Participants also needed to have experienced suicidal ideation in the last six months. Participants with a history of suicidal ideation were recruited so that it was likely the sample would include people who – to at least some limited degree – had some risk of suicide. If the sample did not include individuals at some risk of suicide, the data collected would not accurately encapsulate the dynamic relationship between suicidal ideation and risk factors for suicide. Other eligibility criteria included owning an internet-capable smartphone and being interested in participating in the main study after reading a short description of it.

Currently there is no consensus on how to calculate the sample size required for a temporal network analysis. This makes sample size estimation and power analyses for temporal network analysis somewhat subjective. As per the preregistration, the target sample size for this study was 75 to 85 participants. This number was determined based on similar research and the results of a multi-level power analysis.

A target sample size of 75 to 85 participants was comparable to temporal network studies with a similar number of nodes to the present study (i.e., 11). For example, Greene et al. (2020) had 14 nodes in their temporal network and a sample size of 96 participants, and Levinson et al. (2018) had 10 nodes and 66 participants. With a total number of 50 surveys per participant, a

sample of 75 participants could have resulted in up to 3750 survey responses. Ecological momentary assessment studies of suicide risk similar to this study report survey completion rates around 73.8% (Husky et al., 2014) to 89.7% (Hallensleben et al., 2019). If this research had a completion rate of 70%, a sample of 75 participants would result in 2625 responses, which is a considerable amount of data. It was important to recruit a sample of participants for this study that would result in the collection of a large amount of data because network analysis estimates numerous associations, and the general consensus among network researchers is that parameter selection and estimation is more reliable with higher numbers of observations (Epskamp, Borsboom, et al., 2018).

As well as consulting previous temporal network literature to determine the sample size of the present study, I used Kleiman's (2017) *EMAtools* package in R (R Core Team, 2021) to estimate a multi-level power curve based on a sample size of 75 participants, with 5 surveys per day for a total of 10 days. The results of the power curve suggested there would be adequate power to detect large effects at a 75% completion rate, similar to previous suicide ecological momentary assessment research (Hallensleben et al., 2019). Though having enough power to detect small effects would be the ideal scenario, the multi-level power curve estimated that the participants would have to complete approximately 500 surveys *each* for this to be the case. This was deemed unethical and unfeasible for this study, given the high level of burden it would place on participants.

Recruitment

As this study had more complex participation requirements than single-survey research participation and had multiple participant eligibility criteria, a screening survey was distributed

in order to recruit participants who met the main study eligibility criteria. Advertising for the screening survey began on 24th March 2021 and ended on 27th March 2021, once reaching the stop rule of 150 eligible participants having responded to the survey. Both paid and organic advertising were used to recruit participants. Paid advertising was used to maximise the number of people who completed the screening survey. The paid advertisement (see Appendix A) was shared on Facebook using a page I purposely created for this study, called Research About Suicide Risk in New Zealand. The advertisement target audience was people aged over 18 who lived in New Zealand and had an interest in psychology, such that it was only shown to people who matched this criteria. A total of NZD168.75 was spent on paid advertising over a period of three days, resulting in 863 survey link clicks. The organic advertisement (see Appendix B) was shared on the Research About Suicide Risk in New Zealand page as a post. It was then shared to Facebook groups related to mental health in New Zealand to increase the likelihood of recruiting participants who had some experience of suicidal ideation, which as specified earlier was one of the inclusion criteria for the main study.

Both paid and organic advertisements asked people to participate in a screening survey to see if they were eligible to participate in a study about risk factors for suicide. A link was included in the advertisements, directing people to a brief information sheet hosted on Qualtrics (see Appendix C). This information sheet included details about what participation in the screening survey would involve. For participating in the screening survey, all participants who lived in New Zealand and entered their email address were entered into a prize draw to win one of five NZD20 Gift Pay e-vouchers. These e-vouchers could be redeemed at local shops such as Farmers, Mitre 10, and Whitcoulls.

The screening survey asked individuals to provide information about themselves including their age bracket, the country they live in, whether they had experienced suicidal ideation in the previous six months, and if they had a personal smartphone with internet access between the hours of 8am and 8pm. Participants were then asked to read a brief description of the main study and signal whether they would be interested in participating or not. At the end of the screening survey individuals were asked to provide their email address so they could be entered into the prize draw and could be contacted if eligible to participate in the main study. The exact questions used in the screening survey are in Appendix D.

At this point, contact information for all eligible participants was added to a contact list in Qualtrics. Here I allocated a unique ID number to each participant, which was embedded in the main study survey later on. Allocating ID numbers ensured participant anonymity as the identifiable contact information that was collected (i.e., participant emails) was not included in the dataset that would be shared on the Open Science Framework. It also ensured the survey responses of each participant could still be linked together.

In total, 314 people completed the screening survey to determine their eligibility to participate. Based on their responses to the screening survey, 150 people were eligible to participate, meeting the inclusion criteria of being over 18, living in New Zealand, having experienced suicidal ideation in the last six months, owning an internet-capable smartphone, and being interested in participating in the main study.

Of the 150 people who were eligible to participate, one entered an incomplete email address. Only the 149 eligible participants who provided a complete email address were included in the selection of a random sample of participants for the main study. As per the preregistration,

on 28th March 2021, the day following the screening survey closure, I contacted a random sample of 85 eligible participants via email to invite them to participate in the main study. The random sample was selected using a random number generator which I matched to participant ID numbers. The email sent to eligible participants is included in Appendix E. It stated that the individual's responses to the screening survey indicated that they were eligible to participate in the main study. The individual was invited to take part in the study and provided a link to a detailed information sheet hosted on Qualtrics (see Appendix F). This information sheet described what participation in the main study would involve. At the end of the information sheet, individuals were asked whether they consented to participate in this study. They were told both in the email they received and in the information sheet that they had one week to decide whether they consented to participate or not. This time limit was set in part to ensure that I had time to recruit an adequate sample size.

After one week, of the 85 eligible participants I invited to participate in the main study, 49 had consented to participate. As per the preregistration, a second random sample of 36 of the eligible participants were then contacted in an attempt to reach the planned sample size of 75 to 85 participants. They too were given one week to decide whether to consent to participate or not, after which time an additional 19 people had consented to participate. This resulted in a total sample size of 68 participants. Although this was a lower number than the target sample size of 75 participants, the preregistration for this study specified that data collection would begin after two rounds of invitation emails, regardless of the sample size. This ensured timely completion of data collection, which was important within the confines of the timeline for a clinical psychology doctoral thesis.

After consenting to participate in the main study, participants were immediately asked to provide responses to questions about their demographics. These questions asked participants for their age (in years), gender, and ethnicity.

Main Study Participation

All participants began completing surveys for the main study on the same date, beginning on Tuesday 13th April 2021 and ending on Thursday 22nd April 2021. Using Qualtrics, I sent participants email notifications containing a link to the survey (see Appendix G). These notifications were sent to participants at 8am, 11am, 2pm, 5pm, and 8pm each day for a total of ten days. Participants had 90 minutes to click the survey link before it expired. Once they clicked the link, they had 60 minutes to complete the survey before it automatically recorded their response. The survey can be viewed in Appendix H. I anticipated that the survey would only take participants approximately one minute to complete due to it including just 11 short quantitative items. Giving participants a period of 90 minutes to click the survey link and then 60 minutes to complete the survey once started made it more likely they would be able to complete the survey around other daily commitments. The median time it took participants to fill in the surveys once they clicked the link was 33 seconds, and the mean completion time was 55.86 seconds. Every email notification for the surveys included an opt-out link in case participants were unable to continue participating for any reason. Of the 68 people who consented to participate, 63 completed at least one of the 50 surveys they were sent.

Figure 11

Timeline of Procedure for Recruitment, Screening, and Main Study Participation

The main study information sheet specified that all participants who completed at least 35 of the 50 surveys were eligible to receive a NZD35 Gift Pay e-voucher as compensation for the disruption this study may have caused. I matched each participant's ID number to their email address using the contact list in Qualtrics, separate to the collected data, such that the data file for the main study remained deidentified. I was then able to send 24 eligible participants the Gift Pay e-vouchers via email. This was done on 11th May 2021. A summary of findings was later sent to participants on 12th February 2023 (see Appendix I).

Sample Size

In total, 1637 surveys were completed by the participants. For the 63 participants who completed at least one survey, the compliance rate (i.e., percentage of surveys that were completed overall) was 51.97%. On average, participants completed 25.98 of the 50 surveys, with the number of completed surveys per participant ranging from 1 to 50.

Of the 63 people who took part in data collection, 24 were excluded from the data analysis due to not completing the minimum number of surveys. The exclusion criteria detailed in the preregistration specified that to be included in the analyses, participants must provide responses to at least 20 of the 50 surveys. This exclusion criteria was set because the mlVAR package (Epskamp et al., 2019) in R (R Core Team, 2021) that was used for the network analyses gives a warning when there are less than 20 data points for an individual, stating that if there are less than 20 responses per participant the network may produce biased estimates. After applying this exclusion criteria, 39 participants remained to be included in the analyses, with a total of 1420 surveys to be analysed.

Participant Demographics

Table 3 summarises the demographic information of participants whose responses were included in the statistical analyses. Participant age ranged from 19 to 66 years, with an average age of 41.2 years. One participant did not provide their age in the main study demographics survey, but in the initial screening survey they signalled that they were in the 25 to 34 year old age bracket. The majority of participants identified as Pākehā, while 3 participants identified as Māori and 1 as Pacific Islander.

Table 3

Participant Demographic Information

	Frequency
Gender	
Male	5
Female	32
Gender diverse	2
Ethnicity	
Pākehā/New Zealand European	31
Māori	3
Pacific Islander	1
Asian	0
Other	4

Measures

Thus far no known measures have been designed and validated specifically for use in both ecological momentary assessments and temporal network analyses (Levinson et al., 2018). Ideally previously validated measures would be used. However, for this study simply adapting existing measures from cross-sectional studies was not practical, as such studies often use many items to measure a single construct, and the present study needed to use single-item measures in order to collect data many times with minimal burden to participants. As such, the survey was specifically designed for the purpose of this research.

Another reason for purposely creating the survey for this study was that being able to distribute the survey openly online following the study completion was considered a priority. Existing measures often have limited permissions which specify that the measure cannot be shared outside of the research team and participant group. If such existing measures were used in this study, the survey would likely not have been allowed to be shared on the Open Science Framework. I planned to upload to the Open Science Framework all of the resources used to conduct the study once it was completed, including the survey items, because sharing research materials openly increases research transparency and reproducibility (Tackett et al., 2019). Other researchers are free to test the validity and reliability of items or to replicate the study using the resources shared online if they wish. This was important to me when designing the study, and as creating or adapting the survey items enabled me to uphold these Open Science practices, this was the option I chose to pursue.

The survey contained 11 items, each of which corresponded to one of the 11 variables of interest. Each survey item and the variable it corresponded to is listed in Table 4. Participants

were instructed to respond to the items based on what they were experiencing and feeling at the time of taking the survey. The response scale for all items ranged from 1 *not at all* to 5 *extremely*.

Table 4

Variables and Corresponding Survey Items

Variable	Survey Item
Suicidal ideation	At the moment I am thinking about taking my own life
Depressed mood	At the moment I feel depressed
Fatigue	At the moment I feel tired
Anhedonia	At the moment I feel like nothing I am doing is enjoyable or pleasurable
Worthlessness	At the moment I feel worthless
Hopelessness	At the moment I feel hopeless
Perceived burdensomeness	At the moment I feel like a burden to others
Thwarted belongingness	At the moment I feel like I don't belong
Self-esteem	At the moment I feel good about myself
Social support	At the moment I feel supported by the people around me
Alcohol intoxication	At the moment I feel drunk

The items measuring depressed mood, hopelessness, self-esteem, and suicidal ideation were adapted from the items used to measure each of these variables in the cross-sectional network analysis by Holman and Williams (2022). The items were modified to measure participants' momentary experience for this study.

Other items, such as those measuring perceived burdensomeness and thwarted belongingness were adapted from items used in previous ecological momentary assessment studies by Forkmann et al. (2018) and Hallensleben et al. (2019). In the original studies, multiple items were used to measure perceived burdensomeness and thwarted belongingness. However, in order to cause the least time burden to participants, the number of survey items needed to be kept to a minimum in this study, and the survey items themselves needed to be as brief as possible. Thus, a single item was used to measure each risk factor in this study. The items used to measure perceived burdensomeness and thwarted belongingness in the current study were selected based on content validity, with the chosen item deemed to best measure the variable of interest.

The items measuring fatigue, anhedonia, worthlessness, social support, and alcohol intoxication were created for the purpose of this research and were not adapted from previous studies or existing validated measures. These survey items were reviewed by my supervision team and refined multiple times. During this process, I referred to definitions in current literature and reviewed items that had been used in previous studies that were openly accessible online. In keeping with the brevity and simplicity of the other survey items, the items I created were concise. Brevity was a priority when designing these survey items, because ensuring the survey was concise overall made it more likely participants would complete the surveys. By adapting and creating items for the study, rather than using lengthy existing measures comprised of dozens of items each, the survey was able to be kept brief, thus causing minimal time burden to participants.

Data Analysis

All statistical analyses were completed using R version 4.0.4 (R Core Team, 2021), with the packages *psych* (version 2.1.9; Revelle, 2019), *plyr* (version 1.8.6; Wickham, 2011), *mlVAR* (version 0.4.4; Epskamp et al., 2019), *qgraph* (version 1.9; Epskamp et al., 2012), and *readxl* (version 1.3.1; Wickham & Bryan, 2019). The analysis script used to conduct the analyses has been made available on the Open Science Framework at https://osf.io/rzqm9. Both the preregistered analysis script and a final analysis script including additional exploratory analyses can be accessed there.

Descriptive Statistics

Research questions 1 and 2 were concerned with finding out the degree to which suicidal ideation and the ten risk factors for suicide fluctuated from measurement to measurement. These two research questions were addressed by computing the root mean square successive difference (RMSSD) for each variable. RMSSD is a measure of an item's variability over time, with a larger value reflecting more variability from measurement to measurement (E. M. Kleiman et al., 2017). RMSSD in this study could range between 0 and 4 for each variable. RMSSD is calculated using successive differences. This is the difference between two measurements, calculated by subtracting one measurement from the next one. For example, if a participant rated their suicidal as a 2 at one time point and a 4 at the next, the successive difference between these variables would be 2. With the rating scale for all variables ranging from 1 to 5, the largest possible successive difference was 4, and the smallest was zero (no change between measurements). The successive differences are each squared before averaging them and then calculating the root square of this number (Jenkins et al., 2020).

Network Analysis

All seven preregistered hypotheses were tested by conducting a network analysis. Using R (R Core Team, 2021), the *mlVAR* package (Epskamp et al., 2019) was used to estimate temporal, contemporaneous, and between-persons networks.

To address the assumption of stationarity for temporal data, each of the 11 variables were detrended to remove linear effects. The detrended variables were included in these network analyses, rather than the original variables. This increases our confidence that an edge in the temporal network may be due to a causal effect, rather than occurring as a result of unmodelled nonstationarity (Epskamp, van Borkulo, et al., 2018). The temporal network had a specified lag of 1. In all networks, alpha was set to 0.05. Edges which did not meet this significance level were hidden such that they do not appear in the networks. *Dayvar* and *Beepvar* were both specified in the analysis code (see Epskamp et al., 2019 for more information), such that the first survey of each day was not regressed on the last survey of the previous day, given this was a longer lag interval than that between each survey within a day (12 hours overnight versus 3 hours between surveys during the day). This also occurred in circumstances where a participant completely missed one or more survey responses in a row – the next completed survey was not regressed on the last completed survey, again due to the differing lag interval.

Inference Criteria

Hypotheses 1 to 4 were examined using the temporal network, hypothesis 5 using the contemporaneous network, and hypotheses 6 and 7 using the between-persons network. The seven hypotheses are outlined again below alongside the preregistered inference criteria that was used to determine if they were supported.

H1. In the temporal network, depressed mood will be positively associated with suicidal ideation at the subsequent time point.

If there is a statistically significant and positive (blue) edge between the depressed mood and suicidal ideation nodes in the temporal network, with an arrowhead pointing from the depressed mood node to the suicidal ideation node, then H1 will be supported.

H2. In the temporal network, perceived burdensomeness will be positively associated with suicidal ideation at the subsequent time point.

If there is a statistically significant and positive (blue) edge between the perceived burdensomeness and suicidal ideation nodes in the temporal network, with an arrowhead pointing from the perceived burdensomeness node to the suicidal ideation node, then H2 will be supported.

H3. In the temporal network, thwarted belongingness will be positively associated with suicidal ideation at the subsequent time point.

If there is a statistically significant and positive (blue) edge between the thwarted belongingness and suicidal ideation nodes in the temporal network, with an arrowhead pointing from the thwarted belongingness node to the suicidal ideation node, then H3 will be supported.

H4. In the temporal network, hopelessness will be positively associated with suicidal ideation at the subsequent time point.

If there is a statistically significant and positive (blue) edge between the hopelessness and suicidal ideation nodes in the temporal network, with an arrowhead pointing from the hopelessness node to the suicidal ideation node, then H4 will be supported.

H5. In the contemporaneous network, hopelessness will be positively associated with suicidal ideation.

If there is a statistically significant and positive (blue) edge between the hopelessness and suicidal ideation nodes in the contemporaneous network, then H5 will be supported.

H6. In the between-persons network, hopelessness will be positively associated with suicidal ideation.

If there is a statistically significant and positive (blue) edge between the hopelessness and suicidal ideation nodes in the between-persons network, then H6 will be supported.

H7. In the between-persons network, self-esteem will be negatively associated with suicidal ideation.

If there is a statistically significant and negative (red) edge between the self-esteem and suicidal ideation nodes in the between-persons network, then H7 will be supported.

Research question 3 was also addressed using the temporal, contemporaneous, and between-persons networks. Research question 3 asked which nodes had a direct association with suicidal ideation in each network. To address this research question, in each network I looked at which nodes had a statistically significant association with suicidal ideation, irrespective of the direction of the association (positive or negative).

Centrality Analyses

Research question 4 was concerned with finding out which nodes had the highest strength centrality. Strength centrality is a summation of the strength of the associations that a node has with other nodes (Epskamp, Maris, et al., 2018). In the temporal network, strength centrality is

split into in-strength and out-strength centrality, with in-strength referring to the summed strength of associations directed towards a particular node, and out-strength referring to the summed strength of associations directed away from a particular node (Jones et al., 2021). Research question 4 was addressed by computing the strength centrality of each node in the three networks (temporal, contemporaneous, and between-persons) using the *qgraph* package (Epskamp et al., 2012).

Exploratory N=1 Network Analyses

To explore the utility of individualised temporal and contemporaneous networks, N=1 network analyses were completed. These analyses were completed primarily to illustrate the information that can be drawn from N=1 networks, rather than to make substantive inferences about individual participants. The N=1 network analyses were not preregistered.

Using R (R Core Team, 2021), the *graphicalVAR* (version 0.2.4; Epskamp, 2020) package was used to estimate the temporal and contemporaneous networks for five individual participants, and *qgraph* (version 1.9; Epskamp et al., 2012) package was used to plot the networks. The data used to estimate the N=1 networks was not detrended. Again, the temporal network had a specified lag of 1, and *Dayvar* and *Beepvar* were specified (refer to Network Analysis section above). The five N=1 network analyses reported in this study were the only ones that were able to be computed, with the remaining 34 participants' N=1 networks resulting in error messages in R (R Core Team, 2021) that could not be overcome.

Data Sharing Policy

The data used for this research has been anonymised before being made available on the Open Science Framework. This can be accessed at https://osf.io/jxbhm, along with the

preregistration, the R script that was used to complete the statistical analyses, the survey items, and a data dictionary. The data sharing policy of this research aligns with the open data guidelines stipulated in Massey University's revised Code of Ethical Conduct for Research, Teaching and Evaluation Involving Human Participants (2017).

Ethical Considerations

Approval for this study (Application NOR 20/44) was given by the Massey University Human Ethics Committee: Northern.

When designing this study, the primary ethical consideration that arose was the potential for the survey to precipitate distress and suicidality. However, research suggests it is unlikely for participants to have increased thoughts of suicide as a result of being asked about suicidal ideation multiple times each day. Husky et al. (2014) repeatedly asked participants with a history of suicidal ideation or behaviour about their thoughts of suicide, and found no significant association between suicidal ideation and duration of the study. This is consistent with the findings of other research that suggests asking people about their thoughts of suicide does not increase the occurrence of such thoughts, even when asked repeatedly (Blades et al., 2018; Coppersmith et al., 2022; Dazzi et al., 2014; Law et al., 2015). Although we considered it unlikely that asking participants one survey item about thoughts of suicide five times a day would increase their thoughts of suicide, it was *plausible* this could occur. To mitigate this possibility, support services were listed at the end of every survey, with additional messages at the end of surveys where participants had signalled extremely low mood or strong thoughts of suicide. Participants were also given the option to discontinue participation at any point, with an opt-out link included in every survey notification email.

The second ethical consideration for this study related to the principle of justice, in particular the fair distribution of rewards and burdens. In ecological momentary assessment research, numerous factors impact participant burden, including the number of items included in each assessment, the frequency of assessments, the complexity of assessments, and the duration of the data collection period (Hufford, 2007). If participants were to feel burdened by the survey assessments, they might complete fewer assessments, resulting in reduced data quantity, and potentially reduced data quality too. Research by Eisele and colleagues (Eisele et al., 2022) found longer questionnaires to be associated with significantly higher levels of momentary participant burden and poorer compliance than shorter questionnaires. To mitigate this, I tried to keep time burden to a minimum by purposely designing the survey to be very brief, such that it would only take participants about a minute to complete. This research also involved fewer surveys per day than recent ecological momentary assessment studies of suicide such as Hallensleben et al. (2019; ten surveys per day), and it had a relatively small data collection period compared to others such as Kleiman et al. (2017; data collected for 28 days). If participants were burdened by completing multiple surveys per day we would expect to see a drop in the number of completed surveys as the study progresses. This scenario was not demonstrated in the present study, nor has it been the case in similar ecological momentary assessment research involving individuals with a history of suicidal ideation and behaviour, with participants instead providing *fewer* missing responses further into data collection (Husky et al., 2014). This suggests asking participants to complete five surveys per day is *unlikely* to result in excessive burden. To ensure participants received a fair reward for the time they gave to this research, each participant in the main study received a NZD35 Gift Pay e-voucher if they answered at least 35 surveys. With participants completing an average of 26 surveys, each of

which took an average of 56 seconds to complete, participants were therefore paid NZD35 for about 24 minutes of their time – equivalent to a rate of NZD87.5 per hour.

I also considered research ethics relating to culture. I reviewed Te Ara Tika Guidelines for Māori Research Ethics (Pūtaiora Writing Group, 2010) and engaged in cultural consultation prior to seeking ethical approval for this study. Suggested actions arising from the consultation were to include Te Reo in the advertisement and information sheets to increase the participation of individuals who identify as Māori, and to report ethnicity data with the guidance of cultural consultation from my co-supervisor Dr Matthew Shepherd to ensure the protection of Māori. In this study, the reporting of ethnicity data is limited to describing the number of participants who identify as Māori, Pākehā, Asian, Pacific Islander or another ethnicity. It is well-known that Māori die by suicide at a higher rate than non-Māori (Coronial Services of New Zealand, 2020), though the exact reasons for this are unclear. Unfortunately, this study was underpowered to explore why this might be, and thus no analyses were conducted to compare the risk factors for suicide for Māori versus non-Māori.

For further information about my ethical consultation process and steps taken to mitigate risk, see Appendix J.

Chapter Six: Results

Descriptive Statistics

Descriptive statistics for the ten suicide risk factors and suicidal ideation are presented in Table 5 below. The responses for each survey item were 1 *not at all*, 2 *a little bit*, 3 *a moderate amount*, 4 *a lot*, and 5 *extremely*. On average, participants reported experiencing suicidal ideation only a small quantity (M = 1.58, SD = 0.84). Of the 1420 survey responses, 61.2% were rated as not experiencing any suicidal ideation, while 22.2% reported experiencing suicidal ideation *a little bit*, 13.9% *a moderate amount*, 2.5% *a lot*, and 0.2% *extremely*. Eight participants did not experience any suicidal ideation during the study, and for 13 participants, the highest momentary suicidal ideation rating given was 2, *a little bit*. Just seven participants rated experiencing suicidal ideation *a lot* or *extremely* at some point in the study.

Some level of fatigue was reported by participants in 92.5% of all surveys, with participants on average experiencing fatigue *a moderate amount* (M = 3.20, SD = 1.18). Alcohol intoxication was a very low frequency experience, with just 31 of the 1420 survey responses (2.2%) signalling some alcohol intoxication. On average, participants felt good about themselves very little (M = 1.91, SD = 0.98), with nearly 41% of survey responses signalling the participant did not feel good about themselves at all. Symptoms of depression including depressed mood, anhedonia, and worthlessness were on average experienced *a little bit* (M = 2.29, 2.43, and 2.35 respectively), as were the risk factors hopelessness, perceived burdensomeness, thwarted belongingness, and social support (M = 2.46, 2.63, 2.69, and 2.28 respectively; see Table 5).

Table 5

Descriptive Statistics

Variable	*M*	*SD*	Mean RMSSD	Min RMSSD	Max RMSSD
Suicidal ideation	1.58	0.84	0.37	0.00	1.01
Depressed mood	2.29	0.98	0.64	0.28	1.07
Fatigue	3.20	1.18	0.87	0.00	1.44
Anhedonia	2.43	1.02	0.72	0.00	1.24
Worthlessness	2.35	1.08	0.60	0.00	1.04
Hopelessness	2.46	1.13	0.68	0.00	1.31
Perceived burdensomeness	2.63	1.21	0.69	0.00	1.24
Thwarted belongingness	2.69	1.16	0.76	0.00	1.38
Self-esteem	1.91	0.98	0.61	0.00	1.73
Social support	2.28	1.02	0.59	0.00	1.07
Alcohol intoxication	1.03	0.27	0.10	0.00	1.07

Note. M = mean, SD = standard deviation, Mean RMSSD = mean root mean square successive difference, Min RMSSD = minimum root mean square successive difference, and Max RMSSD = maximum root mean square successive difference. M and SD are averaged across all time points and participants and RMSSD is aggregated across participants.

Figure 12

Graph of Each Participant's Raw Suicidal Ideation Scores Over Time

Note. For suicidal ideation, 1 = not at all, 2 = a little bit, 3 = moderate, 4 = a lot, 5 = extremely. Time represents each survey.

RQ1. To what degree does suicidal ideation fluctuate from measurement to measurement?

Suicidal ideation varied a small amount over time. The item measuring suicidal ideation had an average RMSSD of 0.37, and an RMSSD range of 0.00 to 1.01. Higher RMSSD values reflect higher levels of variability, with a possible range of 0 to 4 for each variable in this study. With the minimum RMSSD for suicidal ideation being 0, in some cases a participant's experience of suicidal ideation remained the same from measurement to measurement, such that there was no variability over time. In other cases, the level of suicidal ideation a participant experienced fluctuated more, as shown by the highest RMSSD of 1.01. These fluctuations are evidenced in Figure 13 below, which shows how each participant's suicidal ideation changed over time.

RQ2. To what degree do risk factors for suicide fluctuate from measurement to measurement?

All ten risk factors for suicide measured in this study showed some variability over time, as shown by the RMSSD values in Table 5. Fatigue showed the highest average variability, followed by thwarted belongingness, anhedonia, perceived burdensomeness, and hopelessness. Alcohol intoxication had the lowest mean RMSSD value at 0.10. However, the RMSSD for alcohol intoxication ranged from 0.00 to 1.07, suggesting that alcohol intoxication did vary across measurements some of the time. Depressed mood was the only risk factor with a minimum RMSSD above 0.00 (minimum RMSSD = 0.28), suggesting that all participants showed some variation in depressed mood over the course of the study.

Network Estimation

In the *mlVAR* package (Epskamp et al., 2019), the position of the nodes in the network reflects the strength of the edges, such that nodes which are positioned closer to one another depict stronger associations. Edge thickness also varies, with a thick edge representing a strong association between a pair of nodes and a thin edge representing a weaker association. The colour of the edges in each network reflect the direction of the association between two nodes. A blue edge represents a positive association, and a red edge represents a negative association. Additionally, the temporal network has directed edges (edges with an arrowhead) to show the direction of the temporal relationship. The temporal network of risk factors for suicide is depicted in Figure 13, contemporaneous network in Figure 14, and between-persons network in Figure 15.

Temporal Network

The temporal network of risk factors for suicide is depicted in Figure 13. This network shows associations between nodes over time.

H1. In the temporal network, depressed mood will be positively associated with suicidal ideation at the subsequent time point.

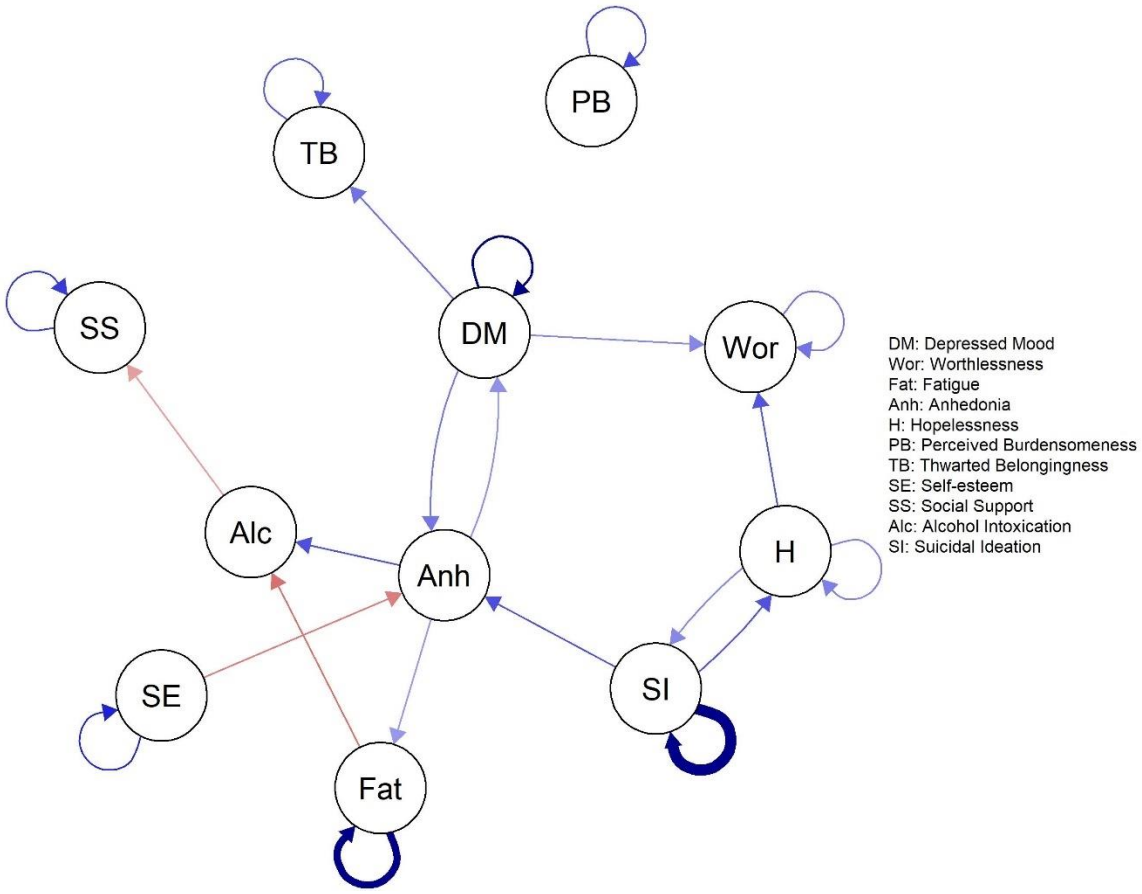
Hypothesis 1 was not supported. Depressed mood did not have a statistically significant positive association with suicidal ideation at the subsequent time point in the temporal network. Because the relationship was not statistically significant, in Figure 13, there is not an edge between the depressed mood and suicidal ideation nodes. Table K1 in Appendix K shows that the relationship between these two nodes was positive and very small (fixed effects coefficient = .014, p = .661).

H2. In the temporal network, perceived burdensomeness will be positively associated with suicidal ideation at the subsequent time point.

Hypothesis 2 was not supported. Perceived burdensomeness did not have a statistically significant positive association with suicidal ideation at the subsequent time point in the temporal network. Because the relationship was not statistically significant, in Figure 13 there is not an edge between the perceived burdensomeness and suicidal ideation nodes. The relationship between these two nodes was negative and very small (fixed effects coefficient = -.012, p = .745).

Figure 13

The Temporal Network of Risk Factors for Suicide



H3. In the temporal network, thwarted belongingness will be positively associated with suicidal ideation at the subsequent time point.

Hypothesis 3 was not supported. Thwarted belongingness did not have a statistically significant positive association with suicidal ideation at the subsequent time point in the temporal network (fixed effects coefficient = -.002, p = .941). Because the relationship was not statistically significant, in Figure 13 there is not an edge between the thwarted belongingness and suicidal ideation nodes.

H4. In the temporal network, hopelessness will be positively associated with suicidal ideation at the subsequent time point.

Hypothesis 4 was supported. As the relationship between hopelessness and suicidal ideation was statistically significant and positive, in Figure 13 there is a blue edge between these nodes, with an arrowhead pointing from hopelessness to suicidal ideation. This suggests that a high level of hopelessness at one time point was associated with a higher levels of suicidal ideation at the subsequent time point in the temporal network. The effect size was small (fixed effects coefficient = .093, p = .012).

RQ3. What nodes are directly associated with increased suicidal ideation in the temporal network?

In the temporal network, hopelessness was the only node that had an edge with an arrowhead pointing towards suicidal ideation. As above, the positive association between these nodes suggests that a high level of hopelessness at one time point was associated with a higher levels of suicidal ideation at the subsequent time point in the temporal network.

Other Associations

In the temporal network, the strongest positive cross-lagged effect was from suicidal ideation to anhedonia (fixed effects coefficient = .138, p = .043), suggesting that higher levels of suicidal ideation at one time point were predictive of increased anhedonia at the subsequent time point. A positive cross-lagged effect of the same strength was present between anhedonia and alcohol intoxication (.138, p = .026), such that higher levels of anhedonia at one time point was associated with an increase in alcohol intoxication at the subsequent time point. Other positive associations were present pointing from suicidal ideation to hopelessness (.135, p = .01), hopelessness to worthlessness (.134, p = .001), and depressed mood to thwarted belongingness (0.11, p = .025). Symptoms of depression including depressed mood, anhedonia, worthlessness, and fatigue were also predictive of one another over time. For example, depressed mood predicted increased anhedonia (0.108, p = .029) and worthlessness (.095, p = .01), and anhedonia predicted increased depressed mood (.086, p = .029) and fatigue (.081, p = .036) at the subsequent time point.

The strongest negative edge was depicted pointing from fatigue to alcohol intoxication (-.113, p = .035). This suggests that feeling tired at one time point was associated with a decrease in alcohol intoxication at the subsequent time point. A similar strength negative edge was present from self-esteem to anhedonia (-.101, p = .036), suggesting that higher levels of self-esteem at one time point were associated with lower levels of anhedonia at the subsequent time.

Perceived burdensomeness had no associations with other nodes in the network. It was only predicted by itself at the previous time point, as shown by the autoregression on the perceived burdensomeness node (.146, p = .012). All other nodes had an autoregression, except

for alcohol intoxication and anhedonia. The suicidal ideation node had the strongest positive autoregression (.274, $p < .001$), suggesting that suicidal ideation at one time point was predictive of increased suicidal ideation at the subsequent time point. The fatigue and depressed mood nodes also had positive autoregressions (.243, $p < .001$, and .208, $p < .001$ respectively). This suggests that fatigue and depressed mood at one time were each predictive of an increase in these nodes at the subsequent time point. Table K1 in Appendix K lists the strength and significance of all possible associations in the temporal network.

Contemporaneous Network

The contemporaneous network of risk factors for suicide is depicted in Figure 14. This network show associations between nodes within the same measurement.

H5. In the contemporaneous network, hopelessness will be positively associated with suicidal ideation.

Hypothesis 5 was not supported. Hopelessness did not have a statistically significant positive association with suicidal ideation in the contemporaneous network, as depicted in Figure 14 where there is not an edge between these two nodes (partial correlation, hereafter $r_p = .08$, $p = .082$).

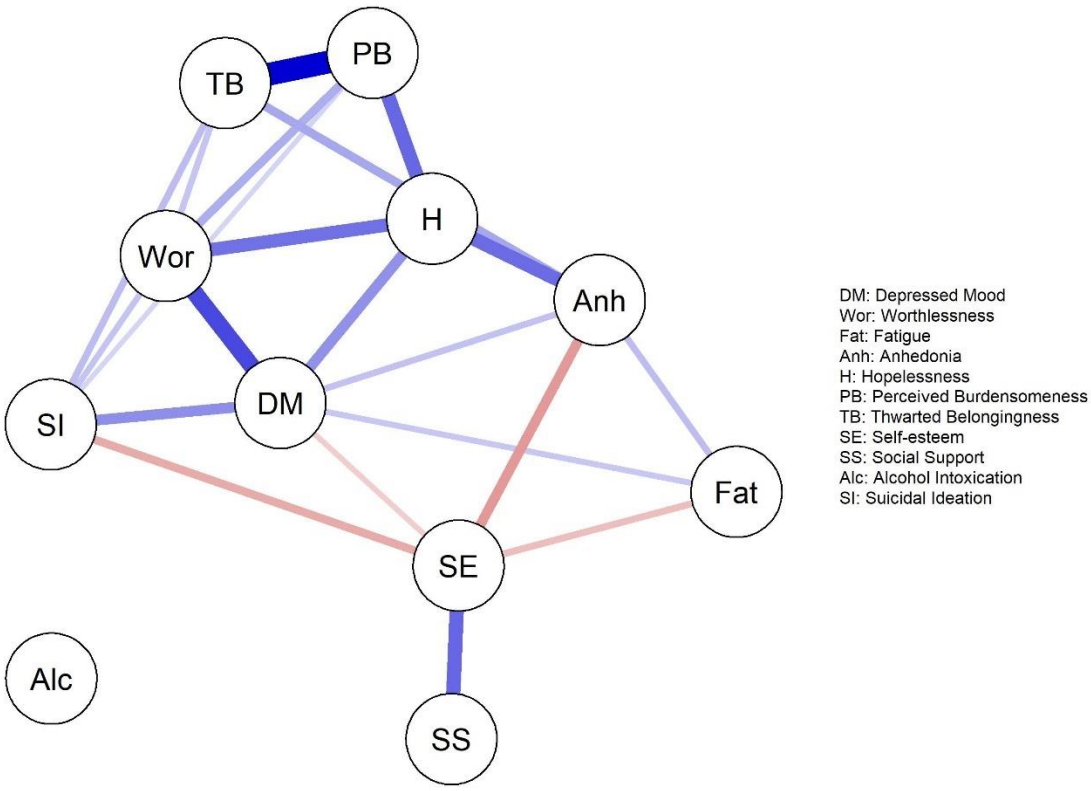
RQ3. What nodes are directly associated with increased suicidal ideation in each network (temporal, contemporaneous, and between-persons)?

The contemporaneous network had a greater number of direct, positive associations between suicide risk factors and suicidal ideation than the temporal network had. The node with the strongest positive edge connected to suicidal ideation was depressed mood ($r_p = .163$, $p =$

.001), followed by thwarted belongingness (r_p = .095, p = .002), worthlessness (r_p = .085, p = .035), and perceived burdensomeness (r_p = .06, p = .03). This suggests that within a single measurement, higher levels of each of these risk factors was associated with higher levels of suicidal ideation. Self-esteem was also directly associated with suicidal ideation in this network. The edge between these two nodes was red, suggesting that within one measurement, lower levels of self-esteem were associated with higher levels of suicidal ideation (r_p = -.122, p < .001).

Figure 14

The Contemporaneous Network of Risk Factors for Suicide



Other Associations

In the contemporaneous network, the strongest positive association was between the thwarted belongingness and perceived burdensomeness nodes (r_p = 0.368, p < .001). There were many other positive associations in this network, such as between social support and self-esteem (r_p = .221, p < .001), perceived burdensomeness and hopelessness (r_p = .219, p < .001), and hopelessness and anhedonia (r_p = .212, p < .001).

Some of the symptoms of depression had positive associations with one another too. For example, positive associations were present between worthlessness and depressed mood (r_p = .263, p < .001), anhedonia and fatigue (r_p = .093, p = .009), anhedonia and depressed mood (r_p = .088, p = .011), and fatigue and depressed mood (r_p = .08, p = .016).

There were a small number of negative associations between self-esteem and anhedonia (r_p = -.147, p < .001), fatigue (r_p = -.094, p = .011), and depressed mood (r_p = -.07, p = .032). This finding suggests that higher levels of self-esteem were associated with lower levels of these variables within the same time point.

Alcohol intoxication was the only node that had no statistically significant associations with other nodes in the contemporaneous network. Table K2 in Appendix K lists the strength and significance of all possible associations in the contemporaneous network.

Between-Persons Network

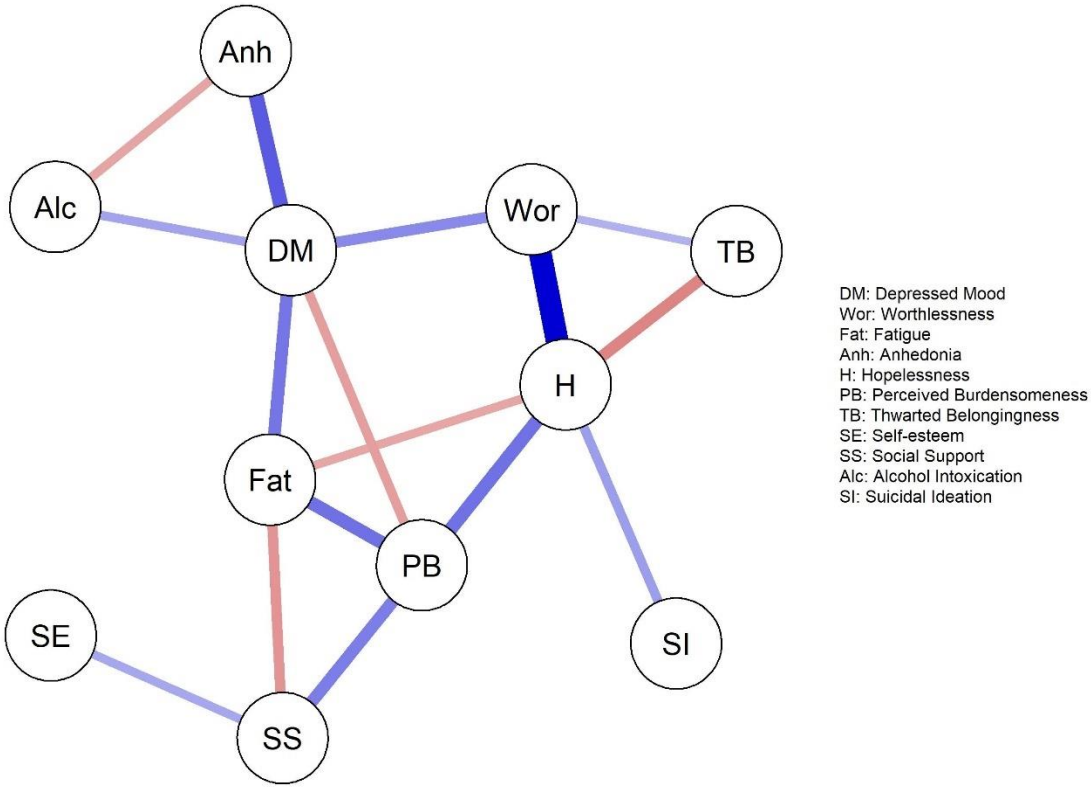
The between-persons network of risk factors for suicide is depicted in Figure 15. This network displays the relationships between mean levels of each node across individuals.

H6. In the between-persons network, hopelessness will be positively associated with suicidal ideation.

Hypothesis 6 was supported. In Figure 15, there is a blue edge present between the hopelessness and suicidal ideation nodes suggesting that, on average, individuals who experienced higher levels of hopelessness tended to experience higher levels of suicidal ideation. The effect size was small (r_p = .27, p = .011).

Figure 15

The Between-Persons Network of Risk Factors for Suicide



H7. In the between-persons network, self-esteem will be negatively associated with suicidal ideation.

Hypothesis 7 was not supported. Self-esteem did not have a statistically significant negative association with suicidal ideation in the between-persons network (r_p = .068, p = .38). As such, there is not an edge between the self-esteem and suicidal ideation nodes in Figure 15.

RQ3. What nodes are directly associated with increased suicidal ideation in each network (temporal, contemporaneous, and between-persons)?

In the between-persons network, hopelessness was the only node to be directly associated with suicidal ideation. As above, the positive association between these two nodes in the between-persons network suggests that on average participants who express higher levels of hopelessness also tend to also express high levels of suicidal ideation.

Other Associations

All nodes in the between-persons network were connected to at least one other node. In this network, the strongest positive association was between hopelessness and worthlessness (r_p = .71, p < .001). Positive partial correlations were also seen between perceived burdensomeness and fatigue (r_p = .398, p < .001), hopelessness (r_p = .397, p = .001), and social support (r_p = .359, p < .001). Similar associations were present between symptoms of depression, including anhedonia and depressed mood (r_p = .459, p < .001), fatigue and depressed mood (r_p = .381, p < .001), and worthlessness and depressed mood (r_p = .325, p = .021).

A number of negative partial correlations were also estimated in the between-persons network. These negative associations were present between the nodes thwarted belongingness

and hopelessness (r_p = -.34, p = .002), social support and fatigue (r_p = -.297, p < .001), perceived burdensomeness and depressed mood (r_p = -.270, p = .022), and alcohol intoxication and anhedonia (r_p = -.251, p = .03). Table K3 in Appendix K lists the strength and significance of all possible associations in the between-persons network.

Centrality

RQ4. What nodes have the highest strength centrality in each network (temporal, contemporaneous, and between-persons)?

The strength centrality plots for the temporal network, contemporaneous network, and between-persons network are presented in Figure 16, Figure 17, and Figure 18, respectively.

The temporal network has two types of strength centrality – out-strength and in-strength. Out-strength is the sum of all edges pointing out from a node. In-strength centrality is the sum of all edges pointing towards a node. In the temporal network, depressed mood had the highest out-strength centrality, followed by anhedonia and suicidal ideation. The nodes with the lowest out-strength centrality in this network were worthlessness, thwarted belonging, social support, and perceived burdensomeness. The node with the highest in-strength centrality in the temporal network was anhedonia, followed by alcohol intoxication and worthlessness. Self-esteem and perceived burdensomeness had the lowest in-strength centrality in the temporal network.

In the contemporaneous network, the node with the highest strength centrality was depressed mood. Hopelessness, perceived burdensomeness, and worthlessness has similarly high strength centrality in this network. The node with the lowest strength centrality in the contemporaneous network was alcohol intoxication.

In the between-persons network, hopelessness had the highest strength centrality. Depressed mood and perceived burdensomeness were also central to this network. The nodes with the lowest strength centrality in the between-persons network were self-esteem and suicidal ideation.

Figure 16

Strength Centrality Plot for the Temporal Network

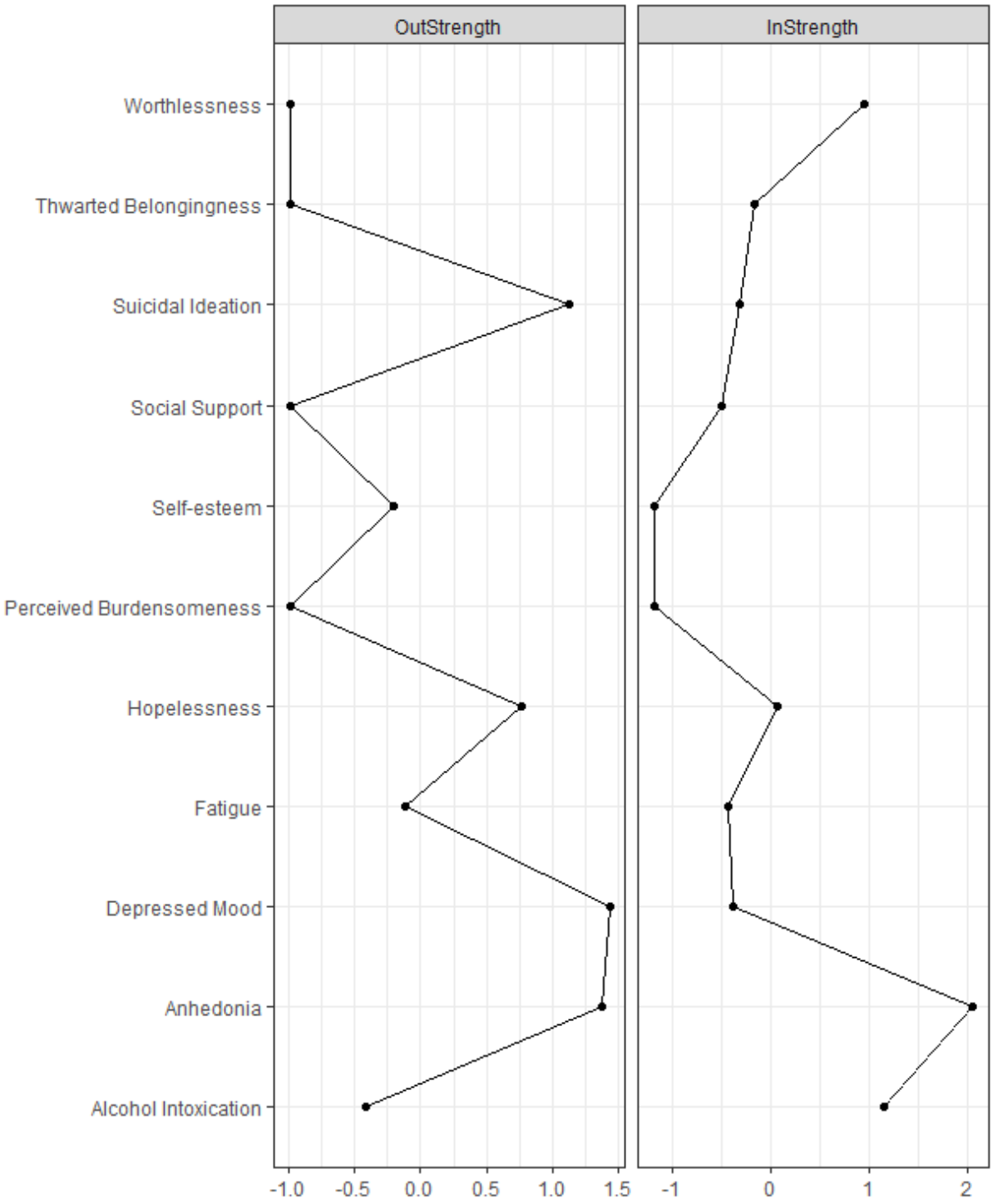


Figure 17

Strength Centrality Plot for the Contemporaneous Network

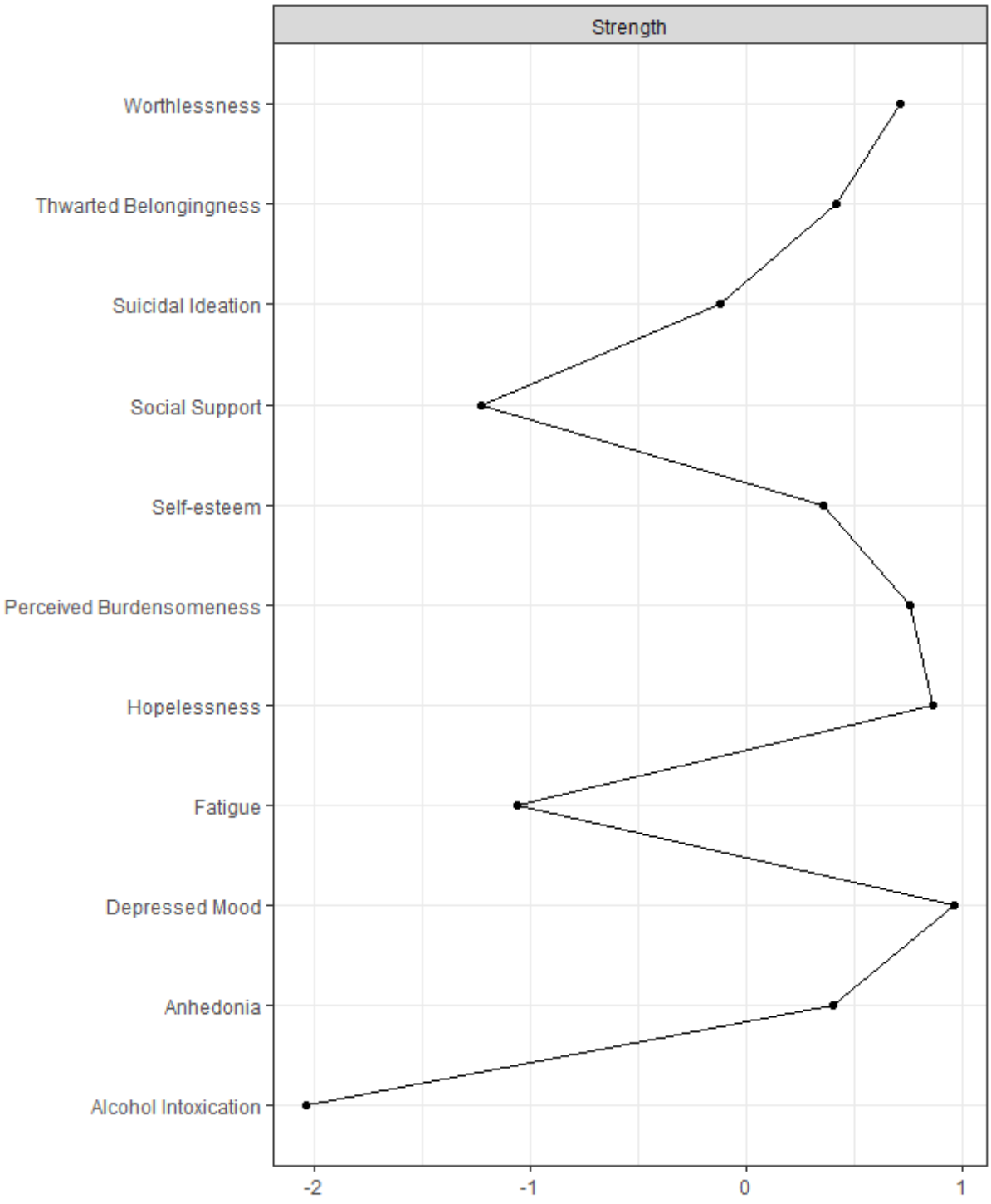
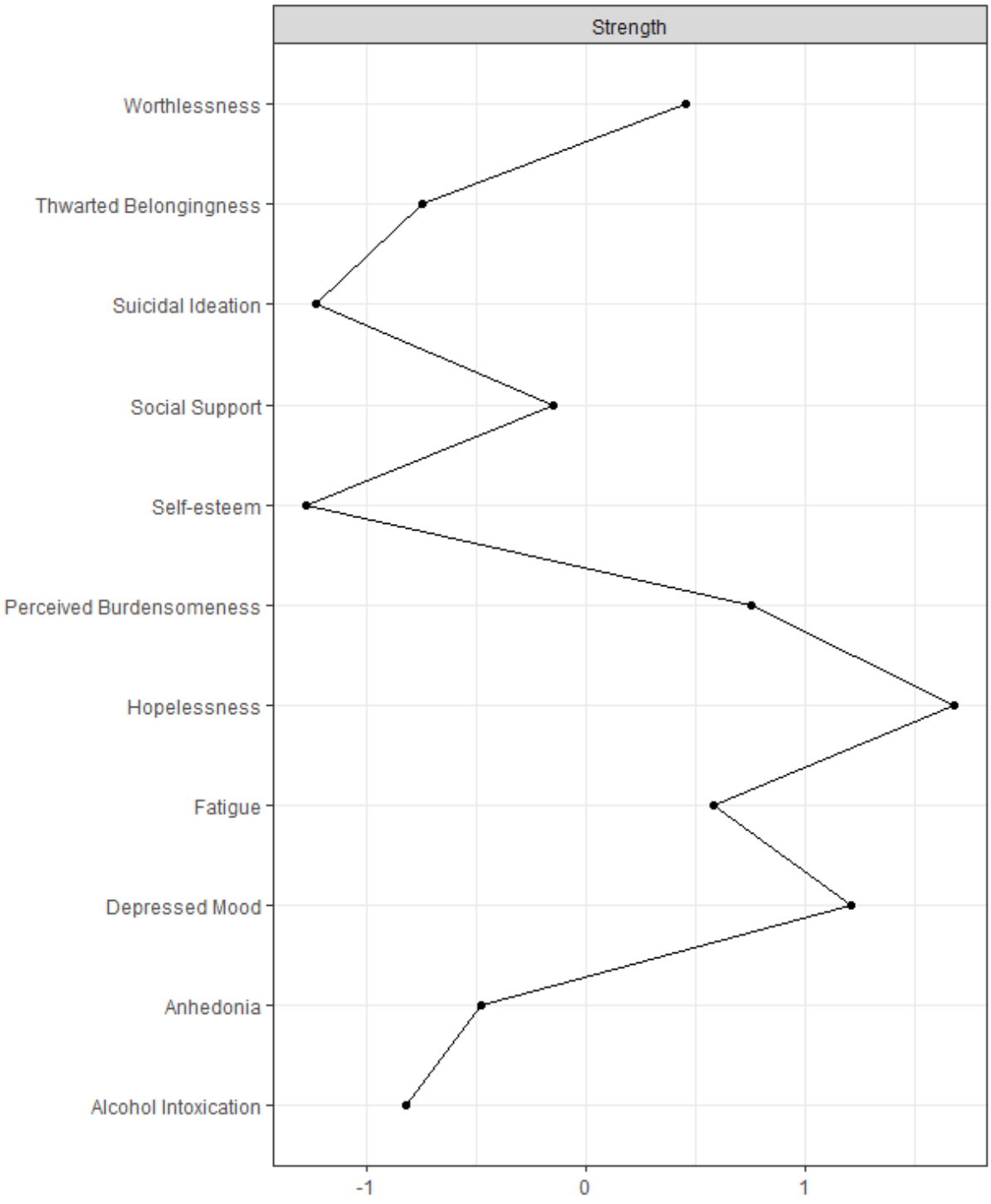


Figure 18

Strength Centrality Plot for the Between-Persons Network



Exploratory N=1 Network Analyses

A small number of N=1 network analyses were completed to illustrate what information can be drawn from this type of network and how these networks may be able to be used to identify suitable suicide intervention targets. The results of individualised temporal and contemporaneous networks for five participants are described below, followed by a brief summary of the differences between these networks. The potential implications of these networks are explored in the Discussion section. This was an exploratory analysis and was not preregistered on the Open Science Framework.

Participant 9

Participant 9's temporal network showed that both depressed mood and suicidal ideation at one time point led to an increase in perceived burdensomeness at the subsequent time point (see Figure 19). As these were the only associations in the temporal network for this participant, the in-strength and out-strength plot shows these three variables to have the highest centrality.

The contemporaneous network for participant 9 depicted many statistically significant relationships, with suicidal ideation, depressed mood, worthlessness, anhedonia, hopelessness, perceived burdensomeness, and thwarted belongingness each having multiple associations with other nodes in the network. The strongest association in this network was between suicidal ideation and anhedonia. Suicidal ideation was also positively associated with hopelessness, thwarted belongingness, and perceived burdensomeness.

Participant 48

Participant 48's temporal network, like participant 9's, showed very few associations (see Figure 20). This was reflected in the centrality plot for the temporal network, which showed just

three variables to be highly central. In participant 48's temporal network, suicidal ideation at one time was positively associated with thwarted belongingness at the subsequent time. Additionally, fatigue at one time point led to lessened feelings of thwarted belongingness, which was an interesting result.

In the contemporaneous network of participant 48, suicidal ideation had a positive significant association with depressed mood. Depressed mood had the highest strength centrality in this network, having positive associations with worthlessness, hopelessness, and anhedonia. Additionally depressed mood was negatively associated with social support, such that the more depressed participant 48 felt, the less socially supported they felt (and vice versa). Hopelessness and worthlessness were also particularly central to participant 48's contemporaneous network.

Participant 58

Participant 58's temporal network depicted numerous associations, though none were with suicidal ideation (see Figure 21). This network showed that when participant 58 felt hopeless, they experienced increased feelings of worthlessness and thwarted belongingness at the subsequent time point, and decreased feelings of social support. Fatigue and feeling depressed each predicted increased anhedonia at the next time point. In the temporal network for participant 58, self-esteem had the highest in-strength centrality, followed by hopelessness, while the node with the highest out-strength centrality was social support, followed by worthlessness.

Participant 58's contemporaneous network estimated suicidal ideation and depressed mood to be positively associated within the same time point. Depressed mood was also positively associated with hopelessness, anhedonia, and perceived burdensomeness.

Hopelessness had the highest centrality in the contemporaneous network for this participant, while depressed mood had the second highest strength centrality.

Participant 62

The temporal network for participant 62 depicted multiple relationships with suicidal ideation (see Figure 22). Fatigue at one time point led to increased suicidal ideation at the subsequent time point. The presence of thoughts of suicide at one time led to subsequent feelings of worthlessness, hopelessness, depressed mood, and anhedonia. Suicidal ideation was the node with the highest out-strength centrality, given its high number of associations with other nodes.

In the contemporaneous network, suicidal ideation was positively associated with perceived burdensomeness and negatively associated with social support. For this participant, the strongest association in the contemporaneous network was a positive one between self-esteem and social support. Self-esteem had the highest strength centrality for this participant, closely followed by social support.

Participant 66

For participant 66, there were no associations estimated between pairs of nodes in the temporal network (see Figure 23). As such, the centrality plot estimated for this network was bare, with no nodes having higher centrality than any others. However, both self-esteem and fatigue showed an increase over time, with autoregressions estimated for both of these nodes.

The contemporaneous network of participant 66 depicted a positive relationship between suicidal ideation and alcohol intoxication. Positive associations were also depicted in this network between depressed mood and worthlessness, worthlessness and hopelessness, and

thwarted belongingness and perceived burdensomeness. For this network, thwarted belongingness had the highest strength centrality. Hopelessness was also particularly central to this network, followed by anhedonia and worthlessness.

Differences Between N=1 Networks

As is visibly evident in the network structures, the N=1 networks are highly individualised, with very different networks being estimated for each of the five participants. For four of the five participants, suicidal ideation was not temporally preceded by any other nodes in the temporal N=1 network. This may be due to these participants experiencing little suicidal ideation for the duration of the study, with very few fluctuations seen in this variable over time. These participants may also have had little temporal variation in their ratings of other survey items too. In contrast, participant 62 had large fluctuations in suicidal ideation over time compared to the other four participants. Their temporal network showed a positive temporal relationship between worthlessness and subsequent suicidal ideation.

Additional information that can be garnered from the temporal N=1 networks is the out-strength centrality. The out-strength centrality of a node reflects the sum of all edges pointing out from that node. Nodes with the highest out-strength centrality are therefore those that have the biggest effect on others, potentially making these nodes targets for effective treatment. This varied from participant to participant. The node with highest out-strength centrality for participants 9, 48, and 62 was suicidal ideation, while for participant 58 it was self-esteem and for participant 66 there were no differences in out-strength centrality.

Figure 19

Temporal (top left) and Contemporaneous (top right) Networks and Centrality Plots for Participant 9

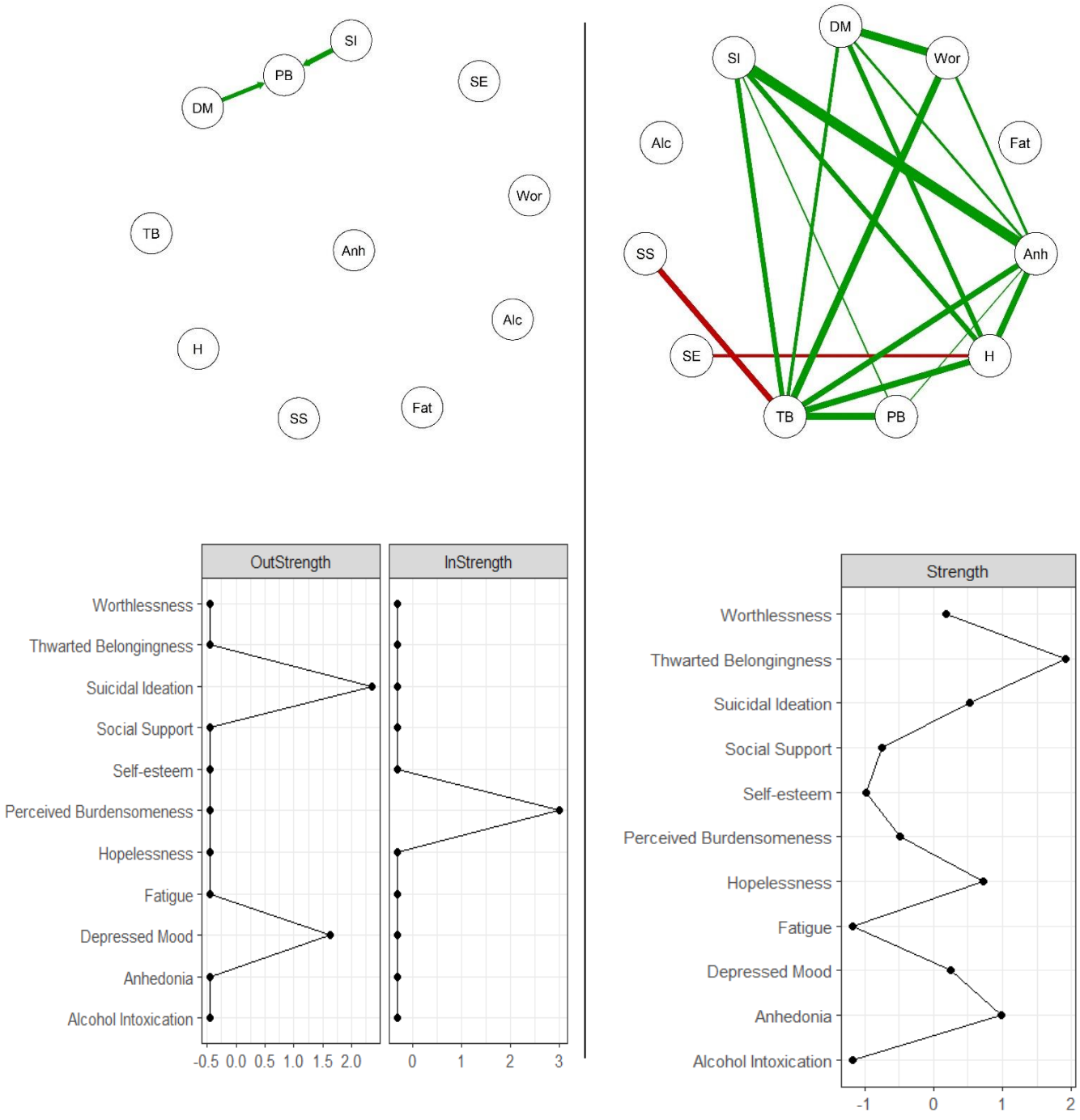


Figure 20

Temporal (top left) and Contemporaneous (top right) Networks and Centrality Plots for Participant 48

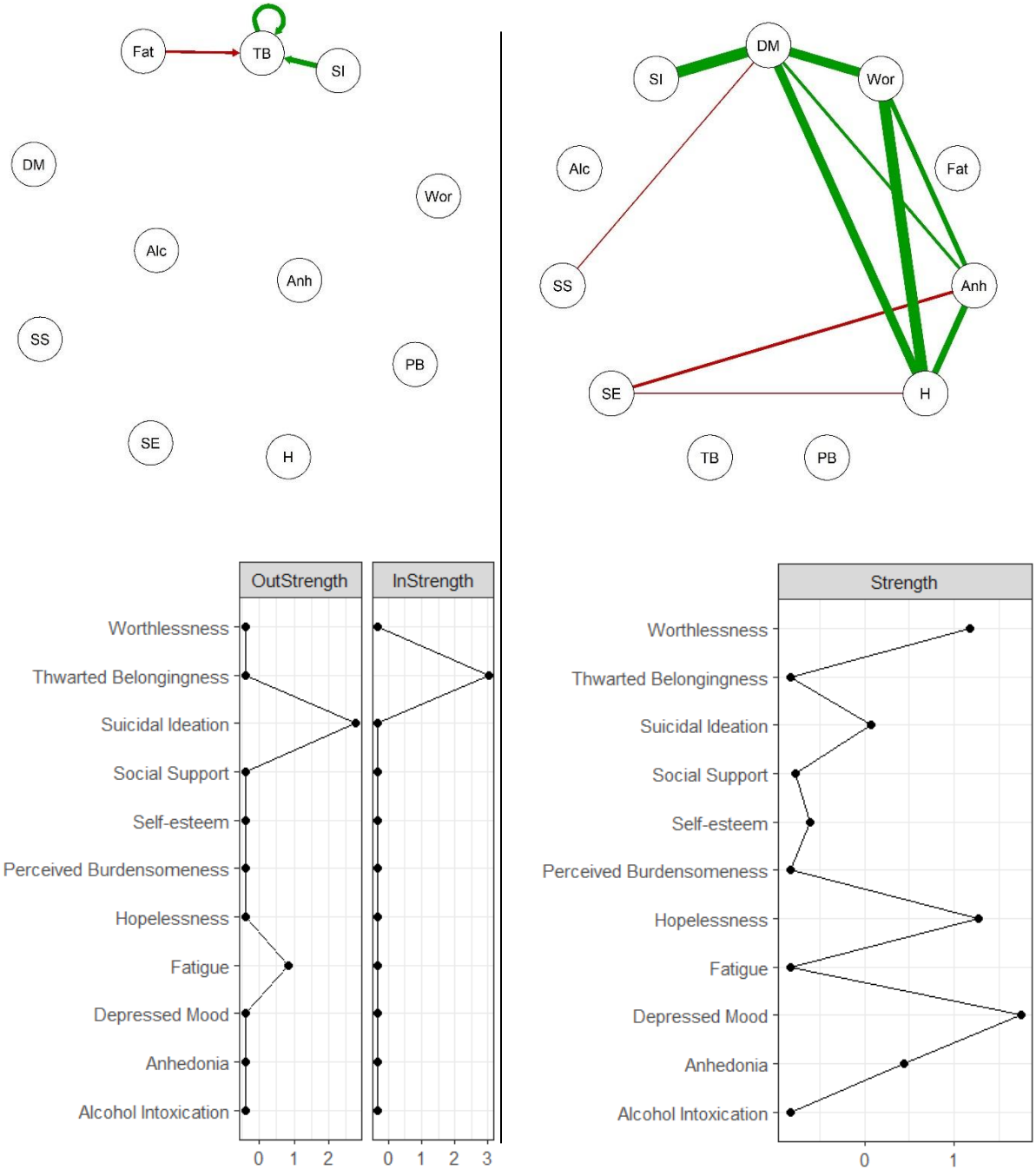


Figure 21

Temporal (top left) and Contemporaneous (top right) Networks and Centrality Plots for Participant 58

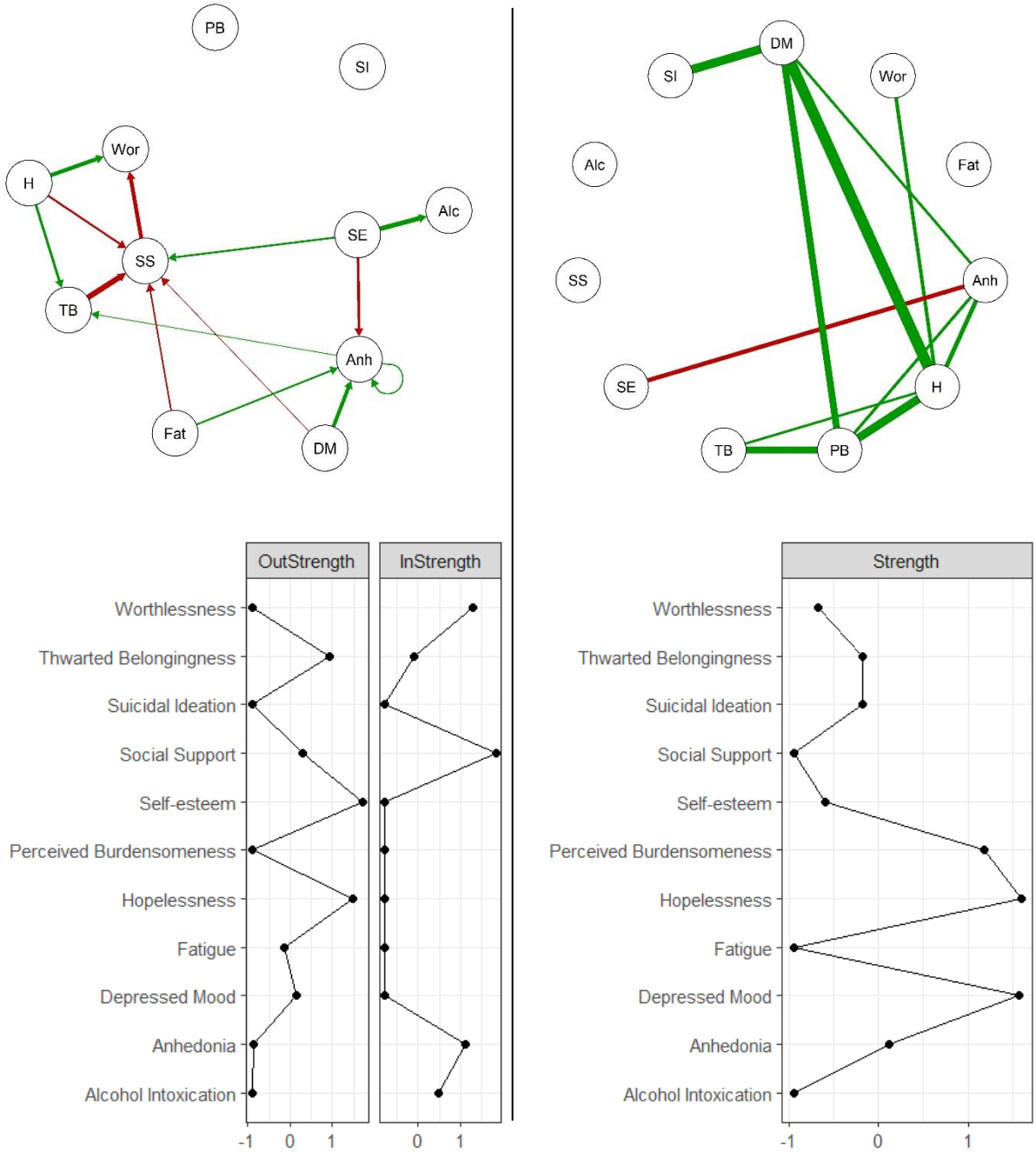


Figure 22

Temporal (top left) and Contemporaneous (top right) Networks and Centrality Plots for Participant 62

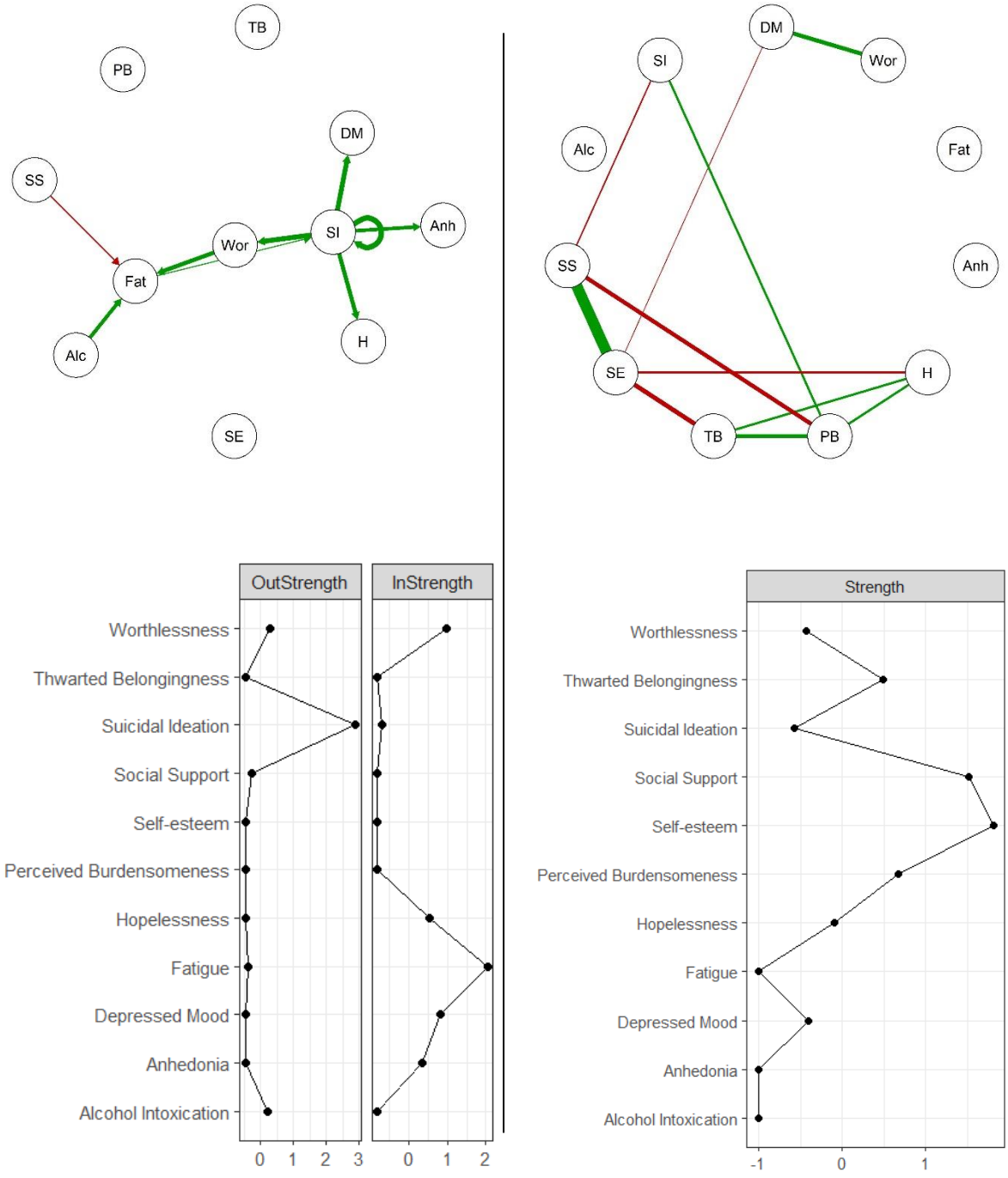
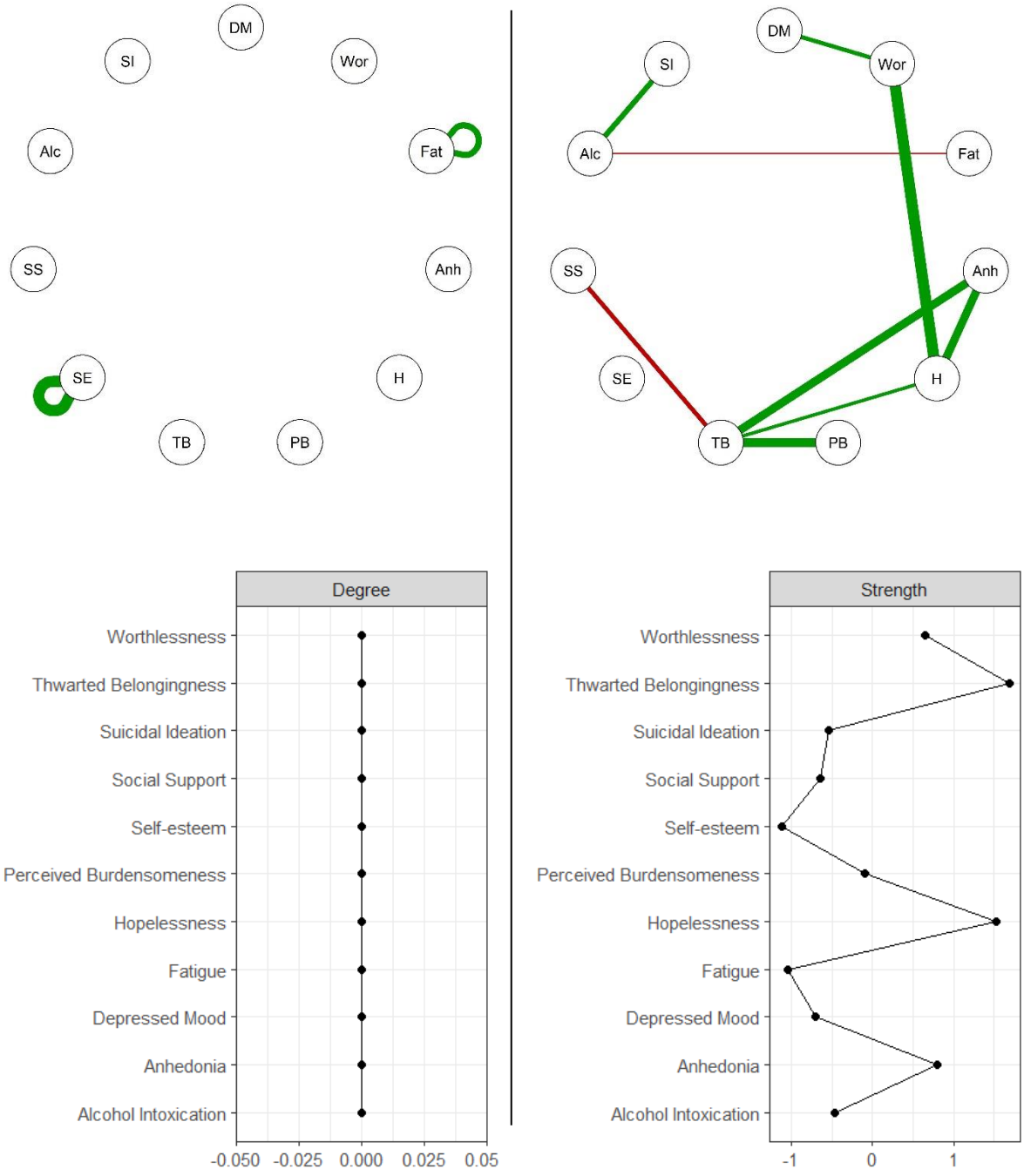


Figure 23

Temporal (top left) and Contemporaneous (top right) Networks and Centrality Plots for Participant 66



Chapter Seven: Discussion

The aim of the present study was to explore how dynamic risk factors for suicide were associated over short periods of time, and which of these risk factors were directly associated with suicidal ideation in temporal, contemporaneous, and between-persons networks. To do this, ecological momentary assessment data about risk factors for suicide and symptoms of depression was collected five times each day for a period of ten days. This data was then analysed using temporal network analysis, producing three network structures: a temporal network, contemporaneous network, and between-persons network. There were seven preregistered hypotheses pertaining to these networks, and four research questions which were also preregistered. Below is a discussion of the key findings of the preregistered analyses and exploratory analyses, the practical and clinical implications of these results, limitations of the study, and future research suggestions.

Key Findings

Research Questions 1 and 2

Research questions 1 and 2 for this study were to find out the degree to which suicidal ideation and the risk factors for suicide fluctuated from measurement to measurement. Each variable included in this study showed variability over time, as suggested by the RMSSD values. RMSSD is a measure of how much a variable fluctuates over time, with a higher value reflecting higher variability from measurement to measurement (E. M. Kleiman et al., 2017). Suicidal ideation had a smaller average RMSSD than all but one of the risk factors for suicide (alcohol intoxication), and the smallest maximum RMSSD. However, there was still moment-to-moment

variability as can be seen in Figure 12 in the Results section, which shows a graph of raw suicidal ideation scores over time.

Fatigue had the highest mean RMSSD, suggesting that on average, participants' experience of fatigue fluctuated from measurement to measurement more than their experience of the other variables. In contrast, alcohol intoxication had the lowest mean RMSSD, suggesting that it fluctuated the least on average. This result is likely due to the low frequency of alcohol intoxication events during the measurement period (see Figure L1 in Appendix L). Interestingly, the risk factor with the highest maximum RMSSD and consequentially the highest moment-to-moment variability was self-esteem.

Overall, these findings support the results of previous ecological momentary assessment research in which suicidal ideation and risk factors for suicide fluctuated over short periods of time (e.g., Hallensleben et al., 2019; E. M. Kleiman et al., 2017).

Hypotheses

This study had seven preregistered hypotheses relating to associations in the temporal, contemporaneous, and between-persons networks. Of these hypotheses, just two were supported – hypothesis 4, that hopelessness would be positively associated with suicidal ideation in the temporal network, and hypothesis 6, that hopelessness would be positively associated with suicidal ideation in the between-persons network. The presence of the relationship between suicidal ideation and hopelessness in the temporal network suggests level of hopelessness at one time was predictive of an increase in future suicidal ideation level, while the presence of the relationship in the between-persons network suggests on average, participants who had a high level of hopelessness tended to also express higher levels of suicidal ideation. These findings

provide support for one of the premises in the three step theory of suicide, which states that when an individual experiences hopelessness, as well as pain, they will experience thoughts of suicide (Klonsky & May, 2015). The present study's findings also partially support the results of research by Rath et al. (2019). Like the present study, their between-persons network showed a significant positive association between the hopelessness and suicidal ideation nodes. However, in contrast to the present study, Rath and colleagues' temporal network estimation did not show a significant relationship between hopelessness and suicidal ideation. The differing temporal network results may be due to the wording of the items used to measure these variables, the length of the interval between surveys, or the sample used in each study. The association between hopelessness and suicidal ideation is well-established in cross-sectional and longitudinal research (Roeder & Cole, 2019; Sueki, 2020), and in recent ecological momentary assessment studies too (Hallensleben et al., 2019). Other than Rath et al. (2019), the present study is the only known study to explore this association using temporal network analysis.

Three hypotheses regarding the temporal network were not supported. The first of these hypotheses was that there would be a statistically significant positive association between depressed mood and suicidal ideation. This was not the case, with no statistically significant association depicted between these two nodes in the temporal network. This finding is consistent with the results of Rath et al. (2019). Their temporal network did not show a significant relationship between depressiveness and suicidal ideation either. One plausible explanation for this relationship not being observed in the temporal network in the present study is that the effect of depressed mood on suicidal ideation may have occurred too fast to be measured by surveys which were three hours apart. If the effect occurred within one measurement interval (i.e., a three hour period) then it would show in the contemporaneous network but not the temporal one

(Epskamp, van Borkulo, et al., 2018). This was the case in the present study, with a statistically significant positive association being observed in the contemporaneous network. If a smaller (or larger) measurement interval was used between surveys, potentially this relationship could have been detected in the temporal network. However, more research needs to be conducted in this area as it is not yet known how long it takes for depressed mood to have a direct causal effect on suicidal ideation.

Hypothesis 2, that there would be a statistically significant positive association between perceived burdensomeness and suicidal ideation in the temporal network, was not supported. Perceived burdensomeness at one time did not significantly increase suicidal ideation at the next time point. This finding is the opposite of what was observed in Rath et al.'s (2019) temporal network, which showed perceived burdensomeness at one time point was significantly associated with increased suicidal ideation at the next time point. A possible explanation for this difference in results is that the way perceived burdensomeness was measured differed between the two studies. I used a single item to measure perceived burdensomeness, whereas Rath et al.'s measure included two items. The item used in the present study was very similar to one of the items used by Rath et al. However, the other item they used to measure perceived burdensomeness showed more variability over time compared to the item that was similar to what was used in the present study (see Forkmann et al., 2018). Perhaps the larger fluctuations in their overall measure of perceived burdensomeness is implicated in why there was a difference in findings between their study and the present one. McNally (2016) suggests using multiple items to measure one variable, as single self-report item measures, like that used in the present study, may not accurately measure the construct of interest.

A second explanation for the difference in results is similar to the explanation for the relationship between depressed mood and suicidal ideation above. It is possible the effect of perceived burdensomeness on suicidal ideation occurs within a different period of time than I allowed for between surveys, such that the relationship could not be captured in the temporal network but was observed in the contemporaneous network (Epskamp, van Borkulo, et al., 2018). The measurement interval used by Rath et al. (2019) was variable, with ten surveys sent between 8am and 8pm, and a minimum interval of 30 minutes between surveys. In contrast, the present study had a fixed measurement interval of three hours. Rath et al.'s measurement interval may have been more appropriate for measuring the temporal effect of perceived burdensomeness on suicidal ideation, such that this relationship was observed in their temporal network but not the present study's.

The third hypothesis, that there would be a statistically significant positive relationship between thwarted belongingness and suicidal ideation in the temporal network, was not supported. This is a similar result to the findings of Rath and colleagues (2019), with their temporal network not showing a significant relationship between thwarted belongingness and suicidal ideation either. These findings and the findings of other ecological momentary assessment research (for example Hallensleben et al., 2019; E. M. Kleiman et al., 2017), do not provide support for one of the main assumptions of the interpersonal psychological theory of suicide. As described in Chapter One, this theory proposes that the presence of thwarted belongingness and perceived burdensomeness lead to the development of suicidal ideation. An association between thwarted belongingness and suicidal ideation is commonly observed within one time point, such as in the contemporaneous networks of the present study and that of Rath et al. (2019), as well as ecological momentary assessment studies by Hallensleben et al. (2019) and

Kleiman et al. (2017). However, there is a lack of evidence thus far for the temporal effect of thwarted belongingness of suicidal ideation, with none of the aforementioned studies reporting a significant temporal association between these variables. It may be the case that the relationship is present in cross-sectional studies but not temporal ones due to confounding in the cross-sectional studies by an uncontrolled third variable.

Hypothesis 5 was that there would be a significant positive association between hopelessness and suicidal ideation in the contemporaneous network. This hypothesis was not supported. This finding contrasted with Rath et al.'s (2019) contemporaneous network result, which showed a significant positive relationship between the hopelessness and suicidal ideation nodes. The lack of a significant association between hopelessness and suicidal ideation in the contemporaneous network in the present study was a surprising result, since as aforementioned, hopelessness had a significant positive association with suicidal ideation in both the temporal and between-persons networks. Although hypothesis 5 was not supported, the underlying theorising that hopelessness is a cause of suicidal ideation, as specified in the three step theory, still appears to be supported, given the presence of a relationship between these variables in the other networks. Though unlikely, it may be the case that the causal effect of hopelessness on suicidal ideation (and vice versa) occurred at a speed which meant the temporal network and between-persons networks were able to completely capture the effect. If this effect occurred over a different period of time to what the measurement interval was, the relationship would be expected to be observed in the contemporaneous network (Epskamp, van Borkulo, et al., 2018), but this was not the case.

Hypothesis 7, that in the between-persons network there would be a statistically significant negative association between self-esteem and suicidal ideation, was not supported.

Participants with a high mean level of self-esteem did not have a significantly low mean level of suicidal ideation. Although the hypothesised relationship was not observed in the between-persons network, a relationship between these nodes was seen in the contemporaneous network, where self-esteem and suicidal ideation had a significant negative association. One possible explanation for this is that there will likely be times where an individual experience lower self-esteem than they do typically, and these periods of lower self-esteem may result in greater suicidal ideation. How these moment to moment levels of self-esteem relate to what is typical for an individual may matter more than an individual's absolute level of self-esteem in the prediction of suicidal ideation.

Research Question 3

The present study sought to find out which nodes were directly associated with increased suicidal ideation in each network (research question 3). As aforementioned, the temporal and between-persons networks each only estimated hopelessness to be significantly associated with suicidal ideation (see Hypotheses section above). In contrast, the contemporaneous network estimated many statistically significant associations between suicidal ideation and other nodes. In the contemporaneous network, suicidal ideation had statistically significant positive associations with thwarted belongingness, perceived burdensomeness, worthlessness, and depressed mood.

The associations seen in the contemporaneous network between suicidal ideation and the nodes depressed mood and worthlessness were somewhat unsurprising. Depressed mood and worthlessness were two of four symptoms of depression measured in the present study. Given that depression in general is associated with suicidal ideation and behaviour (Aaltonen et al., 2019; American Psychiatric Association, 2013; Hawton et al., 2013), it was expected that at least

some of the symptoms of depression would be associated with suicidal ideation in this study. Thus far no known temporal or cross-sectional network analyses have included these exact symptoms of depression alongside suicide risk factors. However, cross-sectional network estimations specifically of depression symptoms, including suicidal ideation and worthlessness, have shown significant positive relationships between suicidal ideation and worthlessness in numerous samples, including Chinese nursing students (Ren et al., 2021) and Norwegian adults in COVID-19 lockdown (Hoffart et al., 2021), as well as individuals diagnosed with epilepsy (Wei et al., 2021), major depressive disorder (Fried et al., 2016; Park & Kim, 2020) and body dysmorphic disorder (Summers et al., 2020). Significant positive associations between suicidal ideation and depressed mood were also estimated in most of the same studies (Fried et al., 2016; Hoffart et al., 2021; Park & Kim, 2020; Summers et al., 2020; Wei et al., 2021). The observed relationships between suicidal ideation and the nodes for worthlessness and depressed mood in the contemporaneous network of the present study suggest these variables are associated within one measurement, aligning with findings of previous network research.

The other two symptoms of depression measured in this study – fatigue and anhedonia – did not have direct significant associations with suicidal ideation in any of the three networks in the present study. If these variables do in reality impact suicidal ideation, the effect may be indirect. In both the between-persons and contemporaneous networks, the nodes for worthlessness, fatigue, and anhedonia were each positively associated with depressed mood, and as aforementioned depressed mood was associated with suicidal ideation in the contemporaneous network. A tentative inference of these findings is that it may be the case that symptoms of depression impact a person's mood, and mood then influences whether a person experiences suicidal ideation or not. Further research is required to examine whether this is the case.

Suicidal ideation had a significant negative association with one node in the contemporaneous network: self-esteem. This observation indicates lower self-esteem was associated with higher suicidal ideation within a single time point. As these nodes were not directly associated in the temporal network, it may be the case that self-esteem affects suicidal ideation within a shorter period of time to what the measurement interval allowed. Self-esteem was not included in Rath et al.'s (2019) network analysis, and as theirs is the only other study that has conducted temporal network analyses about suicide risk factors to my knowledge, this result cannot be compared to other temporal network analysis research. However, in multiple cross-sectional networks of other variables, self-esteem and suicidal ideation have been found to have a significant negative relationship (Holman & Williams, 2022; Kim et al., 2021; Pereira-Morales et al., 2019), while in others this relationship was not statistically significant (Dobson et al., 2021). The majority of these network analyses did not include risk factors for suicide, instead being focused on symptoms of depression and anxiety. Further research is needed to explore the relationship between these nodes in the context of suicide risk specifically.

Research Question 4

The present study also sought to explore what nodes had the highest strength centrality in each network (research question 4). Strength centrality is a sum of the strength of all associations a particular node has (Jones et al., 2021). In-strength and out-strength centrality are specific to the temporal network, with in-strength referring to the summed strength of associations directed towards a particular node, and out-strength referring to the summed strength of associations directed away from a particular node (Jones et al., 2021). Rath et al. (2019) did not report centrality estimates, so a comparison of the present study's centrality estimates to other similar temporal network research about suicide is not possible.

The anhedonia node had the highest in-strength centrality in the temporal network. Level of depressed mood and suicidal ideation at one time point had direct positive associations with anhedonia at the subsequent time point. The depressed mood node had the highest out-strength centrality in the temporal network as well as the highest strength centrality in the contemporaneous network. In the temporal network, depressed mood at one measurement resulted in increased thwarted belonging, anhedonia, and worthlessness at the subsequent time point, while in the contemporaneous network depressed mood has direct associations with suicidal ideation, worthlessness, hopelessness, anhedonia, fatigue, and self-esteem. Given depressed mood has many effects on other risk factors for suicide, both temporally and contemporaneously, it may be a highly effective treatment target. If the associations in these networks are indicative of causal relationships, a reduction in depressed mood could potentially result in a reduction in the other risk factors that it is connected to, such that there is a network-wide reduction in suicide risk.

With anhedonia and depressed mood both having high strength centrality in the temporal network, the relationship between these two nodes and the possible implication for change in suicidal ideation is particularly important to acknowledge. For a diagnosis of major depressive disorder to be made, a person must experience either depressed mood or anhedonia (American Psychiatric Association, 2013). Not only were these two nodes highly central in the temporal network, but they were also temporally associated with one another. Anhedonia and depressed mood at one time point resulted in increases in each other at the subsequent time point. Although these nodes did not result in a direct increase in suicidal ideation over time in the temporal network, depressed mood did have a statistically significant positive association with suicidal ideation in the contemporaneous network, and in that network too depressed mood and

anhedonia had a statistically significant positive association with one another. It is plausible that depressed mood may directly result in increased suicidal ideation in reality even though the relationship was not depicted in the temporal network. This could occur if the three hour measurement interval in this study was too large to encapsulate the speed at which this relationship occurs, hence its depiction in the contemporaneous network but not the temporal network.

The node with the highest strength centrality in the between-persons network was hopelessness, which had associations with five other nodes in the network. The strongest association in this network was between hopelessness and worthlessness. Hopelessness also had positive associations with suicidal ideation and perceived burdensomeness, and negative associations with fatigue and thwarted belongingness.

Exploratory N=1 Network Findings

To date there are no known publications estimating N=1 networks of suicide risk factors and suicidal ideation. Because of this, in addition to the preregistered analyses discussed above, exploratory N=1 network analyses were conducted to showcase the utility of individualised temporal and contemporaneous networks and how they could be used to inform treatment. Temporal and contemporaneous networks were estimated for five participants, each of which showed quite different associations between suicide risk factors and suicidal ideation.

In the temporal networks of all five participants there were very few associations overall. Participant 62's temporal network was the only one where a risk factor predicted increased suicidal ideation, with this network showing that when this participant was fatigued at one time point, at the subsequent time point they experienced increased suicidality. For this participant,

feeling tired could potentially be an early warning sign or at risk situation for having suicidal thoughts. In a mental health setting, identification of this relationship could result in this information being used to strengthen a client's safety plan, providing the client with data and information about what leads them to have thoughts about taking their life to increase awareness of their early warning signs. Increased awareness and identification of these factors would *potentially* help a client to act early, possibly preventing thoughts of suicide from escalating.

In addition to the associations present in the temporal network, looking at the out-strength centrality of these networks may also be useful, as nodes which have many strong effects on other nodes may be suitable targets for intervention. For participant 58, the nodes with the highest out-strength centrality were self-esteem, hopelessness, and thwarted belongingness. It may be the case that if these nodes were targeted in a specific intervention, participant 58 would experience decreases in the many other nodes connected to these variables, resulting in a reduction in overall suicide risk. This idea is discussed further in suggestions for future research, in the subsection titled Experimental Research and Personalised Interventions.

Interestingly, three of the five individual temporal networks showed that suicidal ideation at one time point led to an increase in some risk factors for suicide, including perceived burdensomeness (participant 9) and thwarted belongingness (participant 48), as well as worthlessness, hopelessness, anhedonia, and depressed mood (participant 62). Though the presence of associations between these variables was unsurprising, the finding that suicidal ideation temporally preceded the increase in some risk factors was somewhat unexpected. The focus of suicide risk research is typically on what causes suicidality, not what suicidality causes. The results of the present study suggest that if someone is having thoughts about taking their life they may subsequently have increased feelings of hopelessness, worthlessness, depression, or

burdensomeness. However, it may also be the case that at times the risk factors for suicide were present prior to the suicidal thoughts, but that participants noticed their suicidal thoughts first. The intensity and persistence of their suicidal thoughts may have been comparatively stronger than, for example, their feelings of hopelessness, such that participants identified suicidal thoughts first, and hopelessness subsequently. Further research exploring this idea would be useful. Recognising and rating the presence of suicide risk factors would have required participants to have enough insight to notice and assess their own thoughts and feelings. Insight was not assessed in this study, but it would be an important factor to consider when deciding on whether to utilise networks in practice.

Theoretical Implications

As described in Chapter Three, network analyses of suicide risk factors with and without a theoretical underpinning enable us to refine existing theories of suicide, or to create new ones. In this study, a few variables from three ideation to action theories of suicide were included. The theories are the interpersonal psychological theory of suicide, the integrated motivational-volitional model of suicide, and the three step theory of suicide. These theories postulate a temporal progression whereby an individual begins to ideate suicide due to a number of variables, and then this ideation transitions into suicidal behaviour if other factors are present. If the premises of these theories are true, we would expect to see an association between the relevant variables in a temporal network, unless the measurement interval does not match the time period over which the effect occurs, in which case we would expect to see the relationship in the contemporaneous network. If a particular variable is theorised to have an effect on suicidal ideation, but there is no evidence of that in the temporal network or the contemporaneous network, that finding would contradict the theory. The variables involved in ideation to action

theories of suicide that were included in the network analyses were perceived burdensomeness, thwarted belongingness, social support, self-esteem, and hopelessness.

In the temporal network there were no statistically significant relationships between suicidal ideation and either thwarted belongingness or perceived burdensomeness. These two relationships are key to each of the three theories of suicide mentioned above, with thwarted belongingness and perceived burdensomeness postulated to lead to suicidal ideation (Joiner, 2005; Klonsky & May, 2015; O'Connor, 2011). Although the relationships were not shown in the temporal network, they were estimated in the contemporaneous network, such that suicidal ideation was associated with thwarted belongingness and perceived burdensomeness within the same time point. This provides very tentative support for the related parts of the three ideation to action theories. As mentioned elsewhere in the Discussion section, the interval between surveys in this study may have impacted what each network showed, with the contemporaneous network estimating many relationships while the temporal network depicted relatively fewer. If the effect of thwarted belongingness or perceived burdensomeness on suicidal ideation occurred faster (or slower) than the measurement interval allowed for, then the temporal network would be unable to capture the effect, and instead it would be captured by the contemporaneous network. Thus, even though the relationships were not depicted in the temporal network, it cannot be ruled out that thwarted belongingness and perceived burdensomeness temporally precede an increase in suicidal ideation, as relationships between these variables were shown in the contemporaneous network. However, further research is needed to test this, by replicating the study with a different measurement interval.

Additionally, a statistically significant relationship between suicidal ideation and social support was not evident in either the temporal network or the contemporaneous network. Social

support is involved in both the integrated motivational-volitional model of suicide and the three step theory of suicide. In the integrated motivational-volitional model, social support is implicated in the motivational phase, where a lack of social support increases the likelihood that feelings of entrapment leads to suicidal ideation (O'Connor, 2011). In the three step theory, social support is involved in connection, with individuals who feel connected being less likely to experience suicidal ideation (Klonsky & May, 2015). These theoretical associations between social support and suicidal ideation are not supported by the results of the present study. It may be the case that social support should not be included in these theories of suicide. However, social support is only one facet of what Klonsky and May (2015) meant by connection in their theory, with connection to jobs, roles, and interests also being considered important. Connection in this broader sense was not measured in the present study, which may explain why there was no direct association between social support and suicidal ideation in any of the three networks. Network analysis research that aims to explore the associations specified in ideation to action theories should measure these other facets of connection too, to gain a better understanding of how connection is implicated in the development of suicidal ideation. An item more specific to measuring social connection could be included alongside one relating to social support, to explore how these variables are related to one another, and to suicidal ideation.

Self-esteem was not significantly associated with suicidal ideation in the temporal network either. Self-esteem is only implicated in the three step theory of suicide, where painful experiences such as low self-esteem can lead to suicidal ideation (Klonsky & May, 2015). Though this finding does not support the theoretical association between painful experiences and suicidal ideation, it is important to note that, similar to social support, low self-esteem is but one facet of painful experiences. Klonsky and May (2015) state that many different types of pain can

contribute to the development of suicidal ideation. It may be the case that pain does temporally precede the development of suicidal ideation, but low self-esteem as a specific type of painful experience does not. However, low self-esteem was contemporaneously associated with increased suicidal ideation, so alternatively it may be the case that the measurement interval wasn't the right length to capture the temporal effect of self-esteem on suicidal ideation. A major limitation of the ideation to action theories of suicide is that none of them specify how long the theorised effects take to occur. As a result, it is difficult to determine the appropriate measurement interval required to test these associations.

In contrast to the above theory-driven variables, there *was* a significant relationship between hopelessness and suicidal ideation in the temporal network of the present study. As has already been discussed, in the temporal network, hopelessness at one time point led to increased suicidal ideation at the subsequent time point, and vice versa. This provides support for one of the premises of the three step theory of suicide. This theory postulates that when an individual experiences hopelessness, as well as pain, they will experience thoughts of suicide (Klonsky & May, 2015).

The present study has shown how network research can be used to explore ideation to action theories of suicide to provide further clarity regarding the temporal nature of some of the theorised associations. However, there is much more information to be gleaned from research of this nature. Network analyses testing each of the three ideation to action theories individually would be a valuable next step in our understanding of suicide from a theoretical point of view, and in turn these theories could potentially be used to inform effective interventions for suicide (de Beurs et al., 2019). There is a clear gap in the extant suicide theory literature at present, with

no published studies of this nature using a New Zealand sample of participants and including all theory-implicated variables.

Practical and Clinical Implications

Though more research is needed before the results of this research can be acted on in clinical settings, some tentative implications can be drawn regarding suicide risk development and assessment. Firstly, the results provide stronger evidence of which variables may or may not temporally cause an increase in suicidal ideation. Additionally, this study highlights the importance of assessing symptoms of depression and continuously assessing suicide risk given its dynamic nature. These implications are discussed below.

Temporal network analysis provides us with stronger evidence of causality than is typically implied by cross-sectional research. Observational cross-sectional research provides very limited information about causal relationships, with causality only inferred from the conditional independence structure (Pearl, 2000). In cross-sectional research, the temporal, contemporaneous, and between-persons effects cannot be separated out, like they are in temporal network analysis. In a temporal network, an edge between two nodes shows that a node at one time point predicts an increase in the other node at the subsequent time point, controlling for all other nodes in the network. If a causal relationship exists between two variables, we expect one of the variables to temporally precede the other (Epskamp, van Borkulo, et al., 2018). As the associations in the temporal network show that the cause temporally precedes the effect, we can describe these associations as being indicative of causality (Epskamp, van Borkulo, et al., 2018). For example, in the temporal network of the present study, hopelessness temporally preceded an increase in suicidal ideation, shown by the edge pointing from the hopelessness node to the

suicidal ideation node in the temporal network. We could tentatively conclude that hopelessness *causes* an increase in suicidal ideation, due to the temporal prediction present between these two nodes.

Contemporaneous networks can also be suggestive of causality, with an edge between two nodes in this network showing the nodes are not conditionally independent. An edge in this network depicts a partial correlation that exists between two nodes at one time point after controlling for all other variables in the network within the same time point and the previous one. If there is a causal relationship between two nodes, we would expect the nodes to be associated in the contemporaneous network (Epskamp, van Borkulo, et al., 2018). The contemporaneous network in the present study showed multiple relationships between suicidal ideation and risk factors for suicide, including depressed mood, thwarted belongingness, perceived burdensomeness, worthlessness, and self-esteem. Given the potential causality implied by contemporaneous associations, it may be the case that these risk factors cause a change in suicidal ideation, or it may be the case that suicidal ideation causes a change in the risk factors.

The overarching practical implication of the present study is that it provides us with more information about suicide risk that can then be used to influence decisions about suicide prevention. First, the results of the present study provide support for the common practice of assessing, monitoring, and treating symptoms of depression in order to reduce suicide risk in an efficient, effective way. Though this is an unsurprising implication, it is an important one for clinical psychologists to consider. In the present study, depressed mood, worthlessness, and anhedonia were each either implicated in the development of suicidal ideation, contemporaneously associated with it, on average had an association with it, or were highly central to one or more of the three networks. For example, temporally, suicidal ideation led to

increased anhedonia for participants in this study. The clinical implication of this is that if a clinical psychologist notices increased anhedonia for their client, it could be especially important to ask their client about possible suicidal ideation development or change as part of the assessment process, as a change in suicidal ideation may be underlying the change in anhedonia. Another example implication relates to the contemporaneous associations between worthlessness and suicidal ideation. This finding suggests that it may be important to assess and monitor feelings of worthlessness alongside feelings of depression and hopelessness, which are often asked about when assessing suicidality in the context of depressive symptoms. The present study takes us one step closer towards having an understanding of what symptoms of depression specifically lead to increased suicidal ideation. Clinical psychologists already typically assess anhedonia and worthlessness when it is relevant to do so, such as when a client is experiencing low mood and other depression-congruent symptoms, and the results of the present study support this practice.

Additionally, the results of this study highlight the limited predictability of suicide given its highly dynamic nature, which emphasises the importance of continuous assessment of suicide risk. Again, this is an unsurprising implication, given that clinical psychologists already frequently assess suicidality (along with other presenting difficulties). Knowledge of what factors are more prominent for a particular client at any given time enables clinical psychologists to tailor interventions to ameliorate the symptoms that are worst or most concerning for a client. Some risk factors for suicide were more variable than others, with the largest mean RMSSD seen for fatigue, followed by thwarted belongingness, anhedonia, perceived burdensomeness, and hopelessness. As these variables fluctuated from measurement to measurement, having high variability, clinical psychologists may wish to assess them frequently when assessing and

monitoring suicide risk, to get a more accurate picture of what is going on for their client, and create highly targeted interventions. In contrast, variables which on average did not fluctuate as much over time in this study, such as social support and self-esteem, may not need to be assessed as frequently in the context of suicide risk, depending on the individual client. It is important to note that the amount that risk factors for suicide fluctuate over time will vary from individual to individual, so the results of the group-level analyses in this study may not generalise to individual clients in practice. Further research involving individualised network analyses and the clinical utility of these should be conducted, and the results of such studies should be considered when deciding on whether networks can be used in clinical practice with clients. This is discussed further under Future Research Recommendations below.

Limitations

This main limitations of this study were its sample characteristics, sample size, the low level of suicidal ideation experienced by participants during the study, and the software used to administer the surveys. Assumptions about causality also pose limitations for this study.

Sample Characteristics

It is apparent that the sample in this study was not representative of the demographics of the general population of New Zealand. Participants were primarily female (1:6.4 male to female ratio) and Pākehā (79.5% of participants, compared to 70.2% of the New Zealand population; Statistics New Zealand, 2020). Just 7.7% of participants identified as Māori, compared to 16.5% of the New Zealand population (Statistics New Zealand, 2020). No participants identified as Asian and only 2.6% identified as Pacific Islander, compared to 15.1% and 8.1% of the New Zealand population, respectively. The sample is not representative of the demographic groups

which are statistically at higher risk of suicide (e.g., males, Māori; Coronial Services of New Zealand, 2020). As such, the results of this study may not accurately describe the experience of these higher risk demographic groups. As the sample of participants involved in this study does not match the demographics of the New Zealand population, the results of the study cannot confidently be generalised to the New Zealand population as a whole either.

Sample Size

In this study the overall rate of survey completion was lower than expected, with just 51.97% of all surveys completed by the 63 people who consented to participate in the main study. Other ecological momentary assessment studies about suicide have achieved completion rates such as 73.8% (Husky et al., 2014) and 89.7% (Hallensleben et al., 2019), so a similar rate was expected for this study. Looking at the completion rate of just the 39 participants whose data was included in the analyses, 72.8% of the 1950 surveys were completed. Although this completion rate is comparable to previous research, the overall number of completed surveys was relatively small when compared to other temporal network studies. For example, Rath et al.'s (2019) temporal network analysis involved 4295 data points from 74 participants, with participants being sent 10 surveys each day for six consecutive days. Though there is not a standardised sample size calculation or power analysis for this type of analysis, the current guidance is that more data is better in terms of improving the reliability and validity of results. Therefore, because of the small sample used in this study, researchers may wish to replicate the study using a larger sample to potentially improve upon the reliability and validity of results.

Suicidal Ideation

In order to encapsulate meaningful associations between risk factors for suicide and suicidal ideation, participants in the study needed to experience some level of suicidal ideation during participation. To increase the likelihood of recruiting participants who would experience suicidal ideation, one of the eligibility criteria for participation was having experienced suicidal ideation in the previous six months. Data analyses showed that 61.2% of all survey responses signalled no momentary suicidal ideation at all. Of the 39 participants included in the data analyses, 8 did not experience any suicidal ideation during participation, rating suicidal ideation as 1, *not at all*, for every survey. For 13 participants, the highest rated level of momentary suicidal ideation was 2, *a little bit*. Only 7 participants signalled their momentary suicidal ideation was 4, *a lot*, or 5, *extreme,* at some point during the study.

In hindsight, instead of recruiting participants who had experienced suicidal ideation in the last six months, recruiting participants who were *currently* experiencing suicidal ideation or who had had these thoughts in the last 24 hours may have been more suitable, especially given its highly dynamic nature. This may have captured more temporal variation in suicidal ideation, and therefore increased power to detect relationships between suicidal ideation and other variables included in the network. However, when developing the eligibility criteria for this study, I had concerns about whether it was ethical to place further burden on participants who were potentially vulnerable, such as those currently experiencing (potentially high levels of) suicidal ideation. Some suicide ecological momentary assessment research has been conducted in a hospital inpatient setting (e.g., Hallensleben et al., 2019) where it is possible to monitor participants and provide active intervention when needed. When recruiting participants from the general population and trying to ensure their anonymity, as was the case in the present study, a

high level of observation and engagement with participants is not attainable. Given the intensity and possible burden caused by ecological momentary assessment research, researchers who conduct similar studies to this in the future should carefully consider participant eligibility criteria to ensure their participants are currently having thoughts of suicide to some degree, while weighing up the safety and ethical risks of including this participant group.

Survey Software

Qualtrics was the software used to design and administer the surveys in this study. Qualtrics is not designed specifically for ecological momentary assessment research, but it does have the functionality to be used in this way. It was also the survey software that Massey University had a licence for students to use. I was able to set up the surveys so that participants would automatically receive an email at scheduled times, directing them to a survey which recorded their ID number and the survey number alongside their survey response. Emailing the survey links may not have been the most effective way of directing participants to the surveys. Early in the data collection period, I received emails from participants who said the emails were going to their junk folder or that they did not frequently check their emails and would therefore be unable to respond to every survey. In these cases, participants completely missed a number of the surveys, resulting in a smaller quantity of data than I had expected. A more effective way of distributing the survey to participants may have been to send the survey notifications as a text message. Qualtrics has the functionality to send survey links in a text message. Unfortunately, this feature comes at an additional cost on top of the licence Massey University already pays for, and this cost well-surpassed the funding available for this study.

These days a number of phone applications exist for the purpose of ecological momentary assessment research. Participants can be asked to download an application such as SEMA3 (Melbourne eResearch Group, n.d.) or mEMA (ilumivu, n.d.), such that push notifications can be sent to participants' phones at scheduled times, prompting them to complete surveys. Using an application of this sort would have been a practical alternative to using Qualtrics, possibly increasing the number of surveys participants completed. However, these applications come with their own drawbacks. Concerns have been raised over the privacy of data collected by ecological momentary assessment phone applications, as the data is typically held by a third-party. They also require participants to have a degree of technology literacy, such that they are able to download the application and learn how to use it, as well as be willing to do this even if they know how to. Some applications also come at a considerable cost to the researcher. For example, use of the mEMA application costs upwards of NZD5000 (T. Conner, 2015), depending on the licence purchased. Taking these concerns into consideration, Qualtrics was the logical choice for this study, as it was free for me to use as a researcher under Massey University's licence, and it had the functionality for me to distribute a survey numerous times, even if not in the most effective way.

Assumptions About Causality

The final limitation of this study is that a number of assumptions have to made about causality when using temporal network analysis to explore associations between a system of variables. For example, we have to assume that every variable within the system of variables has been measured and that there is no measurement error (Epskamp, van Borkulo, et al., 2018). The presence of a relationship between two nodes is necessary for causality but it is not sufficient for us to be able to determine the relationship is causal, as relationships can occur spuriously due to

an unmeasured cause (Epskamp, van Borkulo, et al., 2018). In a temporal network specifically, edges between nodes may occur due to unmodelled nonstationarity (which we have tried to address by detrending variables prior to running the analysis) or because of unmodelled measurement error (Epskamp, van Borkulo, et al., 2018). As such, it is crucial that relationships shown in network analysis studies such as the present one are described as being *indicative* of relationships which are *potentially* causal, as we cannot definitively say these relationships are causal, especially when using observational data. Despite not being able to make absolute conclusions about causality, temporal network analysis is still a valuable research tool as it provides a much stronger basis for such conclusion than cross-sectional correlational studies do.

Future Research Recommendations

Based on the findings of the present study, it is recommended that researchers consider conducting network analyses of variables included in common theories of suicide, as this may provide further support for the premises of these theories or may drive the creation of new ones. Additionally, including a measure of suicidal behaviour would be useful to consider when conducting ecological momentary assessment research and temporal network analyses of risk factors for suicide. Experimental research about the effectiveness of personalised interventions based on node centrality should also be explored. Each of these suggestions are described in more detail below.

Theory Testing

The first suggestion for future research is to complete temporal network studies of variables involved in specific ideation to action theories. Due to the potential for the associations depicted in a network to be causal ones, network analyses of theoretical constructs would

provide valuable information to researchers in the field of suicide research. Temporal network analyses of variables involved in theories would enable us to examine the relationships postulated by these theories, and whether these associations are present within a single time point or occur over time. This would provide support or opposition for the main premises of the theories, ultimately helping to refine the existing theories. For example, a temporal network study about the interpersonal psychological theory of suicide could include measures of perceived burdensomeness, thwarted belongingness, capability for suicide, suicidal ideation, and suicidal behaviour. If the estimated networks contained the associations implied by this theory, it would provide support for the theory.

By including some additional risk factors in the network analyses, with or without a theoretical underpinning, new theories about how suicidal ideation develops may also be created. Thus far there is a dearth of research of this description. Researchers may wish to draw on studies such as that by de Beurs et al. (2019), which estimated a cross-sectional network including 17 core theoretical constructs from two ideation to action theories alongside other variables such as depression, stress, and mental wellbeing. They found that some of the core theoretical constructs were strongly related to suicidal ideation, while others were not, suggesting support for specific aspects of the theories and not for others. For example, in the network analysis of variables included in the interpersonal psychological theory of suicide, suicidal ideation and perceived burdensomeness were strongly associated, while suicidal ideation and thwarted belongingness were not. The authors also found that the additional risk factors for suicide that were included in the network analysis were associated with suicidal ideation. These additional risk factors were not involved in the ideation to action theories. As such, the authors questioned the role of these risk factors in the development of suicidal ideation and the

implications this may have for the current theories of suicide. Replication of de Beurs et al.'s (2019) research may help to refine current theories or to develop new ones.

Measure of Suicidal Behaviour

Temporal network studies focused on the development of suicidal behaviour could be used to test the premises of ideation to action theories of suicide. There are likely to be a plethora of variables that influence why someone transitions from ideation to action, and temporal network analysis would be a useful tool for teasing these associations apart. The information gleaned from such a study would provide valuable information about what factors temporally lead to a person trying to take their own life, rather than simply showing what factors are cross-sectionally correlated with suicidal behaviour, as is the case in much of the current suicide attempt literature. Although suicidal behaviour is a key variable in ideation to action theories of suicide, to date there are no known published temporal network studies about suicide risk that have included a measure of suicidal behaviour. According to ideation to action theories of suicide such as the interpersonal psychological theory, integrated motivational volitional model, and three step theory, suicidal behaviour is postulated to occur due to the presence of a variety of different factors such as access to means, fearlessness about death, and high pain tolerance (Joiner, 2005; Klonsky & May, 2015; O'Connor, 2011).

Exploring what tips someone from ideating suicide to actually taking steps towards taking their own life would provide valuable information that could in turn be used for suicide prevention efforts. Some of the information that could be gleaned from a study of this nature would likely provide support for some common-sense suggestions for suicide prevention. For example, if someone has access to a particular method of taking their life at one time point, and

this directly led to suicidal behaviour at the next time point, then the suggestion for how to prevent that suicide would be to remove access to means – something that is commonly done already. In contrast, if a more complex or intangible variable like fearlessness about death directly led to increased suicidal behaviour, more thought and consideration would need to be put into suicide prevention efforts targeting this, as fearlessness about death is not dealt with in typical suicide prevention efforts like safety plans and means restriction.

Measures of suicidal behaviour for such research might focus on specific behaviours relating to suicide planning, such as collecting and preparing means of suicide, or they may focus on whether a person actually attempts suicide. Practically and ethically either of these options would be extremely complicated. Suicidal behaviour is such a low frequency event that it would be difficult to measure the occurrence of this through ecological momentary assessment or other methods of repeated measurement without the studies being very lengthy. There would also likely be both legal and ethical obligations to prevent the occurrence of suicidal behaviour too, so even if a participant attempted suicide during such a study, the data collected leading to that point would likely be influenced by the researcher's attempts to intervene and prevent the behaviour. Ultimately, very careful consideration would be required to ensure participant safety in designing a study to explore what temporally leads to suicidal behaviour, and to ensure the benefits of such a study outweighed the potential risks, not only to the participants but to the researchers too.

Experimental Research and Personalised Interventions

The present study has demonstrated the utility of temporal network analysis for groups of people and for individuals. This represents one step toward the ultimate goal of being able to

determine whether network analysis can be used in some way to create personalised suicide interventions that are more effective than current methods of suicide prevention. The next steps to take to work towards this goal are to conduct more N=1 network studies of suicide risk factors and suicidal ideation, devise an experimental study where some participants receive a personalised intervention targeting central nodes while other participants receive an alternative intervention, followed by an assessment of which method resulted in the biggest reduction in level of central risk factors and level of risk factors the network as a whole.

To start with, researchers should collect ecological momentary assessment data from people who are experiencing high levels of suicidality. Recruiting such participants would increase the likelihood of capturing the temporal variation in suicidal ideation and would therefore increase the power to detect relationships between suicidal ideation and other variables. To be able to create a personalised intervention, we first need to understand how a person's level of suicidal ideation is impacted by risk factors for suicide. As such, for each participant, temporal and contemporaneous networks should be estimated to explore the complex, individualised nature of suicide risk for each participant. The strength centrality of nodes in each network should also be calculated for each participant. As shown in the present study's exploratory N=1 networks, the risk factors that are associated with suicidal ideation vary greatly from person to person, as do the variables which are most central. Ideally N=1 networks would be used alongside a more holistic assessment of what each participant perceives to be increasing their suicidality.

To determine whether effective personalised interventions for suicide risk can be created using knowledge gleaned from N=1 network analyses, the next step would be to devise experimental studies testing whether intervening on central variables is in reality able to reduce

an individual's suicide risk in a drastic way, and how this compares to traditional methods of intervention that are less targeted or personalised. Thus far there have been no studies testing whether personalised network interventions for suicide risk could be effective, let alone how this would compare to traditional interventions. However, there have been a few studies that have explored this in relation to forms of psychopathology such as social anxiety (Rodebaugh et al., 2018) and post-traumatic stress disorder (Papini et al., 2019). The results of such research suggests that nodes which are more central tend to be predictive of symptom change during treatment, such that targeting these central nodes may result in change that generalises across the entire symptom network (Papini et al., 2019; Rodebaugh et al., 2018), reducing overall symptomology. It is possible that this may be the case in networks of risk factors for suicide too, but further research is required to test this.

In assessing whether personalised suicide interventions devised from networks are effective, it would be useful to know whether the intervention resulted in a decreased level of the central variable. For example, if the central variable for a participant was depressed mood, we would hope to see a substantial decrease in the level of depressed mood following the personalised treatment, when compared to a participant who received treatment that did not target this variable specifically. Ideally the personalised intervention would also result in a reduction of the other risk factors in the network too. Such a result would provide support for the premise that associations in a network are potentially causal, and that central symptoms thus causally influence many other nodes. At the moment, these are assumptions which need to be tested by conducting studies such as those described above. Until further research of this nature is completed, our understanding of the utility of networks in relation to suicide risk is fairly limited and built on assumptions.

Conclusion

This study builds on previous temporal (Rath et al., 2019) and cross-sectional network research (de Beurs et al., 2019, 2017; Holman & Williams, 2022; Shiratori et al., 2014; Simons et al., 2019) about suicide, being the first known study to collect ecological momentary assessment style data about both risk factors for suicide and symptoms of depression in a New Zealand context and then use temporal network analysis to explore associations between these variables.

The results of this research highlight the dynamic nature of suicidal ideation and risk factors for suicide. Depressed mood and hopelessness are particularly central variables in the development of suicidal ideation and progression of suicide risk, impacting many other risk factors in the networks and likely increasing overall suicide risk. Hopelessness was the only variable in the network analysis that temporally preceded an increase in suicidal ideation, suggesting that an increase in hopelessness may directly cause suicidal ideation to develop or increase.

Taken together, the findings of this study suggest that mental health clinicians should continue to frequently assess the suicide risk of clients, with a particular focus on assessing hopelessness and symptoms of depression where relevant, given their strong association with suicidal ideation. Further research is required to experimentally test the effectiveness of using network analysis to develop personalised interventions for suicide, as well as to test the premises of common ideation to action theories of suicide. Extensions of the current study should include measures of suicidal behaviour as well as variables theorised to be associated with suicide to expand on the findings of the present study.

Despite significant efforts and interventions, there are still a significant number of suicide deaths each year in New Zealand. Trying something new may be one of the many possible answers to preventing further suicide deaths. I am cautiously optimistic that, with careful research and implementation, network analysis could prove useful in the development of personalised, effective interventions for people at increased risk of suicide in the future.

References

Aaltonen, K. I., Isometsä, E., Sund, R., & Pirkola, S. (2019). Risk factors for suicide in depression in Finland: First-hospitalized patients followed up to 24 years. *Acta Psychiatrica Scandinavica*, *139*(2), 154–163. https://doi.org/10.1111/acps.12990

Ali, B., Staniforth, B., & Adamson, C. (2021). Qualitative research: Reflecting on lived experience: Suicide prevention and the importance of social work in mental health. *Aotearoa New Zealand Social Work*, *33*(2), 6–18. https://doi.org/10.11157/anzswj-vol33iss2id861

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders (5th ed.)*. American Psychiatric Publishing.

Assing Hvidt, E., Ploug, T., & Holm, S. (2016). The impact of telephone crisis services on suicidal users: A systematic review of the past 45 years. *Mental Health Review Journal*, *21*(2), 141–160. https://doi.org/10.1108/MHRJ-07-2015-0019

Baumeister, R. F. (1990). Suicide as escape from self. *Psychological Review*, *97*(1), 90–113. https://doi.org/10.1037/0033-295X.97.1.90

Beard, C., Millner, A. J., Forgeard, M. J. C., Fried, E. I., Hsu, K. J., Treadway, M. T., Leonard, C. V., Kertz, S. J., & Björgvinsson, T. (2016). Network analysis of depression and anxiety symptom relationships in a psychiatric sample. *Psychological Medicine*, *46*(16), 3359–3369. https://doi.org/10.1017/S0033291716002300

Beautrais, A. L. (2000). *Restricting access to means of suicide in New Zealand*. https://www.moh.govt.nz/notebook/nbbooks.nsf/0/53172E5F2B55B4F04C2569300071DBF9/$file/Methodsofsuicide.pdf

Beautrais, A. L., & Fergusson, D. M. (2006). Indigenous suicide in New Zealand. *Archives of Suicide Research, 10*(2), 159–168. https://doi.org/10.1080/13811110600556913

Beautrais, A. L., Fergusson, D. M., & Horwood, L. J. (2006). Firearms legislation and reductions in firearm-related suicide deaths in New Zealand. *Australian & New Zealand Journal of Psychiatry*, *40*(3), 253–259. https://doi.org/10.1080/j.1440-1614.2006.01782.x

Beautrais, A. L., Wells, J. E., McGee, M. A., & Oakley Browne, M. A. (2006). Suicidal Behaviour in Te Rau Hinengaro: The New Zealand Mental Health Survey. *Australian & New Zealand Journal of Psychiatry*, *40*(10), 896–904. https://doi.org/10.1080/j.1440-1614.2006.01909.x

Beck, A. T., Weissman, A., Lester, D., & Trexler, L. (1974). The measurement of pessimism: The Hopelessness Scale. *Journal of Consulting and Clinical Psychology*, *42*(6), 861–865. https://doi.org/10.1037/h0037562

Berman, A. L., & Silverman, M. M. (2014). Suicide risk assessment and risk formulation part II: Suicide risk formulation and the determination of levels of risk. *Suicide and Life-Threatening Behavior*, *44*(4), 432–443. https://doi.org/10.1111/sltb.12067

Blades, C. A., Stritzke, W. G. K., Page, A. C., & Brown, J. D. (2018). The benefits and risks of asking research participants about suicide: A meta-analysis of the impact of exposure to suicide-related content. *Clinical Psychology Review*, *64*, 1–12. https://doi.org/10.1016/j.cpr.2018.07.001

Bolton, J. M., Belik, S.-L., Enns, M. W., Cox, B. J., & Sareen, J. (2008). Exploring the correlates of suicide attempts among individuals with major depressive disorder: Findings from the national epidemiologic survey on alcohol and related conditions. *The Journal of Clinical Psychiatry*, *69*(7), 1139–1149. https://doi.org/10.4088/jcp.v69n0714

Bolton, J. M., Pagura, J., Enns, M. W., Grant, B., & Sareen, J. (2010). A population-based longitudinal study of risk factors for suicide attempts in major depressive disorder. *Journal of Psychiatric Research*, *44*(13), 817–826. https://doi.org/10.1016/j.jpsychires.2010.01.003

Borges, G., Bagge, C., Cherpitel, C. J., Conner, K., Orozco, R., & Rossow, I. (2017). A meta-analysis of acute alcohol use and the risk of suicide attempt. *Psychological Medicine*, *47*(5), 949–957. https://doi.org/10.1017/S0033291716002841

Borsboom, D. (2008). Psychometric perspectives on diagnostic systems. *Journal of Clinical Psychology*, *64*(9), 1089–1108. https://doi.org/10.1002/jclp.20503

Borsboom, D., & Cramer, A. O. J. (2013). Network analysis: An integrative approach to the structure of psychopathology. *Annual Review of Clinical Psychology*, *9*(1), 91–121. https://doi.org/10.1146/annurev-clinpsy-050212-185608

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. https://doi.org/10.1016/j.jpsychires.2019.07.007

Bringmann, L., Elmer, T., Epskamp, S., Krause, R., Schoch, D., Wichers, M., Wigman, J., & Snippe, E. (2019). What do centrality measures measure in psychological networks? *Journal of Abnormal Psychology*, *128*(8), 892–903. https://doi.org/10.1037/abn0000446

Bringmann, L. F., Lemmens, L. H. J. M., Huibers, M. J. H., Borsboom, D., & Tuerlinckx, F. (2014). Revealing the dynamic network structure of the Beck Depression Inventory-II. *Psychological Medicine*, *45*(04), 747–757. https://doi.org/10.1017/s0033291714001809

Brown, S. L., Marshall, A. J., Mitchell, S. M., Roush, J. F., Mumma, G. H., Jahn, D. R., Ribeiro, J. D., Joiner, T. E., & Cukrowicz, K. C. (2021). Suicide ideation and thwarted interpersonal needs among psychiatric inpatients: A network approach. *Clinical Psychological Science*, *9*(6), 1080–1094. https://doi.org/10.1177/21677026211000670

Bryan, C. J., & Rudd, M. D. (2016). The importance of temporal dynamics in the transition from suicidal thought to behavior. *Clinical Psychology: Science and Practice*, *23*(1), 21–25. https://doi.org/10.1111/cpsp.12135

Cameron, S., Brown, V. J., Dritschel, B., Power, K., & Cook, M. (2017). Understanding the relationship between suicidality, current depressed mood, personality, and cognitive factors. *Psychology and Psychotherapy: Theory, Research and Practice*, *90*(4), 530–549. https://doi.org/10.1111/papt.12123

Carmichael, V., & Whitley, R. (2019). Media coverage of Robin Williams' suicide in the United States: A contributor to contagion? *PLOS ONE*, *14*(5), e0216543. https://doi.org/10.1371/journal.pone.0216543

Carter, G., Page, A., Large, M., Hetrick, S., Milner, A. J., Bendit, N., Walton, C., Draper, B., Hazell, P., Fortune, S., Burns, J., Patton, G., Lawrence, M., Dadd, L., Dudley, M., Robinson, J., & Christensen, H. (2016). Royal Australian and New Zealand College of Psychiatrists clinical practice guideline for the management of deliberate self-harm. *Australian & New Zealand Journal of Psychiatry*, *50*(10). https://doi.org/10.1177/0004867416661039

Carter, G., & Spittal, M. J. (2018). Risk stratification is not accurate enough to be clinically useful and alternative approaches are needed. *Crisis*, *39*(4), 229–234. https://doi.org/10.1027/0227-5910/a000558

Cerel, J., Brown, M. M., Maple, M., Singleton, M., Venne, J. van de, Moore, M., & Flaherty, C. (2019). How many people are exposed to suicide? Not six. *Suicide and Life-Threatening Behavior*, *49*(2), 529–534. https://doi.org/10.1111/sltb.12450

Cerel, J., Maple, M., van de Venne, J., Moore, M., Flaherty, C., & Brown, M. (2016). Exposure to suicide in the community: Prevalence and correlates in one U.S. state. *Public Health Reports*, *131*(1), 100–107. https://doi.org/10.1177/003335491613100116

Cherpitel, C. J., Borges, G. L. G., & Wilcox, H. C. (2004). Acute alcohol use and suicidal behavior: A review of the literature. *Alcoholism: Clinical and Experimental Research*, *28*(5), S18–S28. https://doi.org/10.1097/01.ALC.0000127411.61634.14

Chiang, A., Paynter, J., Edlin, R., & Exeter, D. J. (2021). Suicide preceded by health services contact – A whole-of-population study in New Zealand 2013-2015. *PLOS ONE*, *16*(12), e0261163. https://doi.org/10.1371/journal.pone.0261163

Conner, K. R., Huguet, N., Caetano, R., Giesbrecht, N., McFarland, B. H., Nolte, K. B., & Kaplan, M. S. (2013). Acute use of alcohol and methods of suicide in a US national sample. *American Journal of Public Health*, *104*(1), 171–178. https://doi.org/10.2105/AJPH.2013.301352

Conner, K. R., Langley, J., Tomaszewski, K. J., & Conwell, Y. (2003). Injury hospitalization and risks for subsequent self-Injury and suicide: A national study From New Zealand. *American Journal of Public Health*, *93*(7), 1128–1131. https://doi.org/10.2105/AJPH.93.7.1128

Conner, T. (2015). *Experience sampling and ecological momentary assessment with mobile phones*. University of Otago. https://www.otago.ac.nz/psychology/otago047475.pdf

Coppersmith, D. D. L., Fortgang, R. G., Kleiman, E. M., Millner, A. J., Yeager, A. L., Mair, P., & Nock, M. K. (2022). Effect of frequent assessment of suicidal thinking on its incidence and severity: High-resolution real-time monitoring study. *The British Journal of Psychiatry*, *220*(1), 41–43. https://doi.org/10.1192/bjp.2021.97

Coppersmith, D. D. L., 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. https://doi.org/10.1016/j.brat.2018.11.016

Coronial Services of New Zealand. (2020). *2020 annual provisional suicide statistics*. https://coronialservices.justice.govt.nz/assets/Documents/Publications/2020-Annual-Provisional-Suicide-Statistics.pdf

Cramer, A. O. J., van Borkulo, C. D., Giltay, E. J., van der Maas, H. L. J., Kendler, K. S., Scheffer, M., & Borsboom, D. (2016). Major depression as a complex dynamic system. *PLOS ONE*, *11*(12), e0167490. https://doi.org/10.1371/journal.pone.0167490

Crossin, R., Cleland, L., Beautrais, A. L., Witt, K., & Boden, J. M. (2022). Acute alcohol use and suicide deaths: An analysis of New Zealand coronial data from 2007–2020. *New Zealand Medical Journal*, *135*(1558). https://journal.nzma.org.nz/journal-articles/acute-alcohol-use-and-suicide-deaths-an-analysis-of-new-zealand-coronial-data-from-2007-2020

Crowe, E., Daly, M., Delaney, L., Carroll, S., & Malone, K. M. (2019). The intra-day dynamics of affect, self-esteem, tiredness, and suicidality in Major Depression. *Psychiatry Research*, *279*, 98–108. https://doi.org/10.1016/j.psychres.2018.02.032

Czyz, E. K., King, C. A., & Nahum-Shani, I. (2018). Ecological assessment of daily suicidal thoughts and attempts among suicidal teens after psychiatric hospitalization: Lessons

about feasibility and acceptability. *Psychiatry Research*, *267*, 566–574. https://doi.org/10.1016/j.psychres.2018.06.031

Davidson, C. L., Anestis, M. D., & Gutierrez, P. M. (2016). Ecological momentary assessment is a neglected methodology in suicidology. *Archives of Suicide Research*, *21*(1), 1–11. https://doi.org/10.1080/13811118.2015.1004482

Dazzi, T., Gribble, R., Wessely, S., & Fear, N. T. (2014). Does asking about suicide and related behaviours induce suicidal ideation? What is the evidence? *Psychological Medicine*, *44*(16), 3361–3363. https://doi.org/10.1017/S0033291714001299

de Beer, W., de Witt, B., Schofield, J., Clark, H., & Gibbons, V. (2018). An audit of risk assessments for suicide and attempted suicide in ED: A retrospective review of quality. *New Zealand Medical Journal*, *131*(1470), 14–21.

de Beurs, D., Fried, E., Wetherall, K., Cleare, S., O'Connor, D., Ferguson, E., O'Carroll, R., & O'Connor, R. (2019). Exploring the psychology of suicidal ideation: A theory driven network analysis. *Behaviour Research and Therapy*, *120*. https://doi.org/10.1016/j.brat.2019.103419

de Beurs, Derek., van Borkulo, C. D., & O'Connor, R. C. (2017). Association between suicidal symptoms and repeat suicidal behaviour within a sample of hospital-treated suicide attempters. *BJPsych Open*, *3*(3), 120–126. https://doi.org/10.1192/bjpo.bp.116.004275

Delam, H., & Bazrafshan, M. R. (2019). Anxiety and self-esteem score in adults with a suicide attempt history. *Journal of Health Sciences & Surveillance System*, *7*(4), 5. https://doi.org/10.30476/JHSSS.2020.85615.1071

Dhingra, K., Klonsky, E. D., & Tapola, V. (2019). An empirical test of the Three-Step Theory of Suicide in U.K. university students. *Suicide and Life-Threatening Behavior*, *49*(2), 478–487. https://doi.org/10.1111/sltb.12437

Dobson, E. T., Croarkin, P. E., Schroeder, H. K., Varney, S. T., Mossman, S. A., Cecil, K., & Strawn, J. R. (2021). Bridging anxiety and depression: A network approach in anxious adolescents. *Journal of Affective Disorders*, *280*, 305–314. https://doi.org/10.1016/j.jad.2020.11.027

Dong, M., Zeng, L.-N., Lu, L., Li, X.-H., Ungvari, G. S., Ng, C. H., Chow, I. H. I., Zhang, L., Zhou, Y., & Xiang, Y.-T. (2019). Prevalence of suicide attempt in individuals with major depressive disorder: A meta-analysis of observational surveys. *Psychological Medicine*, *49*(10), 1691–1704. https://doi.org/10.1017/S0033291718002301

Ducasse, D., Loas, G., Dassa, D., Gramaglia, C., Zeppegno, P., Guillaume, S., Olié, E., & Courtet, P. (2018). Anhedonia is associated with suicidal ideation independently of depression: A meta-analysis. *Depression and Anxiety*, *35*(5), 382–392. https://doi.org/10.1002/da.22709

Duffy, M. E., Mueller, N. E., Cougle, J. R., & Joiner, T. E. (2020). Perceived burdensomeness uniquely accounts for suicidal ideation severity in social anxiety disorder. *Journal of Affective Disorders*, *266*, 43–48. https://doi.org/10.1016/j.jad.2020.01.116

Durkheim, E. (2006). *On suicide*. Penguin.

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). https://doi.org/10.1177/1073191120957102

Elliott, H., Jones, P. J., & Schmidt, U. (2020). Central symptoms predict posttreatment outcomes and clinical impairment in Anorexia Nervosa: A network analysis. *Clinical Psychological Science*, *8*(1), 139–154. https://doi.org/10.1177/2167702619865958

Epskamp, S. (2020). *graphicalVAR: Graphical VAR for Experience Sampling Data* (0.2.4) [R]. https://CRAN.R-project.org/package=graphicalVAR

Epskamp, S., Borsboom, D., & Fried, E. I. (2018). Estimating psychological networks and their accuracy: A tutorial paper. *Behavior Research Methods*, *50*(1), 195–212. https://doi.org/10.3758/s13428-017-0862-1

Epskamp, S., Cramer, A. O. J., Waldorp, L. J., Schmittmann, V. D., & Borsboom, D. (2012). qgraph: Network visualizations of relationships in psychometric data. *Journal of Statistical Software*, *48*(4), 1–18. https://doi.org/10.18637/jss.v048.i04

Epskamp, S., Deserno, M. K., & Bringmann, L. F. (2019). *mlVAR: Multi-level vector autoregression* (0.4.4) [R]. https://CRAN.R-project.org/package=mlVAR

Epskamp, S., & Fried, E. I. (2018). A tutorial on regularized partial correlation networks. *Psychological Methods*, *23*(4), 617–634. https://doi.org/10.1037/met0000167

Epskamp, S., Maris, G. K. J., Waldorp, L. J., & Borsboom, D. (2018). Network Psychometrics. In P. Irwing, T. Booth, & D. J. Hughes (Eds.), *The Wiley Handbook of Psychometric Testing: A Multidisciplinary Reference on Survey, Scale and Test Development*.

Epskamp, S., van Borkulo, C., van der Veen, D. C., Servaas, M. N., Isvoranu, A.-M., Riese, H., & Cramer, A. O. J. (2018). Personalized network modeling in psychopathology: The importance of contemporaneous and temporal connections. *Clinical Psychological Science*, *6*, 416–427. https://doi.org/10.1177/2167702617744325

Epskamp, S., Waldorp, L. J., Mõttus, R., & Borsboom, D. (2018). The Gaussian graphical model in cross-sectional and time-series data. *Multivariate Behavioral Research*, *53*(4), 453–480. https://doi.org/10.1080/00273171.2018.1454823

Feigelman, W., Cerel, J., McIntosh, J. L., Brent, D., & Gutin, N. (2018). Suicide exposures and bereavement among American adults: Evidence from the 2016 General Social Survey. *Journal of Affective Disorders*, *227*, 1–6. https://doi.org/10.1016/j.jad.2017.09.056

Ferguson, M., Rhodes, K., Loughhead, M., McIntyre, H., & Procter, N. (2022). The effectiveness of the safety planning intervention for adults experiencing suicide-related distress: A systematic review. *Archives of Suicide Research*, *26*(3), 1022–1045. https://doi.org/10.1080/13811118.2021.1915217

Fergusson, D. M., Beautrais, A. L., & Horwood, L. J. (2003). Vulnerability and resiliency to suicidal behaviours in young people. *Psychological Medicine*, *33*(1), 61–73. https://doi.org/10.1017/S0033291702006748

Fink, D. S., Santaella-Tenorio, J., & Keyes, K. M. (2018). Increase in suicides the months after the death of Robin Williams in the US. *PLOS ONE*, *13*(2), e0191405. https://doi.org/10.1371/journal.pone.0191405

Finlayson, M., & Simmonds, J. G. (2018). Impact of client suicide on psychologists in Australia. *Australian Psychologist*, *53*(1), 23–32. https://doi.org/10.1111/ap.12240

Fonseca-Pedrero, E. (2018). Network analysis in psychology. *Papeles Del Psicólogo - Psychologist Papers*, *39*(1), 1–12. https://doi.org/10.23923/pap.psicol2018.2852

Forkmann, T., Spangenberg, L., Rath, D., Hallensleben, N., Hegerl, U., Kersting, A., & Glaesmer, H. (2018). Assessing suicidality in real time: A psychometric evaluation of self-report items for the assessment of suicidal ideation and its proximal risk factors using

ecological momentary assessments. *Journal of Abnormal Psychology*, *127*(8), 758–769. https://doi.org/10.1037/abn0000381

Forrest, L. N., Jones, P. J., Ortiz, S. N., & Smith, A. R. (2018). Core psychopathology in anorexia nervosa and bulimia nervosa: A network analysis. *International Journal of Eating Disorders*, *51*(7), 668–679. https://doi.org/10.1002/eat.22871

Fortune, S., & Hetrick, S. (2022). Suicide risk assessments: Why are we still relying on these a decade after the evidence showed they perform poorly? *Australian & New Zealand Journal of Psychiatry*, *56*(12), 1529–1534. https://doi.org/10.1177/00048674221107316

Fox, K. R., Huang, X., Guzmán, E. M., Funsch, K. M., Cha, C. B., Ribeiro, J. D., & Franklin, J. C. (2020). Interventions for suicide and self-injury: A meta-analysis of randomized controlled trials across nearly 50 years of research. *Psychological Bulletin*, *146*(12), 1117–1145. https://doi.org/10.1037/bul0000305

Franklin, J. C., Ribeiro, J. D., Fox, K. R., Bentley, K. H., Kleiman, E. M., Huang, X., Musacchio, K. M., Jaroszewski, A. C., Chang, B. P., & Nock, M. K. (2017). Risk factors for suicidal thoughts and behaviors: A meta-analysis of 50 years of research. *Psychological Bulletin*, *143*(2), 187–232. https://doi.org/10.1037/bul0000084

Fried, E. I., Epskamp, S., Nesse, R. M., Tuerlinckx, F., & Borsboom, D. (2016). What are 'good' depression symptoms? Comparing the centrality of DSM and non-DSM symptoms of depression in a network analysis. *Journal of Affective Disorders*, *189*, 314–320. https://doi.org/10.1016/j.jad.2015.09.005

Ftanou, M., Cox, G., Nicholas, A., Spittal, M. J., Machlin, A., Robinson, J., & Pirkis, J. (2017). Suicide prevention public service announcements (PSAs): Examples from around the

world. *Health Communication*, *32*(4), 493–501. https://doi.org/10.1080/10410236.2016.1140269

Gibb, S. J., Beautrais, A. L., & Fergusson, D. M. (2005). Mortality and further suicidal behaviour after an index suicide attempt: A 10 year study. *Australian and New Zealand Journal of Psychiatry*, *39*(1), 95–100. https://doi.org/10.1080/j.1440-1614.2005.01514.x

Glenn, C. R., Kleiman, E. M., Kearns, J. C., Santee, A. C., Esposito, E. C., Conwell, Y., & Alpert-Gillis, L. J. (2022). Feasibility and acceptability of ecological momentary assessment with high-risk suicidal adolescents following acute psychiatric care. *Journal of Clinical Child & Adolescent Psychology*, *51*(1), 32–48. https://doi.org/10.1080/15374416.2020.1741377

Greene, T., Gelkopf, M., Fried, E. I., Robinaugh, D. J., & Pickman, L. L. (2020). Dynamic network analysis of negative emotions and DSM-5 posttraumatic stress disorder symptom clusters during conflict. *Journal of Traumatic Stress*, *33*(1), 72–83. https://doi.org/10.1002/jts.22433

Gunn, J. F., & Lester, D. (2015). *Theories of Suicide: Past, Present and Future*. Charles C Thomas Publisher.

Hains, A., Janackovski, A., Deane, F. P., & Rankin, K. (2019). Perceived burdensomeness predicts outcomes of short-term psychological treatment of young people at risk of suicide. *Suicide and Life-Threatening Behavior*, *49*(2), 586–597. https://doi.org/10.1111/sltb.12452

Hallensleben, N., Glaesmer, H., Forkmann, T., Rath, D., Strauss, M., Kersting, A., & Spangenberg, L. (2019). Predicting suicidal ideation by interpersonal variables, hopelessness and depression in real-time. An ecological momentary assessment study in

psychiatric inpatients with depression. *European Psychiatry*, *56*, 43–50. https://doi.org/10.1016/j.eurpsy.2018.11.003

Hallensleben, N., Spangenberg, L., Forkmann, T., Rath, D., Hegerl, U., Kersting, A., Kallert, T. W., & Glaesmer, H. (2017). Investigating the dynamics of suicidal ideation. *Crisis*, *39*(1), 65–69. https://doi.org/10.1027/0227-5910/a000464

Harter, S. (2012). *Self-perception profile for adolescents: Manual and questionnaires*. University of Denver, Department of Psychology.

Hawes, M., Galynker, I., Barzilay, S., & Yaseen, Z. S. (2018). Anhedonia and suicidal thoughts and behaviors in psychiatric outpatients: The role of acuity. *Depression and Anxiety*, *35*(12), 1218–1227. https://doi.org/10.1002/da.22814

Hawton, K., Casañas i Comabella, C., Haw, C., & Saunders, K. (2013). Risk factors for suicide in individuals with depression: A systematic review. *Journal of Affective Disorders*, *147*(1), 17–28. https://doi.org/10.1016/j.jad.2013.01.004

Head, M. L., Holman, L., Lanfear, R., Kahn, A. T., & Jennions, M. D. (2015). The extent and consequences of p-hacking in science. *PLoS Biology*, *13*(3), e1002106. https://doi.org/10.1371/journal.pbio.1002106

Heeren, A., Jones, P. J., & McNally, R. J. (2018). Mapping network connectivity among symptoms of social anxiety and comorbid depression in people with social anxiety disorder. *Journal of Affective Disorders*, *228*, 75–82. https://doi.org/10.1016/j.jad.2017.12.003

Hill, R. M., & Pettit, J. W. (2014). Perceived burdensomeness and suicide-related behaviors in clinical samples: Current evidence and future directions. *Journal of Clinical Psychology*, *70*(7), 631–643. https://doi.org/10.1002/jclp.22071

Hoffart, A., Johnson, S. U., & Ebrahimi, O. V. (2021). The network of stress-related states and depression and anxiety symptoms during the COVID-19 lockdown. *Journal of Affective Disorders*, *294*, 671–678. https://doi.org/10.1016/j.jad.2021.07.019

Holman, M. S., & Williams, M. N. (2019). *Young New Zealanders' Beliefs About Youth Suicide and How It Can Be Prevented* [Preprint]. PsyArXiv. https://psyarxiv.com/wgmp4/

Holman, M. S., & Williams, M. N. (2020). Young New Zealanders' beliefs about youth suicide and how it can be prevented. *New Zealand Journal of Psychology*, *49*(1). https://www.psychology.org.nz/application/files/7615/9538/4266/Holman_and_Williams_22-28.pdf

Holman, M. S., & Williams, M. N. (2022). Suicide risk and protective factors: A network approach. *Archives of Suicide Research*, *26*(1), 137–154. https://doi.org/10.1080/13811118.2020.1774454

Howson, M. A., Yates, K. M., & Hatcher, S. (2008). Re-presentation and suicide rates in emergency department patients who self-harm. *Emergency Medicine Australasia*, *20*(4), 322–327. https://doi.org/10.1111/j.1742-6723.2008.01104.x

Hufford, M. R. (2007). Special methodological challenges and opportunities in ecological momentary assessment. In A. Stone, S. Shiffman, A. Atienza, & L. Nebeling (Eds.), *The Science of Real-Time Data Capture: Self-Reports in Health Research*. Oxford University Press.

Humphry, S. M., & McGrane, J. A. (2010). Is there a contradiction between the network and latent variable perspectives? *Behavioral and Brain Sciences*, *33*(2–3), 160–161. https://doi.org/10.1017/S0140525X10000786

Husky, M., Olié, E., Guillaume, S., Genty, C., Swendsen, J., & Courtet, P. (2014). Feasibility and validity of ecological momentary assessment in the investigation of suicide risk. *Psychiatry Research, 220*(1), 564–570. https://doi.org/10.1016/j.psychres.2014.08.019

ilumivu. (n.d.). *mEMA App*. Ilumivu. Retrieved 30 July 2021, from https://ilumivu.com/solutions/ecological-momentary-assessment-app/

Jenkins, B. N., Hunter, J. F., Richardson, M. J., Conner, T. S., & Pressman, S. D. (2020). Affect variability and predictability: Using recurrence quantification analysis to better understand how the dynamics of affect relate to health. *Emotion, 20*(3), 391–402. https://doi.org/10.1037/emo0000556

Johnson, B. D. (1965). Durkheim's one cause of suicide. *American Sociological Review, 30*(6), 875–886. https://doi.org/10.2307/2090966

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

Jones, P. J., Ma, R., & McNally, R. J. (2021). Bridge centrality: A network approach to understanding comorbidity. *Multivariate Behavioral Research, 56*(2), 353–367. https://doi.org/10.1080/00273171.2019.1614898

Kerr, N. L. (1998). HARKing: Hypothesizing after the results are known. *Personality and Social Psychology Review, 2*(3), 196–217. https://doi.org/10.1207/s15327957pspr0203_4

Kim, K. M., Kim, H., Kim, D., & Kim, J.-W. (2021). The analysis of network structure among the depressive symptoms in a clinical sample of children and adolescents. *Asian Journal of Psychiatry, 62*, 102748. https://doi.org/10.1016/j.ajp.2021.102748

Kirtley, O. J., Lafit, G., Achterhof, R., Hiekkaranta, A. P., & Myin-Germeys, I. (2020). *A template and tutorial for (pre-)registration of studies using experience sampling methods (ESM)*. https://doi.org/10.17605/OSF.IO/2CHMU

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. https://doi.org/10.1177/2515245920924686

Kleiman, E. (2017). *Package 'EMAtools'*. https://cran.r-project.org/web/packages/EMAtools/EMAtools.pdf

Kleiman, E. M., & Liu, R. T. (2013). Social support as a protective factor in suicide: Findings from two nationally representative samples. *Journal of Affective Disorders*, *150*(2), 540–545. https://doi.org/10.1016/j.jad.2013.01.033

Kleiman, E. M., Turner, B. J., Chapman, A. L., & Nock, M. K. (2018). Fatigue moderates the relationship between perceived stress and suicidal ideation: Evidence from two high-resolution studies. *Journal of Clinical Child & Adolescent Psychology*, *47*(1), 116–130. https://doi.org/10.1080/15374416.2017.1342543

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), 726–738. https://doi.org/10.1037/abn0000273

Klonsky, E. D., & May, A. M. (2014). Differentiating suicide attempters from suicide ideators: A critical frontier for suicidology research. *Suicide and Life-Threatening Behavior*, *44*(1), 1–5. https://doi.org/10.1111/sltb.12068

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. https://doi.org/10.1521/ijct.2015.8.2.114

Knowles, R., Tai, S., Jones, S. H., Highfield, J., Morriss, R., & Bentall, R. P. (2007). Stability of self-esteem in bipolar disorder: Comparisons among remitted bipolar patients, remitted unipolar patients and healthy controls. *Bipolar Disorders*, *9*(5), 490–495. https://doi.org/10.1111/j.1399-5618.2007.00457.x

Kuo, W. H., Gallo, J. J., & Eaton, W. W. (2004). Hopelessness, depression, substance disorder, and suicidality—A 13-year community-based study. *Social Psychiatry and Psychiatric Epidemiology*, *39*(6), 497–501. https://doi.org/10.1007/s00127-004-0775-z

Kyron, M. J., Hooke, G. R., & Page, A. C. (2019). Assessing interpersonal and mood factors to predict trajectories of suicidal ideation within an inpatient setting. *Journal of Affective Disorders*, *252*, 315–324. https://doi.org/10.1016/j.jad.2019.04.029

Lakens, D. (2019). *The Value of Preregistration for Psychological Science: A Conceptual Analysis*. https://doi.org/10.31234/osf.io/jbh4w

Large, M., Sharma, S., Cannon, E., Ryan, C., & Nielssen, O. (2011). Risk factors for suicide within a year of discharge from psychiatric hospital: A systematic meta-analysis. *Australian & New Zealand Journal of Psychiatry*, *45*(8), 619–628. https://doi.org/10.3109/00048674.2011.590465

Law, M. K., Furr, R. M., Arnold, E. M., Mneimne, M., Jaquett, C., & Fleeson, W. (2015). Does assessing suicidality frequently and repeatedly cause harm? A randomized control study. *Psychological Assessment*, *27*(4), 1171–1181. https://doi.org/10.1037/pas0000118

Levinson, C. A., Vanzhula, I., & Brosof, L. C. (2018). Longitudinal and personalized networks of eating disorder cognitions and behaviors: Targets for precision intervention a proof of concept study. *International Journal of Eating Disorders*, *51*(11), 1233–1243. https://doi.org/10.1002/eat.22952

Liu, Y., Zhang, J., & Sun, L. (2017). Who are likely to attempt suicide again? A comparative study between the first and multiple timers. *Comprehensive Psychiatry, 78*, 54–60. https://doi.org/10.1016/j.comppsych.2017.07.007

Luoma, J. B., Martin, C. E., & Pearson, J. L. (2002). Contact with mental health and primary care providers before suicide: A review of the evidence. *The American Journal of Psychiatry, 159*(6), 909–916. https://doi.org/10.1176/appi.ajp.159.6.909

Lynch, T. R., Johnson, C. S., Mendelson, T., Robins, C. J., Krishnan, K. R. R., & Blazer, D. G. (1999). Correlates of suicidal ideation among an elderly depressed sample. *Journal of Affective Disorders*, *56*(1), 9–15. https://doi.org/10.1016/S0165-0327(99)00022-1

Ma, J., Batterham, P. J., Calear, A. L., & Han, J. (2016). A systematic review of the predictions of the Interpersonal–Psychological Theory of Suicidal Behavior. *Clinical Psychology Review*, *46*, 34–45. https://doi.org/10.1016/j.cpr.2016.04.008

Machado, C. dos S., Ballester, P. L., Cao, B., Mwangi, B., Caldieraro, M. A., Kapczinski, F., & Passos, I. C. (2022). Prediction of suicide attempts in a prospective cohort study with a nationally representative sample of the US population. *Psychological Medicine*, *52*(14), 2985–2996. https://doi.org/10.1017/S0033291720004997

Madsen, T., Erlangsen, A., Hjorthøj, C., & Nordentoft, M. (2020). High suicide rates during psychiatric inpatient stay and shortly after discharge. *Acta Psychiatrica Scandinavica*, *142*(5), 355–365. https://doi.org/10.1111/acps.13221

Mates in Construction New Zealand. (n.d.). *MATES*. https://mates.net.nz/

McNally, R. J. (2016). Can network analysis transform psychopathology? *Behaviour Research and Therapy*, *86*, 95–104. https://doi.org/10.1016/j.brat.2016.06.006

Melbourne eResearch Group. (n.d.). *SEMA3*. Retrieved 30 July 2021, from https://sema3.com/

Mental Health Foundation. (2014). *Mental Health Foundation: Quick facts and stats 2014*. Mental Health Foundation. https://www.mentalhealth.org.nz/assets/Uploads/MHF-Quick-facts-and-stats-FINAL-2016.pdf

Mental Health Foundation. (n.d.). *Suicide statistics*. https://mentalhealth.org.nz/suicide-prevention/suicide-statistics

Ministry of Health. (1998). *Guidelines for clinical risk assessment and management in mental health services*. Ministry of Health. https://www.moh.govt.nz/notebook/nbbooks.nsf/0/2fe380c25ed2f1b34c25668600741eba/$FILE/mentalra.pdf

Ministry of Health. (2003). *The assessment and management of people at risk of suicide: For emergency departments and mental health service acute assessment settings.* New Zealand Guidelines Group : Ministry of Health. https://www.health.govt.nz/publication/assessment-and-management-people-risk-suicide

Ministry of Health. (2011). *Reporting suicide: A resource for the media*. https://www.health.govt.nz/system/files/documents/publications/reporting-suicide-a-resource-for-media-dec2011.pdf

Ministry of Health. (2019). *Every Life Matters – He Tapu te Oranga o ia tangata: Suicide Prevention Strategy 2019–2029 and Suicide Prevention Action Plan 2019–2024 for Aotearoa New Zealand.* Ministry of Health. https://www.health.govt.nz/system/files/documents/publications/suicide-prevention-strategy-2019-2029-and-plan-2019-2024-v2.pdf

Ministry of Health. (2022). *Self-harm hospitalisations and short stay ED presentations—September 2022*. https://nsfl.health.govt.nz/dhb-planning-package/system-level-measures-framework/data-support-system-level-measures/youth-slm--2

Ministry of Justice. (2021). *Request for Statistics Regarding Alcohol and Suicides*.

Nadorff, M. R., Ellis, T. E., Allen, J. G., Winer, E. S., & Herrera, S. (2014). Presence and persistence of sleep-related symptoms and suicidal ideation in psychiatric inpatients. *Crisis*, *35*(6). https://doi.org/10.1027/0227-5910/a000279

National Institute for Health and Care Excellence. (2022). *Self-harm: Assessment, management and preventing recurrence*. NICE. https://www.nice.org.uk/guidance/ng225

Nock, M. K., Prinstein, M. J., & Sterba, S. K. (2010). Revealing the form and function of self-injurious thoughts and behaviors: A real-time ecological assessment study among adolescents and young adults. *Journal of Abnormal Psychology*, *118*(4), 816–827. https://doi.org/10.1037/a0016948

Nosek, B. A., Ebersole, C. R., DeHaven, A. C., & Mellor, D. T. (2018). The preregistration revolution. *Proceedings of the National Academy of Sciences*, *115*(11), 2600. https://doi.org/10.1073/pnas.1708274114

O'Connor, R. C. (2011). Towards an integrated motivational–volitional model of suicidal behaviour. In *International Handbook of Suicide Prevention* (pp. 181–198). John Wiley & Sons, Ltd. https://doi.org/10.1002/9781119998556.ch11

O'Connor, R. C., & Portzky, G. (2018). Looking to the future: A synthesis of new developments and challenges in suicide research and prevention. *Frontiers in Psychology, 9*. https://doi.org/10.3389/fpsyg.2018.02139

O'Dea, D., & Tucker, S. (2005). *The cost of suicide to society*. https://www.health.govt.nz/system/files/documents/publications/thecostofsuicidetosociety.pdf

Papini, S., Rubin, M., Telch, M. J., Smits, J. A. J., & Hien, D. A. (2019). Pre-treatment post-traumatic stress disorder symptom network metrics predict the strength of the association between node change and network change during treatment. *Journal of Traumatic Stress*, *0*(0). https://doi.org/10.1002/jts.22379

Park, S.-C., & Kim, D. (2020). The centrality of depression and anxiety symptoms in Major Depressive Disorder determined using a network analysis. *Journal of Affective Disorders*, *271*, 19–26. https://doi.org/10.1016/j.jad.2020.03.078

Pearl, J. (2000). *Causality: Models, reasoning and inference* (Vol. 29). Cambridge University Press.

Pereira-Morales, A. J., Adan, A., & Forero, D. A. (2019). Network analysis of multiple risk factors for mental health in young Colombian adults. *Journal of Mental Health*, *28*(2), 153–160. https://doi.org/10.1080/09638237.2017.1417568

Pirkis, J., & Blood, W. (2010). *Suicide and the news and information media*. http://www.mindframe-media.info/__data/assets/pdf_file/0016/5164/Pirkis-and-Blood-2010,-Suicide-and-the-news-and-information-media.pdf

Pirkis, J., Currier, D., Too, L. S., Bryant, M., Bartlett, S., Sinyor, M., & Spittal, M. J. (2020). Suicides in Australia following media reports of the death of Robin Williams. *Australian & New Zealand Journal of Psychiatry*, *54*(1), 99–104. https://doi.org/10.1177/0004867419888297

Pisani, A. R., Murrie, D. C., & Silverman, M. M. (2016). Reformulating suicide risk formulation: From prediction to prevention. *Academic Psychiatry*, *40*, 623–629. https://doi.org/10.1007/s40596-015-0434-6

Pitman, A., Khrisna Putri, A., De Souza, T., Stevenson, F., King, M., Osborn, D., & Morant, N. (2018). The impact of suicide bereavement on educational and occupational functioning: A qualitative study of 460 bereaved adults. *International Journal of Environmental Research and Public Health*, *15*(4), 643. https://doi.org/10.3390/ijerph15040643

Pitman, A., Osborn, D., Rantell, K., & King, M. (2016). Bereavement by suicide as a risk factor for suicide attempt: A cross-sectional national UK-wide study of 3432 young bereaved adults. *BMJ Open*, *6*(1), e009948. https://doi.org/10.1136/bmjopen-2015-009948

Pokorny, A. D. (1983). Prediction of suicide in psychiatric patients: Report of a prospective study. *Archives of General Psychiatry*, *40*(3), 249. https://doi.org/10.1001/archpsyc.1983.01790030019002

Pompili, M., Innamorati, M., Di Vittorio, C., Sher, L., Girardi, P., & Amore, M. (2014). Sociodemographic and clinical differences between suicide ideators and attempters: A study of mood disordered patients 50 years and older. *Suicide and Life-Threatening Behavior*, *44*(1), 34–45. https://doi.org/10.1111/sltb.12051

Pūtaiora Writing Group. (2010). *Te ara tika guidelines for Māori research ethics: A framework for researchers and ethics committee members*. Health Research Council of New Zealand on behalf of the Pūtaiora Writing Group. http://www.hrc.govt.nz/assets/pdfs/publications/Te%20Ara%20Tika%20R21Jul10.pdf

R Core Team. (2021). *R: A language and environment for statistical computing* [Computer software]. R Foundation for Statistical Computing. https://www.R-project.org/

Rath, D., de Beurs, D., Hallensleben, N., Spangenberg, L., Glaesmer, H., & Forkmann, T. (2019). Modelling suicide ideation from beep to beep: Application of network analysis to ecological momentary assessment data. *Internet Interventions*, *18*. https://doi.org/10.1016/j.invent.2019.100292

Ren, L., Wang, Y., Wu, L., Wei, Z., Cui, L.-B., Wei, X., Hu, X., Peng, J., Jin, Y., Li, F., Yang, Q., & Liu, X. (2021). Network structure of depression and anxiety symptoms in Chinese female nursing students. *BMC Psychiatry*, *21*(1), 279. https://doi.org/10.1186/s12888-021-03276-1

Revelle, W. (2019). *psych: Procedures for Personality and Psychological Research* (2.0.12) [R]. https://cran.r-project.org/web/packages/psych/index.html

Ribeiro, J. D., Pease, J. L., Gutierrez, P. M., Silva, C., Bernert, R. A., Rudd, M. D., & Joiner, T. E. (2012). Sleep problems outperform depression and hopelessness as cross-sectional and longitudinal predictors of suicidal ideation and behavior in young adults in the military. *Journal of Affective Disorders*, *136*(3), 743–750. https://doi.org/10.1016/j.jad.2011.09.049

Richie, F. J., Bonner, J., Wittenborn, A., Weinstock, L. M., Zlotnick, C., & Johnson, J. E. (2019). Social support and suicidal ideation among prisoners with major depressive disorder. *Archives of Suicide Research*, 1–8. https://doi.org/10.1080/13811118.2019.1649773

Robins, J. E., Kalk, N. J., Ross, K. R., Pritchard, M., Curtis, V., & Morley, K. I. (2021). The association of acute alcohol use and dynamic suicide risk with variation in onward care after psychiatric crisis. *Drug and Alcohol Review*, *40*(3), 499–508. https://doi.org/10.1111/dar.13231

Rodebaugh, T. L., Tonge, N. A., Piccirillo, M. L., Fried, E., Horenstein, A., Morrison, A. S., Goldin, P., Gross, J. J., Lim, M. H., Fernandez, K. C., Blanco, C., Schneier, F. R., Bogdan, R., Thompson, R. J., & Heimberg, R. G. (2018). Does centrality in a cross-sectional network suggest intervention targets for social anxiety disorder? *Journal of Consulting and Clinical Psychology*, *86*(10), 831–844. https://doi.org/10.1037/ccp0000336

Roeder, K. M., & Cole, D. A. (2019). Simultaneous longitudinal examination of hopelessness, thwarted belongingness, and perceived burdensomeness as predictors of suicide ideation. *Suicide and Life-Threatening Behavior*, *49*(4), 1058–1071. https://doi.org/10.1111/sltb.12508

Rogers, M. L., & Joiner, T. E. (2019). Exploring the temporal dynamics of the interpersonal theory of suicide constructs: A dynamic systems modeling approach. *Journal of Consulting and Clinical Psychology*, *87*(1), 56–66. https://doi.org/10.1037/ccp0000373

Schiepek, G., Fartacek, C., Sturm, J., Kralovec, K., Fartacek, R., & Plöderl, M. (2011). Nonlinear Dynamics: Theoretical Perspectives and Application to Suicidology. *Suicide and Life-Threatening Behavior*, *41*(6), 661–675. https://doi.org/10.1111/j.1943-278X.2011.00062.x

Schönfelder, A., Rath, D., Forkmann, T., Paashaus, L., Lucht, L., Teismann, T., Stengler, K., Juckel, G., & Glaesmer, H. (2021). Child abuse and suicidality in the context of the Interpersonal Psychological Theory of Suicide: A network analysis. *British Journal of Clinical Psychology*, *60*(4), 425–442. https://doi.org/10.1111/bjc.12293

Shepherd, D., Taylor, S., Csako, R., Liao, A.-T., & Duncan, R. (2022). Predictors of suicide ideation and attempt planning in a large sample of New Zealand help-seekers. *Frontiers in Psychiatry*, *13*, 794775. https://doi.org/10.3389/fpsyt.2022.794775

Sher, L. (2020). Suicide in men: An underappreciated public health challenge. *European Archives of Psychiatry and Clinical Neuroscience*, *270*(2), 277–278. https://doi.org/10.1007/s00406-019-01041-w

Shiffman, S., Stone, A. A., & Hufford, M. R. (2008). Ecological momentary assessment. *Annual Review of Clinical Psychology*, *4*(1), 1–32. https://doi.org/10.1146/annurev.clinpsy.3.022806.091415

Shiratori, Y., Tachikawa, H., Nemoto, K., Endo, G., Aiba, M., Matsui, Y., & Asada, T. (2014). Network analysis for motives in suicide cases: A cross-sectional study. *Psychiatry and Clinical Neurosciences*, *68*(4), 299–307. https://doi.org/10.1111/pcn.12132

Shneidman, E. (1972). Foreword. In A. Cain (Ed.), *Survivors of Suicide* (pp. ix–xi). Charles C. Thomas.

Shneidman, E. S. (1993). *Suicide as psychache: A clinical approach to self-destructive behavior*. Jason Aronson.

Short, N. A., Stentz, L., Raines, A. M., Boffa, J. W., & Schmidt, N. B. (2019). Intervening on thwarted belongingness and perceived burdensomeness to reduce suicidality among veterans: Subanalyses from a randomized controlled trial. *Behavior Therapy*, *50*(5), 886–897. https://doi.org/10.1016/j.beth.2019.01.004

Simmons, J. P., Nelson, L. D., & Simonsohn, U. (2011). False-positive psychology: Undisclosed flexibility in data collection and analysis allows presenting anything as significant. *Psychological Science*, *22*(11), 1359–1366. https://doi.org/10.1177/0956797611417632

Simons, J. S., Simons, R. M., Walters, K. J., Keith, J. A., O'Brien, C., Andal, K., & Stoltenberg, S. F. (2019). Nexus of despair: A network analysis of suicidal ideation among veterans. *Archives of Suicide Research*, 1–23. https://doi.org/10.1080/13811118.2019.1574689

Soto-Sanz, V., Piqueras, J. A., Rodríguez-Marín, J., Pérez-Vázquez, M. T., Rodríguez-Jiménez, T., Castellvi, P., Miranda-Mendizábal, A., Parés-Badell, O., Almenara, J., Blasco, M. J., Cebrià, A., Gabilondo, A., Gili, M., Roca, M., Lagares, C., & Alonso, J. (2019). Self-esteem and suicidal behaviour in youth: A meta-analysis of longitudinal studies. *Psicothema*, *31.3*, 246–254. https://doi.org/10.7334/psicothema2018.339

Spangenberg, L., Glaesmer, H., Hallensleben, N., Rath, D., & Forkmann, T. (2019). (In)stability of capability for suicide in psychiatric inpatients: Longitudinal assessment using ecological momentary assessments. *Suicide and Life-Threatening Behavior*, *49*(6), 1560–1572. https://doi.org/10.1111/sltb.12547

Stack, S. (2005). Suicide in the media: A quantitative review of studies based on nonfictional stories. *Suicide and Life-Threatening Behavior*, *35*(2), 121–133. https://doi.org/10.1521/suli.35.2.121.62877

Statistics New Zealand. (2020). *Ethnic group summaries reveal New Zealand's multicultural make-up*. https://www.stats.govt.nz/news/ethnic-group-summaries-reveal-new-zealands-multicultural-make-up

Sueki, H. (2020). Relationship between Beck Hopelessness Scale and suicidal ideation: A short-term longitudinal study. *Death Studies*, 1–6. https://doi.org/10.1080/07481187.2020.1740833

Summers, B. J., Aalbers, G., Jones, P. J., McNally, R. J., Phillips, K. A., & Wilhelm, S. (2020). A network perspective on body dysmorphic disorder and major depressive disorder. *Journal of Affective Disorders, 262*, 165–173. https://doi.org/10.1016/j.jad.2019.11.011

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*(1), 579–604. https://doi.org/10.1146/annurev-clinpsy-050718-095710

Te Whatu Ora. (2022). *Suicide Web Tool*. https://minhealthnz.shinyapps.io/suicide-web-tool/

Teismann, T., Forkmann, T., Glaesmer, H., Egeri, L., & Margraf, J. (2016). Remission of suicidal thoughts: Findings from a longitudinal epidemiological study. *Journal of Affective Disorders, 190*, 723–725. https://doi.org/10.1016/j.jad.2015.09.066

Thom, K., McKenna, B., Edwards, G., O'Brien, A., & Nakarada-Kordic, I. (2012). Reporting of suicide by the New Zealand media. *Crisis*. https://econtent.hogrefe.com/doi/abs/10.1027/0227-5910/a000133

Torous, J., Staples, P., Shanahan, M., Lin, C., Peck, P., Keshavan, M., & Onnela, J.-P. (2015). Utilizing a personal smartphone custom app to assess the Patient Health Questionnaire-9 (PHQ-9) depressive symptoms in patients with Major Depressive Disorder. *JMIR Mental Health*, *2*(1), e8. https://doi.org/10.2196/mental.3889

Trimble, L., Jackson, K., & Harvey, D. (2000). Client suicidal behaviour: Impact, interventions, and implications for psychologists. *Australian Psychologist*, *35*(3), 227–232. https://doi.org/10.1080/00050060008257483

Tsai, M., Lari, H., Saffy, S., & Klonsky, E. D. (2020). Examining the Three-Step Theory (3ST) of suicide in a prospective study of adult psychiatric inpatients. *Behavior Therapy*. https://doi.org/10.1016/j.beth.2020.08.007

UNICEF. (2020). *New Report Card shows that New Zealand is failing its children*. https://www.unicef.org.nz/stories/new-report-card-shows-that-new-zealand-is-failing-its-children

Vaccarino, A. L., Sills, T. L., Evans, K. R., & Kalali, A. H. (2008). Prevalence and association of somatic symptoms in patients with Major Depressive Disorder. *Journal of Affective Disorders*, *110*(3), 270–276. https://doi.org/10.1016/j.jad.2008.01.009

Van Orden, K. A., Witte, T. K., Cukrowicz, K. C., Braithwaite, S. R., Selby, E. A., & Joiner, T. E. (2010). The interpersonal theory of suicide. *Psychological Review*, *117*(2), 575–600. https://doi.org/10.1037/a0018697

Veale, J., Byrne, J., Tan, K., Guy, S., Yee, A., Nopera, T., & Bentham, R. (2019). *Counting Ourselves: The Health and Wellbeing of Trans and Non-Binary People in Aotearoa New Zealand*. Transgender Health Research Lab, University of Waikato.

Wakefield, J. C., & Schmitz, M. F. (2016). Feelings of worthlessness during a single complicated major depressive episode predict postremission suicide attempt. *Acta Psychiatrica Scandinavica*, *133*(4), 257–265. https://doi.org/10.1111/acps.12521

Wei, Z., Ren, L., Wang, X., Liu, C., Cao, M., Hu, M., Jiang, Z., Hui, B., Xia, F., Yang, Q., Liu, Y., & Deng, Y. (2021). Network of depression and anxiety symptoms in patients with epilepsy. *Epilepsy Research*, *175*, 106696. https://doi.org/10.1016/j.eplepsyres.2021.106696

Wetherall, K., Cleare, S., Eschle, S., Ferguson, E., O'Connor, D. B., O'Carroll, R. E., & O'Connor, R. C. (2018). From ideation to action: Differentiating between those who think about suicide and those who attempt suicide in a national study of young adults. *Journal of Affective Disorders*, *241*, 475–483. https://doi.org/10.1016/j.jad.2018.07.074

Wickham, H. (2011). The split-apply-combine strategy for data analysis. *Journal of Statistical Software, 40*(1), 1–29. https://doi.org/10.18637/jss.v040.i01

Wickham, H., & Bryan, J. (2019). *readxl: Read Excel Files* (1.3.1) [R]. https://CRAN.R-project.org/package=readxl

Wild, L. G., Flisher, A. J., & Lombard, C. (2004). Suicidal ideation and attempts in adolescents: Associations with depression and six domains of self-esteem. *Journal of Adolescence, 27*(6), 611–624. https://doi.org/10.1016/j.adolescence.2004.03.001

Wolfe, K. L., Nakonezny, P. A., Owen, V. J., Rial, K. V., Moorehead, A. P., Kennard, B. D., & Emslie, G. J. (2019). Hopelessness as a predictor of suicide ideation in depressed male and female adolescent youth. *Suicide and Life-Threatening Behavior, 49*(1), 253–263. https://doi.org/10.1111/sltb.12428

Wolford-Clevenger, C., Stuart, G. L., Elledge, L. C., McNulty, J. K., & Spirito, A. (2020). Proximal correlates of suicidal ideation and behaviors: A test of the Interpersonal-Psychological Theory of Suicide. *Suicide and Life-Threatening Behavior, 50*(1), 249–262. https://doi.org/10.1111/sltb.12585

World Health Organisation. (2018). *Depression*. https://www.who.int/news-room/fact-sheets/detail/depression

World Health Organisation. (2021). *Suicide*. https://www.who.int/news-room/fact-sheets/detail/suicide

World Health Organization. (2008). *Preventing suicide: A resource for media professionals.* World Health Organization. https://www.who.int/mental_health/prevention/suicide/resource_media.pdf

World Health Organization. (2019). *Suicide in the world. Global health estimates.* https://apps.who.int/iris/bitstream/handle/10665/326948/WHO-MSD-MER-19.3-eng.pdf

Yang, X., Yuan, X., Liu, G., & Harrision, P. (2020). The specific roles of loss of interest and loss of pleasure in recent suicidal ideation. *Archives of Suicide Research: Official Journal of the International Academy for Suicide Research*, 1–10. https://doi.org/10.1080/13811118.2020.1838981

Appendices

The appendices provided in the following pages include the study's advertising material, and the information and surveys I sent to participants (Appendices A to H) and the summary of findings that was sent to participants (Appendix I). It also includes a document outlining how I mitigated the ethical risks for the study (Appendix J), as per a request from a panel member at my doctoral confirmation. Appendix K has tables of edge statistics for the temporal, contemporaneous, and between-persons networks. Appendix L includes graphs of each the variables included in this study over time for each participant. Lastly, Appendix M is a case study included as per the Doctor of Clinical Psychology programme requirements.

Appendix A: Paid Advertisement

Appendix B: Organic Advertisement

Appendix C: Screening Survey Information Sheet

Eligibility Survey

Kia ora, my name is Mikayla Holman, and as part of my Doctor of Clinical Psychology degree I am researching relationships between factors that are known to have some correlation with suicide risk and whether these factors change over time. To determine who is eligible to participate in the main study, and who might be interested in participating, I need people to fill in a brief eligibility survey.

You are invited to take part in a short survey to see whether you are eligible to participate. Whether or not you take part is your choice.

Who can participate?
If you live in New Zealand and can complete a survey written in English, you can participate in this eligibility survey.

What will participation involve?
The eligibility survey will take 5 minutes to complete. If you choose to participate you will be asked about your age, what country you live in, and your experience of thoughts of suicide. You will then be provided with a short description of the main study and will be asked whether you are interested in participating.

If you live in New Zealand and you complete the eligibility survey, you will go in the draw to win one of five Gift Pay e-vouchers worth $20, even if you are not eligible to participate in the main study. If you do not live in New Zealand, you will not be entered into the prize draw.

The eligibility survey includes questions which may cause discomfort. If you choose to participate in this eligibility survey, you will be asked about your current experience of suicidal thoughts. If you anticipate that answering this question will cause you undue distress we suggest that you do not participate. If you find that completing the survey causes you to feel distressed, it is recommended that you stop, and call someone you trust, or one of the below services. The following free support services are available 24/7:

- Lifeline – call 0800 LIFELINE (0800 543 354) or text 4357
- Suicide Crisis Helpline – call 0508 TAUTOKO (0508 828 865)
- Need To Talk – call or text 1737

If you need urgent help, please contact your local DHB mental health crisis team.

If you are in immediate physical danger to yourself, please call 111.

Your rights

You are under no obligation to accept this invitation to participate. If you decide to participate, you have the right to decline to answer any question, or to stop responding at any time.

Questions?

If you have any questions about this eligibility survey, please feel free to contact me via email:

[redacted]@uni.massey.ac.nz – Mikayla Holman

This project is supervised by Dr Matt Williams, Dr Matt Shepherd, and Dr Michael Philipp. If you have any questions or concerns regarding this research, you may wish to contact my primary supervisor:

M.N.Williams@massey.ac.nz – Dr Matt Williams

Committee Approval Statement

This project has been reviewed and approved by the Massey University Human Ethics Committee: Northern, Application NOR 20/44. If you have any concerns about the conduct of this research, please contact Dr Fiona Te Momo, Chair, Massey University Human Ethics Committee: Northern, telephone 09 414 0800, x 43347, email humanethicsnorth@massey.ac.nz.

I consent to participate in this survey.

- ◯ Yes
- ◯ No

Next →

Appendix D: Screening Survey

Eligibility Survey

What is your age?

- Under 18
- 18-24
- 25-34
- 35-44
- 45-54
- 55-64
- 65-74
- 75+

In which country do you currently reside?

In the last six months, have you had thoughts about taking your own life?

- Yes
- No

Do you have a personal smart phone that has internet access between the hours of 8am and 8pm?

- Yes
- No

Please read the information below before answering the next question.

I am researching relationships between factors which are known to have some correlation with suicide risk. I want to find out whether these risk factors change over time. Your participation in the main study would involve receiving email notifications asking you to fill in a brief survey 5 times per day for 10 days. You would have 90 minutes to complete the survey after receiving the email notification before it would time out. The survey would ask questions about how you are currently feeling, and it would take about a minute to fill in. Over the course of the study, you would be sent a total of 50 surveys and would need to complete a minimum of 35 of these to be eligible for a $35 Gift Pay e-voucher.

Would you be interested in participating in this research?

- Yes
- No

For participating in this eligibility survey, you will go in the draw to win one of five $20 Gift Pay e-vouchers. If you win, we will send the e-voucher to your email.

Please enter your email address below.

Next →

Appendix E: Main Study Invitation Email

Invitation to participate in research

MH **Mikayla Holman <noreply@qemailserver.com>**
10:10 AM

To: mikaylaholman@hotmail.com

Kia ora,

Recently you participated in a survey to see if you were eligible to participate in a study about relationships between factors that are known to have some correlation with suicide risk. Your responses to this survey indicated that you are eligible to participate, and that you were interested in participating.

I would now like to invite you to take part in the main study. To find out more information about what the study is about and what your participation would involve, please head to https://massey.au1.qualtrics.com/jfe/form/SV_bQ7ij2GpHpaCVqR?Q_DL=r4I9CgNYgqyA7vZ_bQ7ij2GpHpaCVqR_MLRP_4OXMWJ8RTFZyWIE&Q_CHL=email.

The surveys will begin on Tuesday 13th April and end on Thursday 22nd April. For participating, you will receive a Gift Pay e-voucher worth $35.

If you would like to participate, you have until Monday 12th April to respond to the sign-up sheet via the link above.

If you do not want to participate, you do not need to do anything.

If you have any questions, please feel free to email me at [redacted]@uni.massey.ac.nz.

Thank you for your time.

Warm regards,
Mikayla Holman
DClinPsych candidate
Massey University, New Zealand

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

Click the link below to opt out of future emails about this research
Click here to unsubscribe

Appendix F: Main Study Information Sheet

Kia ora, my name is Mikayla Holman, and as part of my Doctor of Clinical Psychology degree I am researching relationships between factors that are known to have some correlation with suicide risk and whether these factors change over time. To measure these risk factors, I need participants to complete a brief online survey 5 times per day for a total of 10 days.

You are invited to take part in the main study. Whether or not you take part is your choice.

You have until Monday 12th April to decide whether you wish to participate or not. Before you decide, you may wish to talk about the study with supportive people, such as family, whānau, friends, or health providers.

We suggest that you do not participate if you anticipate that answering multiple surveys per day would be too disruptive or burdensome for you, or if you would not be able to answer surveys on your phone during the day (e.g., due to work environment).

What will participation involve?

If you choose to participate in this study, you will be asked to provide basic demographic information about your age, gender, and ethnicity on the next page. You will be given a unique ID number so that the data you provide is kept separate from your email address, making it anonymous. This ID number will automatically be entered into the survey – you do not need to remember it.

From Tuesday 13th April until Thursday 22nd April, you will need to complete a brief survey five times a day. During this time, between the hours of 8am and 8pm you will be sent notifications via email asking you to complete the surveys. From the time of the notification you will have 90 minutes to fill in the survey. Each survey will take approximately 1 minute to fill in. It contains just 11 questions, with the same questions asked each time. The questions you will be asked are all quantitative (i.e., they are answered by ticking a box).

When you have completed the study, you will receive a Gift Pay e-voucher worth $35 to compensate you for the inconvenience involved in participating. To be eligible for this koha, you must complete at least 35 of the 50 surveys that you are sent, but we would like you to complete as many of the surveys as you can! If you wish, the Gift Pay e-voucher can be redeemed for prepay credit to recover the cost of any data you may have used in participating in the study. Alternatively, you may choose to redeem the voucher to use at a different Gift Pay store such as Farmers or Mitre 10.

The study includes some questions which may cause discomfort. If you choose to participate, in every survey you will be asked one question about your current experience of suicidal thoughts. If you anticipate that answering this question will cause you undue distress we suggest that you do not participate in this study. If you find that completing these surveys causes you to feel distressed, remember that you can stop completing them at any time. You may also wish to contact one of the below services which are freely available 24/7:

- Lifeline – call 0800 LIFELINE (0800 543 354) or text 4357
- Suicide Crisis Helpline – call 0508 TAUTOKO (0508 828 865)
- Need To Talk – call or text 1737

If you need urgent help, please contact your local DHB mental health crisis team.
If you are in immediate physical danger to yourself, please call 111.

The above services will be listed at the completion of every survey.

How will data be managed?

You provided your email address in the eligibility survey. If you participate in this study, I will use this email address to send you email notifications to complete the surveys. However, this information will be stored separately to your survey responses. You will not be asked to provide your name or any other contact details.

For the duration of this research project, the data that you provide will be accessed only by myself and the three supervisors who are directly involved in this study. Once the data has been analysed and my thesis has been completed, a de-identified copy of the data will be made publicly available in an online repository. This means that other researchers and members of the public will be able to check our results, and complete additional analyses using the data if they wish. Any personally identifying information (your email) will not be included in the public dataset, to ensure that it is not possible to identify who you are. Any identifying information that you provide will be stored on a password-protected computer until the research is complete (estimated date: December 2022), and then it will be deleted. The de-identified public dataset will be stored indefinitely.

Your rights

You are under no obligation to accept this invitation to participate. If you decide to participate, you have the right to decline to answer any question and be given access to a summary of the project findings when they are available. At any point you can stop answering the surveys. If you decide that you no longer wish to participate and you want to stop receiving email notifications to fill in the surveys, you may signal this to us using the “opt out” link located at the bottom of the email notification.

Although this survey will contain questions relating to mental health and thoughts of suicide, the study is set up so that I know very little about your identity (just your email address). As such, even if you do indicate that you are having thoughts of suicide, I won't be able to contact mental health or emergency services to provide you with assistance. This is a deliberate choice to protect your privacy. If you do require assistance from mental health services at any time, please do use the contact numbers above.

Questions?

If you have any questions about this research, please feel free to contact me via email:
[redacted]@uni.massey.ac.nz – Mikayla Holman

This project is supervised by Dr Matt Williams, Dr Matt Shepherd, and Dr Michael Philipp. If you have any questions or concerns regarding this research, you may wish to contact my primary supervisor:
M.N.Williams@massey.ac.nz – Dr Matt Williams

Committee Approval Statement

This project has been reviewed and approved by the Massey University Human Ethics Committee: Northern, Application NOR 20/44. If you have any concerns about the conduct of this research, please contact Dr Fiona Te Momo, Chair, Massey University Human Ethics Committee: Northern, telephone 09 414 0800, x 43347, email humanethicsnorth@massey.ac.nz.

I consent to participate in this research.

- Yes
- No

→

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

Please enter your age in years

What is your gender?

- Male
- Female
- Gender diverse

Which ethnic group do you belong to?

- New Zealand European/Pākehā
- Māori
- Pacific Islander
- Asian
- Other - please specify

→

Appendix G: Main Study Survey Notification

Research Participation - Survey to Complete

MH **Mikayla Holman <noreply@qemailserver.com>**
6:46 PM

To: mikaylaholman@hotmail.com

Kia ora,

Your next survey is ready to complete.

Follow the link below to access the Survey:
https://massey.au1.qualtrics.com/jfe/form/SV_cuQ2UbzPwIg1SO9?Q_DL=rAN1UvvaqT01l2v_cuQ2UbzPwIg1SO9_MLRP_4OXMWJ8RTFZyWIE&Q_CHL=email&Session_N=2&Day=1&Beep=2

The survey link above will expire in 90 minutes. Once you click the link, you will have 60 minutes to complete the survey, but it should only take you a minute or two to fill in.

If you have any questions, or if the link does not work for you, please contact me (Mikayla) via email: [redacted]@uni.massey.ac.nz.

Thank you!
Mikayla

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

If you no longer wish to participate in this study, and would like to opt out of it, click the link below:
Click here to unsubscribe

Appendix H: Main Study Survey

Research Survey

For each of the statements below, please rate how much you are currently having that experience.

	Not at all	A little bit	A moderate amount	A lot	Extremely
At the moment I feel depressed.	○	○	○	○	○
At the moment I feel worthless.	○	○	○	○	○
At the moment I feel tired.	○	○	○	○	○
At the moment I feel like nothing I am doing is enjoyable or pleasurable.	○	○	○	○	○
At the moment I feel hopeless.	○	○	○	○	○
At the moment I feel like a burden to others.	○	○	○	○	○
At the moment I feel like I don't belong.	○	○	○	○	○
At the moment I feel good about myself.	○	○	○	○	○
At the moment I feel supported by the people around me.	○	○	○	○	○
At the moment I feel drunk.	○	○	○	○	○
At the moment I am thinking about taking my own life.	○	○	○	○	○

FINISH →

Appendix I: Summary of Findings for Participants

At the beginning of 2021 you participated in my research about relationships between factors that are known to have some correlation with suicide risk, and whether these factors change over time. I greatly appreciate your participation, and I am pleased to let you know that a summary of the findings is now available.

If you feel distressed when reading the summary below, a list of Support Services is provided at the end.

Research Aim

The aim of this research was to explore the relationships between factors which are known to put someone at risk of suicide (risk factors) and whether these changed over short periods of time. This was an unusual type of study which involved collecting data lots of times from the same people. I appreciate how much of a hassle this may have been for you as a participant. Your understanding and willingness to participate during this study was incredibly valuable.

Procedure

As a participant, you were invited to complete a survey online five times per day for ten days. You were asked how much you were having the experiences described in each of the 11 statements, such as “At the moment I feel depressed” and “At the moment I feel hopeless”. These items corresponded to 11 different variables, such as feeling depressed and feeling hopeless. The responses you could choose from for each survey item were 1 *not at all*, 2 *a little bit*, 3 *a moderate amount*, 4 *a lot*, and 5 *extremely*.

The data collected in the survey were analysed using temporal network analysis. This is a relatively new statistical technique for studies examining suicide, but it has been used in the field of psychology for some time. In simple terms, network analysis can be used to explore how variables relate to one another in one survey or across surveys. Many of the results of the network analysis are too complex to discuss in this summary. However, my supervisors (Dr Matt Williams, Dr Matt Shepherd, and Dr Michael Philipp) and I will be writing a full scientific report of this research for publication after examination of this thesis. You are welcome to contact me if you would like to read the report when it is published, or if you would like to read the thesis itself after it has been examined.

Participant Demographics

In total, 68 participants were recruited for this study. Of these, 63 people completed at least one of the surveys they were sent, and 39 people completed the minimum number of surveys needed to be included in the analysis (20/50 surveys). On average, participants completed about 26 surveys.

Of the 39 participants included in the analyses, 5 were male, 32 were female, and 2 were gender diverse. Participant age ranged from 19 to 66 years, with an average age of 41.2 years. 31 participants identified as Pākehā/New Zealand European, 3 as Māori, 1 as Pacific Islander, and 4 as other ethnicities.

Results

Of the 1420 survey responses, 61.2% were rated as not experiencing any suicidal ideation, while 22.2% reported experiencing suicidal ideation *a little bit*, 13.9% *a moderate amount*, 2.5% *a lot*, and 0.2% *extremely*. Eight participants did not experience any suicidal

ideation during the study. Fatigue was reported by participants in 92.5% of all surveys. Alcohol intoxication was not experienced much during this study, with just 31 instances of alcohol intoxication reported (2.2% of all surveys). Feeling depressed, worthless, hopeless, like a burden, and like you didn't belong were each on average experienced *a little bit* by participants, with the average for each variable ranging from 2.29 to 2.69.

Feeling hopeless at one survey was associated with an increase in suicidal ideation at the next survey. Experiencing suicidal ideation in turn increased hopelessness and anhedonia (loss of pleasure/interest) at the next survey.

Within one survey, higher suicidal ideation was associated with higher levels of worthlessness, depressed mood, feeling like a burden, and feeling like you didn't belong. Higher levels of suicidal ideation were also associated with lower levels of self-esteem within one survey.

On average, suicidal ideation was associated with higher levels of hopelessness. Hopelessness was on average associated with higher levels of worthlessness and feeling like a burden. Depressed mood was on average associated with higher levels of worthlessness, anhedonia, fatigue, and alcohol intoxication.

Conclusion

Understanding how risk factors for suicide relate to one another over time is a key step to improving our suicide prevention methods in the future. This study showed suicidal thoughts to be associated with a variety of risk factors for suicide within one survey. Only hopelessness predicted an increase in suicidal ideation over time in this study.

I will be submitting my Doctorate of Clinical Psychology thesis to Massey University for marking later this year. In the months following this, my supervisors and I will be writing this research up as a journal article in the hopes of getting it published.

Thank you again for your interest and participation in this study – it is greatly appreciated! If you have any questions, please feel free to contact me via email - mikaylaholman@hotmail.com.

Ngā mihi nui

Mikayla Holman

Support Services

The following free support services are available 24/7:

- Lifeline – call 0800 LIFELINE (0800 543 354) or text 4357
- Suicide Crisis Helpline – call 0508 TAUTOKO (0508 828 865)
- Need to Talk – call or text 1737
- If you need urgent help, please contact your local DHB mental health crisis team
- If you are in immediate physical danger to yourself, please call 111

Appendix J: Risk Mitigation

During my DClinPsych confirmation for this research, it was recommended that I include an appendix outlining the consultation process for this study and the ways I had mitigated potential risks to participants who may be experiencing suicidal ideation. Some of this information is included throughout my thesis, but it is repeated briefly here for completeness.

From the outset I considered my ethical obligation to maintain the safety of my participants and to minimise potential distress. I planned for my study to include details in the information sheet about what the study involved, recommending people did not participate if they believed that being asked about suicidal ideation would cause them distress. In the information sheet I also planned to include details about which support services participants could freely access, which would then be repeated at the end of each survey as well. In addition, I wanted participants to have the option to opt out of the study at any point without having to contact me or give a reason for why, so that if the survey or survey prompts were causing increased distress, they could click a button and then no longer receive the survey prompts. These risk mitigation processes arose from discussions with my supervisors and these processes were all used in the completed study.

In the initial stages of planning this study, I also consulted literature to see what other risk mitigation measures could be used. Predominantly I looked at research where there had been repeated measurements of suicidal ideation and risk factors for suicide. There were a variety of options which did not seem feasible for this study. For example, one study had survey responses monitored by an on-call clinician at all times. This person then called participants who signalled they were experiencing high levels of suicidality during the study, actively intervening, and

directing them to local services for further assessment. Including this method of risk mitigation in my study would have been resource-intensive, which was not possible within the financial confines of a DClinPsych degree. The studies which used this method of risk mitigation also involved participants who were categorically at higher risk than those I planned to recruit. For example, the studies with more active interventions typically recruited people recently discharged from an inpatient unit, or currently still in an inpatient unit, whereas I planned to recruit from the general population. In addition, anonymity was an important component of my study, as I wanted to encourage honest, accurate responses from participants. Having participants provide contact details so that active intervention could occur may had stopped some people from participating.

I noticed that in many cases information about how researchers maintained the safety of their participants was missing from published literature. Because of this, I also contacted a few researchers directly to ask what they had done to mitigate risk, but I received no responses to my queries. As a result, I also contacted Dr John Fitzgerald, who is an expert in the field of suicide research and was the clinical supervisor of this research for the first couple of months. His view was that I needed to have some way of managing ratings of strong suicidal thoughts in a slightly more targeted, active way than my existing plan. As a result, I decided to include an additional end of survey message that was triggered only if a participant rated that they were having strong suicidal ideation or really low mood. This included an empathic comment and suggestion for the participant to contact one of the support services, which were listed again.

In September 2020, prior to confirmation, I submitted an ethics application to the Massey University Human Ethics Committee: Northern, including details about how I planned to mitigate risk for this study. The review board approved this ethics application with no changes to

my plan. However, I was asked to provide evidence that the benefits outweighed the risks to participants. Their question and my reply is copied below:

> **Question:** Is the researcher aware of any studies that have been undertaken on this topic using repeated measures? The committee is seeking to ensure that the evidence suggests, on balance, that the risks are low or there is a small positive impact of asking these questions on an individual basis, i.e., that overall, the risks are outweighed by the benefits. Please consider and comment.
>
> **Answer:** There are many studies that have used repeated measures to study suicidal ideation and suicide risk factors (for example, see Coppersmith et al., 2019; Crowe et al., 2019; Czyz et al., 2018; Glenn et al., 2022; Hallensleben et al., 2017, 2019; E. M. Kleiman et al., 2017; Spangenberg et al., 2019). The studies which are the most similar to the proposed research are those by Kleiman et al. (2017) and Hallensleben et al. (2019). Both studies found that suicidal ideation and risk factors for suicide such as hopelessness, perceived burdensomeness, and loneliness varied considerably over short periods of time (i.e., there was a change from measurement to measurement). Some of these risk factors at one time were able to predict suicidal ideation at the next time. For example, feeling really hopeless at one measurement was associated with increased thoughts of suicide at the next measurement (Hallensleben et al., 2019).
>
> There are two primary risks associated with repeatedly measuring suicidal ideation and risk factors for suicide – the risk of time burden on participants and the risk of their thoughts of suicide increasing as a result of participation.

Regarding the risk of time burden on participants: In Kleiman et al.'s (2017) study, measurements were taken four times a day for 28 days, while in Hallensleben et al.'s (2019) study, measurements were taken ten times a day for six days. My proposed study will ask participants to fill in a survey five times a day for ten days, such that it places less time burden on participants each day than Hallensleben et al. and this burden occurs over a shorter period of time than Kleiman et al. The survey for the proposed study is also very brief. Participants will only take around one minute to complete it each time, keeping the time burden to a minimum.

Research by Husky et al. (2014) explored whether completing surveys five times per day for one week were burdensome for participants with a history of suicidal ideation and behaviour. Their study included individuals who had a diagnosed mood disorder and/or previous a suicide attempt. Husky et al. found there were fewer missing survey responses later in the study compared to at the start. If participants were burdened by the assessments, we would expect to see a higher number of missing responses as the study progressed, rather than fewer as was observed in this study. The time spent on each assessment also significantly decreased as time went on, suggesting that participants were able to respond to questions faster the more times they had come across the question, thus reducing the time burden participants experienced each day.

Regarding the risk of participants having more thoughts of suicide as a result of participation: The research conducted by Husky et al. (2014) mentioned above also examined whether repeatedly measuring suicidal ideation might increase participants' experience of suicidal ideation. The authors found no significant association between suicidal ideation and duration of the study. This is consistent with the findings of other

research that suggests asking about thoughts of suicide does not increase the occurrence of such thoughts, even when asked repeatedly (Blades et al., 2018; Dazzi et al., 2014; Law et al., 2015). It is unlikely that asking participants one survey item about thoughts of suicide five times per day will increase their thoughts of suicide. However, as it is still possible that this could occur, support services are provided following every survey so that participants have access to relevant support should they want it.

Following confirmation, my supervisors and I continued to discuss whether there were any additional ways we could mitigate risk to participants without compromising the study or participant anonymity. We decided I would explicitly state in the information sheet that I would not be able to contact mental health services on the behalf of participants due to the study being anonymous. This was also repeated in the end of survey message when a participant signalled strong suicidal ideation. In addition, we decided that if a participant contacted me via email to say they were considering harming themselves, I would reiterate the relevant support services. For example, if the participant stated that they were in imminent/serious harm to themselves then I would emphasise they needed to contact 111 and the crisis service. In other cases, it may have been more relevant to suggest a couple of helplines/the websites associated with these and suggest the participant contacted their GP who could refer them for free sessions with a psychologist. It is important to note that none of the participants contacted me to express distress during this study.

Other strategies we considered including are listed below alongside reasons why we did not implement the strategy:

- Telling participants what the survey items were prior to them consenting to participate: We did not think this would have a big impact on the data we collected, as participants would be repeatedly exposed to the same items anyway. However, we were concerned that seeing the items and drawing attention to how cautious we were being might put some participants off joining the study. We decided there would be little to no benefit of using this strategy, as participants could choose to opt out of the study at any point after consenting to participate.

- Developing safety plans for each participant and cuing participants to use this based on their survey responses: We thought this was impractical given the planned sample size of 75-85 participants and the limited availability of clinicians (there was one clinical psychologist supervising this study), especially with participants living New Zealand-wide, rather than in the locality of the research team (Auckland, New Zealand). Engaging participants in this way would have also compromised participant anonymity, which was something I chose to prioritise, to increase participant honesty and openness during survey responses.

- Collecting contact information for a designated emergency contact for each participant: My supervisors and I had concerns that doing this would decrease participant honesty during the survey. We thought that participants may worry that if they signalled thoughts of suicide/low mood we would be contacting their emergency contact and/or a crisis team, and this worry would reduce the likelihood that they would signal thoughts of suicide/low mood. This would have compromised data quality. It is likely that such intervention would include many false positives too, where the intervention was not needed.

- Providing participants with a phone number they could use to contact me directly: As I am not a fully qualified health professional, if participants were to contact me via phone I would only be able to direct them to existing support services such as emergency services, a crisis team, and helplines. Participants would likely receive faster support if they contacted these services themselves, so providing them with a phone number to contact me directly was of no extra benefit to participants. We also thought it would be clear to participants where to seek support from, given this information was repeated at multiple points throughout the study (e.g., in the information sheet and following each of the fifty surveys).

Appendix K: Summary Tables of Edge Statistics

Table K1

Summary of Statistics for Edges in the Temporal Network

From	To	Fixed	SE	*p*	Ran_SD
DM	DM	1	0.208	0.043	0.000
DM	Wor	1	0.095	0.037	0.010
DM	Fat	1	-0.047	0.045	0.295
DM	Anh	1	0.108	0.049	0.029
DM	H	1	0.079	0.045	0.079
DM	PB	1	0.017	0.038	0.659
DM	TB	1	0.110	0.049	0.025
DM	SE	1	-0.031	0.041	0.447
DM	SS	1	-0.037	0.037	0.316
DM	Alc	1	0.108	0.059	0.067
DM	SI	1	0.014	0.032	0.661
Wor	DM	1	0.079	0.047	0.096
Wor	Wor	1	0.109	0.051	0.032
Wor	Fat	1	0.060	0.053	0.260
Wor	Anh	1	0.034	0.052	0.509
Wor	H	1	0.006	0.052	0.913
Wor	PB	1	0.031	0.047	0.510
Wor	TB	1	0.015	0.054	0.774
Wor	SE	1	0.039	0.060	0.518
Wor	SS	1	0.036	0.046	0.438
Wor	Alc	1	-0.042	0.065	0.512
Wor	SI	1	0.037	0.036	0.305
Fat	DM	1	-0.011	0.029	0.698
Fat	Wor	1	-0.018	0.027	0.490

Table K1 continued

From	To	Fixed	SE	*p*	Ran_SD
Fat	Fat	1	0.243	0.039	0.000
Fat	Anh	1	-0.011	0.035	0.753
Fat	H	1	-0.027	0.030	0.361
Fat	PB	1	-0.009	0.028	0.756
Fat	TB	1	-0.026	0.031	0.399
Fat	SE	1	-0.018	0.031	0.561
Fat	SS	1	0.028	0.027	0.300
Fat	Alc	1	-0.113	0.053	0.035
Fat	SI	1	0.008	0.024	0.731
Anh	DM	1	0.086	0.039	0.029
Anh	Wor	1	0.032	0.033	0.328
Anh	Fat	1	0.081	0.039	0.036
Anh	Anh	1	0.087	0.046	0.059
Anh	H	1	0.004	0.036	0.905
Anh	PB	1	-0.002	0.041	0.969
Anh	TB	1	-0.006	0.041	0.874
Anh	SE	1	0.016	0.035	0.656
Anh	SS	1	-0.043	0.036	0.234
Anh	Alc	1	0.138	0.062	0.026
Anh	SI	1	0.048	0.030	0.109
H	DM	1	0.061	0.046	0.189
H	Wor	1	0.134	0.042	0.001
H	Fat	1	0.002	0.051	0.968
H	Anh	1	0.088	0.051	0.083
H	H	1	0.099	0.045	0.029
H	PB	1	0.063	0.044	0.146
H	TB	1	0.040	0.047	0.404

Table K1 continued

From	To	Fixed	SE	*p*	Ran_SD
H	SE	1	-0.071	0.046	0.127
H	SS	1	-0.057	0.042	0.176
H	Alc	1	-0.028	0.069	0.688
H	SI	1	0.093	0.037	0.012
PB	DM	1	0.067	0.044	0.127
PB	Wor	1	-0.007	0.040	0.855
PB	Fat	1	0.012	0.051	0.818
PB	Anh	1	0.006	0.057	0.921
PB	H	1	0.063	0.050	0.203
PB	PB	1	0.146	0.058	0.012
PB	TB	1	0.040	0.057	0.475
PB	SE	1	-0.061	0.044	0.164
PB	SS	1	0.062	0.050	0.212
PB	Alc	1	0.013	0.065	0.838
PB	SI	1	-0.012	0.038	0.745
TB	DM	1	-0.015	0.042	0.723
TB	Wor	1	0.037	0.036	0.296
TB	Fat	1	-0.026	0.048	0.584
TB	Anh	1	-0.009	0.050	0.859
TB	H	1	0.052	0.045	0.242
TB	PB	1	0.037	0.040	0.359
TB	TB	1	0.131	0.042	0.002
TB	SE	1	-0.047	0.040	0.242
TB	SS	1	-0.032	0.041	0.433
TB	Alc	1	-0.017	0.058	0.764
TB	SI	1	-0.002	0.032	0.941
SE	DM	1	0.000	0.035	0.992
SE	Wor	1	-0.070	0.037	0.062

Table K1 continued

From	To	Fixed	SE	*p*	Ran_SD
SE	Fat	1	-0.014	0.038	0.708
SE	Anh	1	-0.101	0.048	0.036
SE	H	1	-0.050	0.039	0.197
SE	PB	1	-0.015	0.035	0.672
SE	TB	1	-0.032	0.040	0.417
SE	SE	1	0.174	0.057	0.002
SE	SS	1	0.011	0.039	0.776
SE	Alc	1	0.138	0.103	0.181
SE	SI	1	0.024	0.028	0.376
SS	DM	1	-0.014	0.038	0.712
SS	Wor	1	0.002	0.045	0.961
SS	Fat	1	0.006	0.040	0.881
SS	Anh	1	-0.046	0.045	0.309
SS	H	1	-0.052	0.035	0.138
SS	PB	1	-0.007	0.034	0.832
SS	TB	1	0.005	0.037	0.894
SS	SE	1	0.012	0.037	0.749
SS	SS	1	0.155	0.042	0.000
SS	Alc	1	-0.027	0.053	0.609
SS	SI	1	0.020	0.029	0.494
Alc	DM	1	0.048	0.032	0.135
Alc	Wor	1	0.025	0.028	0.377
Alc	Fat	1	0.063	0.034	0.063
Alc	Anh	1	0.005	0.035	0.895
Alc	H	1	0.010	0.031	0.742
Alc	PB	1	0.029	0.029	0.325
Alc	TB	1	-0.021	0.033	0.511
Alc	SE	1	-0.055	0.031	0.072

Table K1 continued

From	To	Fixed	SE	*p*	Ran_SD
Alc	SS	1	-0.074	0.038	0.049
Alc	Alc	1	0.185	0.140	0.187
Alc	SI	1	0.037	0.041	0.368
SI	DM	1	0.069	0.063	0.277
SI	Wor	1	0.051	0.058	0.381
SI	Fat	1	0.011	0.046	0.810
SI	Anh	1	0.138	0.069	0.043
SI	H	1	0.135	0.052	0.010
SI	PB	1	0.070	0.053	0.187
SI	TB	1	0.060	0.054	0.269
SI	SE	1	-0.036	0.043	0.400
SI	SS	1	0.048	0.046	0.301
SI	Alc	1	-0.084	0.062	0.174
SI	SI	1	0.274	0.055	0.000

Note. fixed = fixed effects coefficient, SE = standard error, *p* = p value, ran_SD = random effects standard deviation, DM = depressed mood, Wor = worthlessness, Fat = fatigue, Anh = anhedonia, H = hopelessness, PB = perceived burdensomeness, TB = thwarted belongingness, SE = self-esteem, SS = social support, Alc = alcohol intoxication, SI = suicidal ideation.

Table K2

Summary of Statistics for Edges in the Contemporaneous Network

		$p\ 1 \rightarrow 2$	$p\ 1 \leftarrow 2$	r_p	ran_SD_ r_p	r	ran_SD_ r
Wor	DM	0.000	0.000	0.263	0.013	0.469	0.028
Fat	DM	0.016	0.044	0.080	0.002	0.215	0.014
Fat	Wor	0.429	0.610	0.020	0.000	0.187	0.013
Anh	DM	0.011	0.017	0.088	0.003	0.312	0.027
Anh	Wor	0.146	0.138	0.059	0.007	0.306	0.034
Anh	Fat	0.009	0.004	0.093	0.001	0.216	0.012
H	DM	0.000	0.000	0.157	0.000	0.424	0.023
H	Wor	0.000	0.000	0.206	0.010	0.465	0.030
H	Fat	0.067	0.092	0.054	0.000	0.214	0.013
H	Anh	0.000	0.000	0.212	0.007	0.396	0.028
PB	DM	0.333	0.363	0.030	0.000	0.310	0.027
PB	Wor	0.001	0.002	0.117	0.002	0.383	0.027
PB	Fat	0.133	0.111	0.048	0.000	0.188	0.013
PB	Anh	0.360	0.620	-0.027	0.005	0.245	0.035
PB	H	0.000	0.000	0.219	0.011	0.449	0.030
TB	DM	0.677	0.586	0.016	0.000	0.295	0.028
TB	Wor	0.026	0.028	0.082	0.003	0.354	0.029
TB	Fat	0.253	0.102	0.047	0.001	0.190	0.015
TB	Anh	0.002	0.018	0.126	0.018	0.312	0.041
TB	H	0.115	0.062	0.069	0.006	0.384	0.030
TB	PB	0.000	0.000	0.368	0.012	0.519	0.021
SE	DM	0.032	0.027	-0.070	0.000	-0.262	0.017
SE	Wor	0.265	0.093	-0.053	0.003	-0.242	0.020
SE	Fat	0.011	0.067	-0.094	0.012	-0.188	0.021
SE	Anh	0.000	0.001	-0.147	0.008	-0.280	0.021

Table K2 continued

		$p\ 1 \rightarrow 2$	$p\ 1 \leftarrow 2$	r_p	ran_SD_ r_p	r	ran_SD_ r
SE	H	0.851	0.671	0.011	0.003	-0.221	0.023
SE	PB	0.787	0.881	-0.003	0.004	-0.192	0.027
SE	TB	0.233	0.267	-0.045	0.004	-0.230	0.023
SS	DM	0.119	0.223	-0.054	0.006	-0.186	0.024
SS	Wor	0.783	0.829	-0.001	0.000	-0.157	0.022
SS	Fat	0.904	0.685	0.010	0.004	-0.081	0.012
SS	Anh	0.727	0.542	-0.017	0.001	-0.154	0.016
SS	H	0.371	0.272	-0.033	0.000	-0.177	0.023
SS	PB	0.470	0.633	-0.029	0.023	-0.166	0.051
SS	TB	0.054	0.061	-0.063	0.000	-0.192	0.024
SS	SE	0.000	0.000	0.221	0.007	0.292	0.015
Alc	DM	0.251	0.188	-0.043	0.001	-0.021	0.010
Alc	Wor	0.380	0.472	-0.025	0.000	-0.008	0.006
Alc	Fat	0.062	0.110	-0.073	0.002	-0.068	0.009
Alc	Anh	0.743	0.864	0.008	0.000	0.010	0.009
Alc	H	0.344	0.307	0.034	0.001	0.033	0.009
Alc	PB	0.694	0.796	-0.002	0.000	0.016	0.007
Alc	TB	0.826	0.496	0.014	0.000	0.027	0.006
Alc	SE	0.715	0.904	0.012	0.006	-0.003	0.014
Alc	SS	0.198	0.148	-0.042	0.000	-0.047	0.004
SI	DM	0.000	0.001	0.163	0.011	0.342	0.031
SI	Wor	0.035	0.091	0.085	0.009	0.310	0.031
SI	Fat	0.761	0.397	-0.018	0.000	0.109	0.013
SI	Anh	0.953	0.742	-0.006	0.000	0.199	0.026
SI	H	0.082	0.115	0.080	0.017	0.309	0.044
SI	PB	0.030	0.169	0.060	0.002	0.278	0.025
SI	TB	0.002	0.006	0.095	0.000	0.290	0.020

Table K2 continued

		p 1 → 2	p 1 ← 2	r_p	ran_SD_ r_p	r	ran_SD_ r
SI	SE	0.000	0.000	-0.122	0.000	-0.251	0.012
SI	SS	0.264	0.610	-0.031	0.002	-0.161	0.016
SI	Alc	0.090	0.121	0.087	0.007	0.084	0.014

Note. r_p = partial correlation, ran_SD_ r_p = random effects standard deviation of partial correlation, r = correlation, ran_SD_ r = random effects standard deviation of correlation, DM = depressed mood, Wor = worthlessness, Fat = fatigue, Anh = anhedonia, H = hopelessness, PB = perceived burdensomeness, TB = thwarted belongingness, SE = self-esteem, SS = social support, Alc = alcohol intoxication, SI = suicidal ideation.

Table K3

Summary of Statistics for Edges in the Between-Persons Network

		$p\ 1 \rightarrow 2$	$p\ 1 \leftarrow 2$	r_p	r
Wor	DM	0.021	0.071	0.325	0.999
Fat	DM	0.000	0.003	0.381	0.972
Fat	Wor	0.652	0.865	0.024	0.970
Anh	DM	0.000	0.000	0.459	0.997
Anh	Wor	0.880	0.944	-0.007	0.997
Anh	Fat	0.098	0.169	-0.169	0.967
H	DM	0.154	0.071	0.247	0.999
H	Wor	0.000	0.000	0.710	1.000
H	Fat	0.101	0.039	-0.248	0.969
H	Anh	0.724	0.716	-0.053	0.997
PB	DM	0.022	0.078	-0.270	0.997
PB	Wor	0.840	0.535	0.059	0.998
PB	Fat	0.000	0.000	0.398	0.972
PB	Anh	0.517	0.462	0.087	0.995
PB	H	0.001	0.027	0.397	0.998
TB	DM	0.303	0.592	-0.041	-0.980
TB	Wor	0.353	0.023	0.214	-0.980
TB	Fat	0.788	0.886	0.022	-0.945
TB	Anh	0.875	0.294	0.072	-0.976
TB	H	0.002	0.126	-0.340	-0.981
TB	PB	0.379	0.108	0.146	-0.978
SE	DM	0.962	0.847	-0.013	-0.989
SE	Wor	0.851	0.795	-0.003	-0.990
SE	Fat	0.292	0.741	0.067	-0.960
SE	Anh	0.633	0.577	-0.057	-0.988
SE	H	0.410	0.599	-0.092	-0.990

Table K3 continued

		$p\ 1 \rightarrow 2$	$p\ 1 \leftarrow 2$	r_p	r
SE	PB	0.184	0.129	-0.148	-0.989
SE	TB	0.537	0.706	0.052	0.972
SS	DM	0.065	0.126	0.185	0.966
SS	Wor	0.527	0.419	-0.087	0.966
SS	Fat	0.000	0.000	-0.297	0.926
SS	Anh	0.273	0.399	-0.101	0.962
SS	H	0.900	0.881	-0.016	0.967
SS	PB	0.000	0.000	0.359	0.969
SS	TB	0.127	0.230	-0.133	-0.955
SS	SE	0.002	0.002	0.242	-0.950
Alc	DM	0.034	0.105	0.255	0.927
Alc	Wor	0.774	0.849	0.037	0.926
Alc	Fat	0.163	0.092	-0.181	0.894
Alc	Anh	0.030	0.072	-0.251	0.918
Alc	H	0.399	0.379	-0.127	0.925
Alc	PB	0.164	0.274	0.158	0.925
Alc	TB	0.521	0.696	0.064	-0.901
Alc	SE	0.258	0.368	0.113	-0.909
Alc	SS	0.458	0.529	-0.073	0.897
SI	DM	0.852	0.602	-0.012	0.996
SI	Wor	0.836	0.518	-0.048	0.997
SI	Fat	0.481	0.424	0.068	0.967
SI	Anh	0.165	0.185	0.136	0.994
SI	H	0.011	0.034	0.270	0.997
SI	PB	0.522	0.542	-0.062	0.995
SI	TB	0.355	0.466	0.079	-0.976
SI	SE	0.380	0.484	0.068	-0.986
SI	SS	0.939	0.828	-0.012	0.963

Table K3 continued

		$p\ 1 \rightarrow 2$	$p\ 1 \leftarrow 2$	r_p	r
SI	Alc	0.144	0.282	0.134	0.926

Note. r_p = partial correlation, r = correlation, DM = depressed mood, Wor = worthlessness, Fat = fatigue, Anh = anhedonia, H = hopelessness, PB = perceived burdensomeness, TB = thwarted belongingness, SE = self-esteem, SS = social support, Alc = alcohol intoxication, SI = suicidal ideation.

Appendix L: Variability of Risk Factors and Suicidal Ideation Over Time

The below is a list of the figures included in this appendix, in order of appearance. Each of these figures depicts the raw scores of each participant over time for each variable. The figure listed first is for the variable with the lowest mean root mean square successive difference (RMSSD) while the last listed figure is for the variable with the highest mean RMSSD. Higher RMSSD reflects higher variability from measurement to measurement, such that the graphs of variables with higher RMSSD show an exaggerated saw-tooth pattern compared to variables with lower RMSSD.

Figure L1

Graph of Each Participant's Raw Alcohol Intoxication Scores Over Time

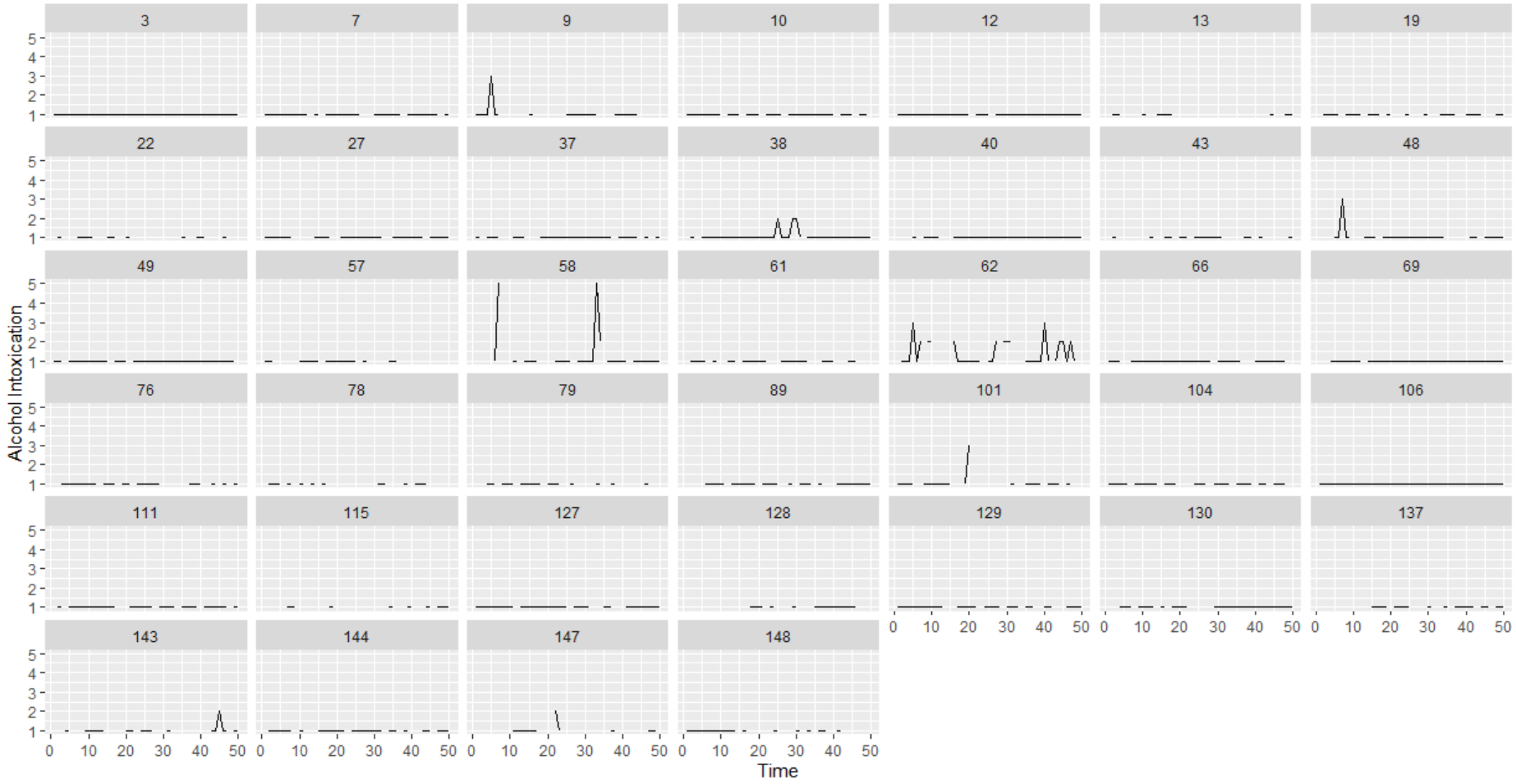


Figure L2

Graph of Each Participant's Raw Suicidal Ideation Scores Over Time

Figure L3

Graph of Each Participant's Raw Social Support Scores Over Time

Figure L4

Graph of Each Participant's Raw Worthlessness *Scores Over Time*

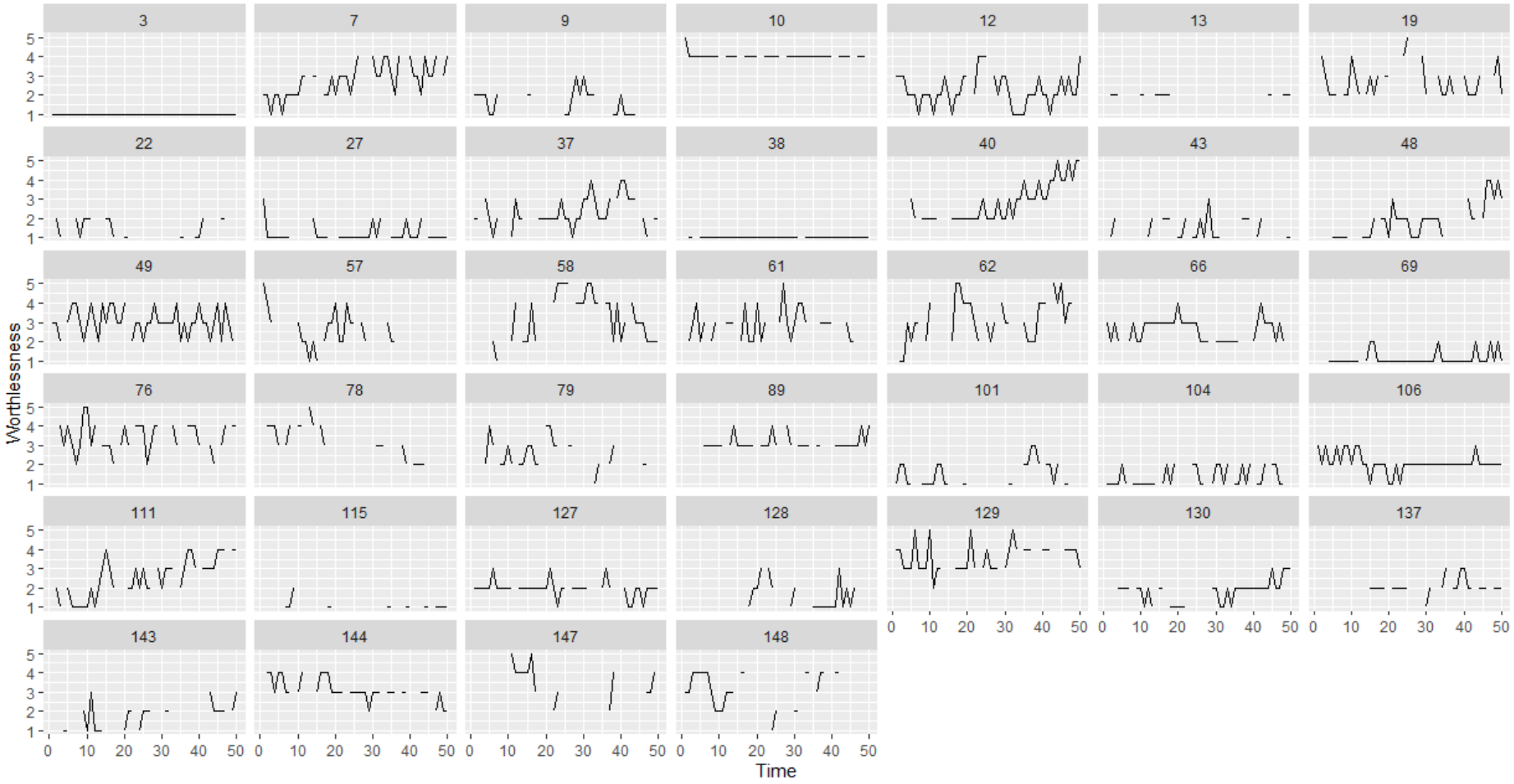


Figure L5

Graph of Each Participant's Raw Self-Esteem Scores Over Time

Figure L6

Graph of Each Participant's Raw Depressed Mood Scores Over Time

Figure L7

Graph of Each Participant's Raw Hopelessness Scores Over Time

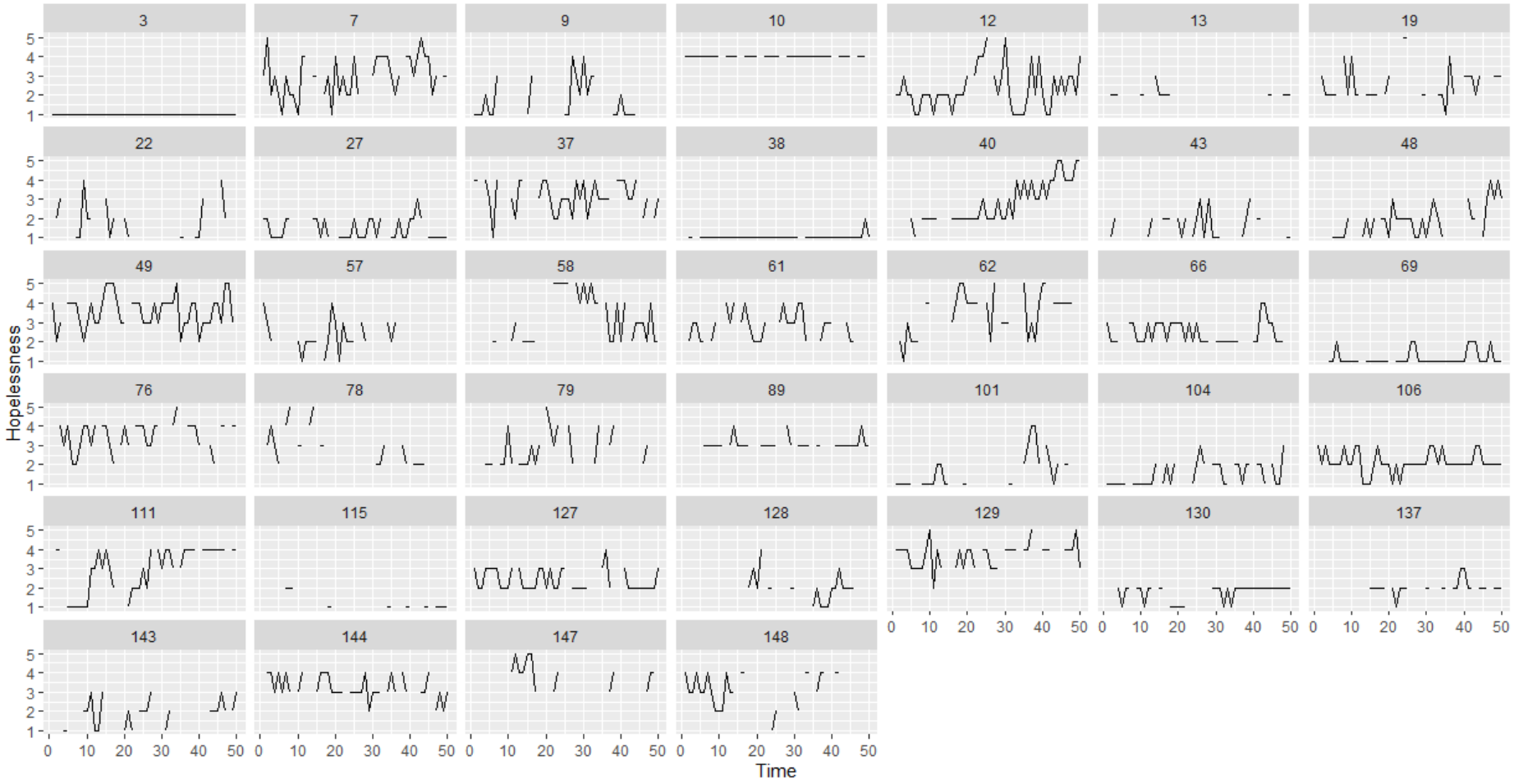


Figure L8

Graph of Each Participant's Raw Perceived Burdensomeness Scores Over Time

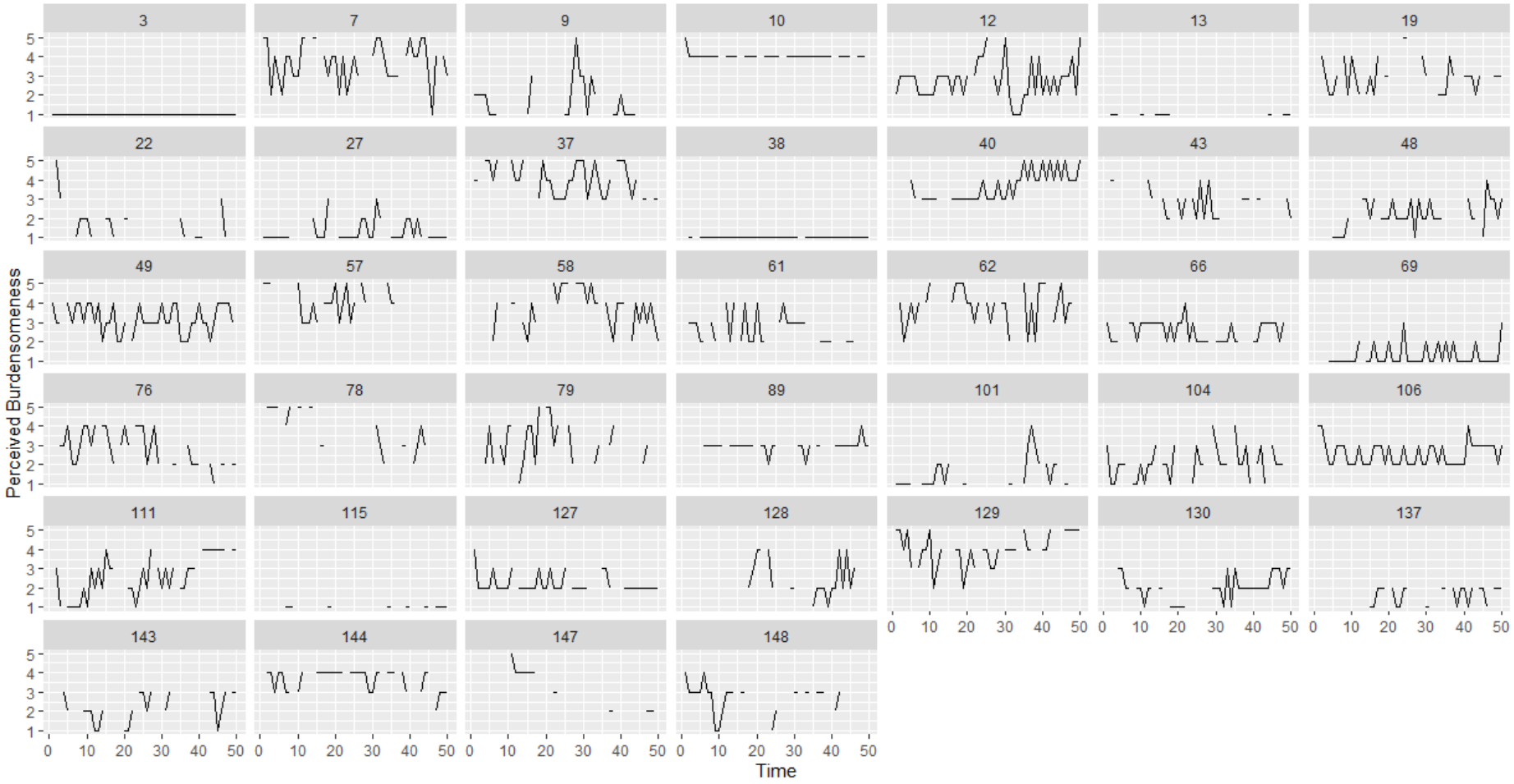


Figure L9

Graph of Each Participant's Raw Anhedonia Scores Over Time

Figure L10

Graph of Each Participant's Raw Thwarted Belongingness Scores Over Time

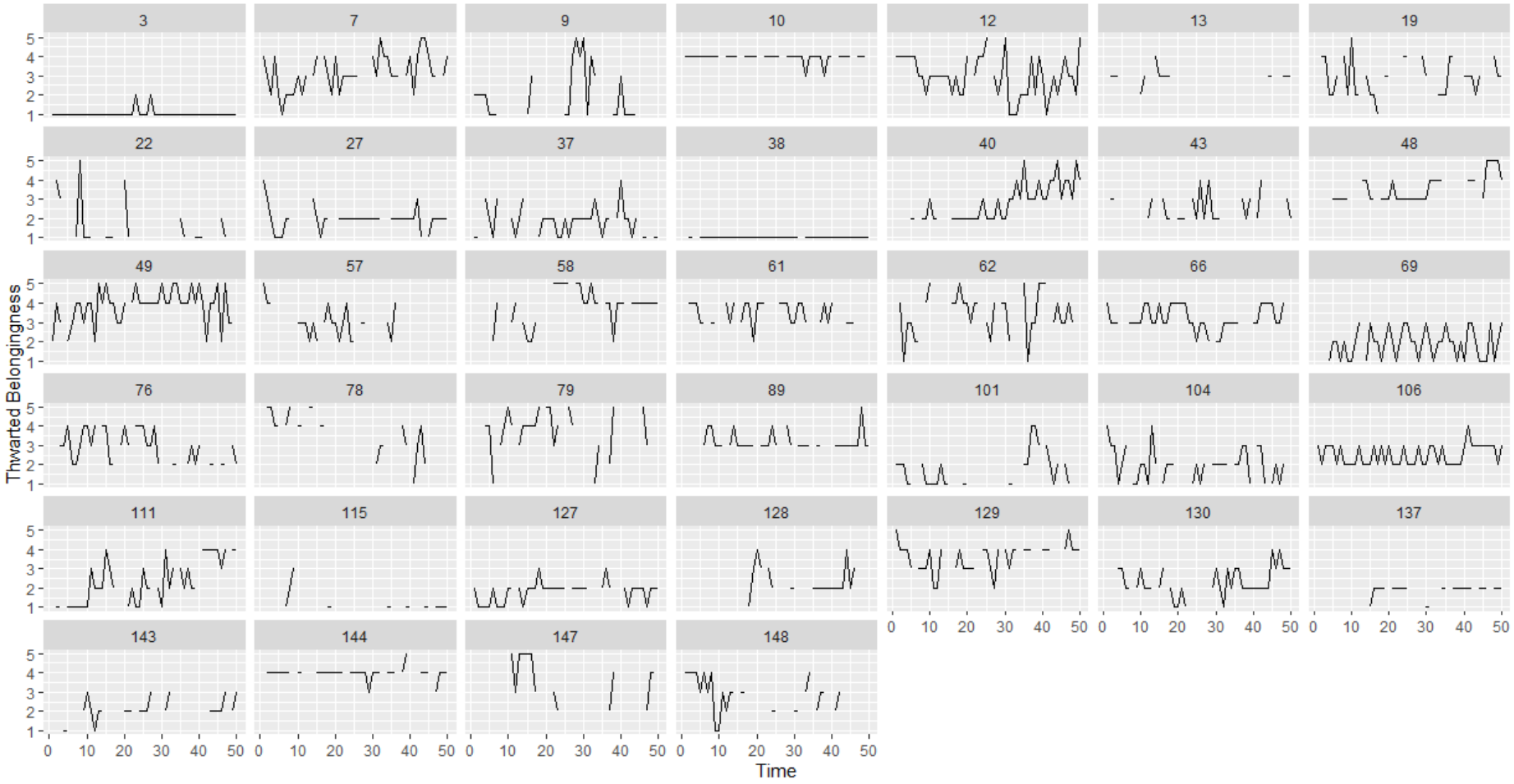
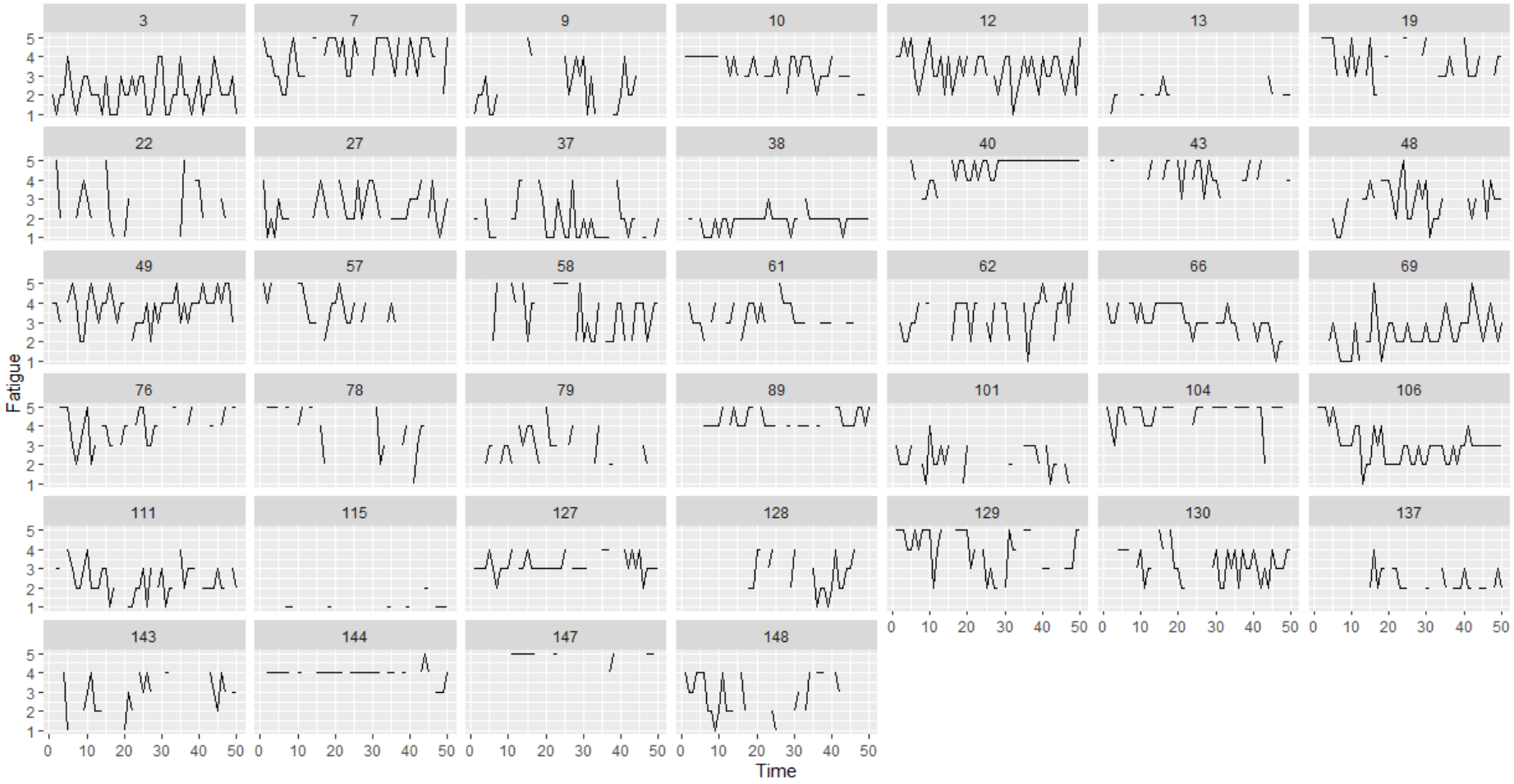


Figure L11

Graph of Each Participant's Raw Fatigue Scores Over Time



Appendix M: Research Case Study

This research case study was completed as part of the requirements for the Doctor of Clinical Psychology programme at Massey University. It is required to be included as an appendix.

A Temporal Network Analysis of Risk Factors for Suicide: Applications to Practice as an Intern Psychologist

Abstract

This case study demonstrates how my doctoral research has shaped my practice as an intern psychologist within the Child and Adolescent Mental Health Service in Palmerston North. First I explain my doctoral research in an article-style format, including relevant literature, research aims, the method, and lastly the results of this research. Following this I provide reflections about how this research has impacted my practice as an Intern Psychologist, particularly relating to the role of a Clinical Psychologist as a scientist-practitioner and how suicide risk assessment looks in practice.

A Temporal Network Analysis of Risk Factors for Suicide: Applications to Practice as an Intern Psychologist

Suicide is a major public health concern worldwide, including in New Zealand. It is estimated that about 3% of the population in New Zealand experience will experience suicidal ideation in any given twelve month period, and 16% will experience suicidal ideation at some time in their life (Beautrais, Wells, et al., 2006). Recent statistics show that suicide attempts and intentional self-harm result in around 9,000 hospitalisations annually (Ministry of Health, 2022). Regarding suicide deaths, in the year to June 2022, 538 people died by suicide in New Zealand, equal to a rate of 10.2 suicides per 100,000 people (Ministry of Health, 2022).

There are numerous risk factors which may contribute to whether a person experiences suicidality. Some of these risk factors are considered dynamic as they fluctuate over time (Bryan & Rudd, 2016). Dynamic suicide risk factors are a useful focus for suicide prevention efforts, because if these risk factors are altered, an individual's overall risk of suicide may also change. To date, very few studies have focused on how dynamic suicide risk factors fluctuate over short periods of time, such as minutes or hours, and how these changes impact a person's experience of suicidal ideation. One way to explore the dynamic nature of suicide risk is to collect data through ecological momentary assessments – the repeated collection of data across a period of days or weeks (Davidson et al., 2016). Thus far, ecological momentary assessment studies have shown suicidal ideation and risk factors for suicide to fluctuate to at least some degree between measurements taken from thirty minutes to eight hours apart (Hallensleben et al., 2019; E. M. Kleiman et al., 2017). These studies have also found risk factors such as hopelessness and perceived burdensomeness to be temporally associated with an increase in suicidal ideation (Hallensleben et al., 2019).

Suicide risk is complex, with many variables contributing to whether a person is experiencing suicidality. In recent years, the novel data analysis method of network analysis has been used to explore complex associations between variables and how these associations change over time. The output of network analysis is a visual network structure of the strength and direction of the associations between variables, making the complexity of these associations visually accessible. This provides us with a better understanding of how the variables might mutually influence one another, compared to what typical methods of analysis in psychological research might be able to depict. From the network perspective, suicide risk can be understood as a system of variables (i.e., risk factors), each of which causally influences others to produce a network of variables which together create 'suicide risk'. If an individual experiences an increase in a particular risk factor, this may then lead to further activation of other risk factors in the network, ultimately resulting in a change in overall risk. Some risk factors are likely to also be temporally associated with an increase in suicidal ideation within such a network, which can be explored using temporal network analysis. The presence of a relationship between two variables in a temporal network is suggestive of a *potentially* causal relationship. This is because the cause temporally precedes the effect in this network, which is known as Granger causality. In addition, temporal networks depict only the associations which remain after controlling for stable interindividual differences and the effect of all other variables in the network. This provides us with stronger evidence of causality than that suggested by cross-sectional research which might be confounded by numerous individual differences.

Utilising network analysis to explore which risk factors are central to suicide risk could potentially help us to devise more targeted, effective interventions. Central risk factors are those which have a strong influence on many other variables in the network. When the most central

risk factors in a network are activated or changed, the many risk factors associated with these central risk factors may also be activated, resulting in network-wide activation and a change in overall suicide risk. Targeting central risk factors in specific interventions may therefore be an effective way to reduce suicide risk, compared to targeting factors that are not connected to many others.

By conducting temporal network analyses of suicide risk factors using data collected through ecological momentary assessments, we can study the short-term dynamic relationships between suicidal ideation and risk factors for suicide. Thus far there is just one known published study of this nature, which was by Rath et al. (2019). The authors had 74 psychiatric inpatient participants complete six days of surveys with ten survey prompts sent each day. Their surveys measured momentary suicidal ideation, perceived burdensomeness, thwarted belongingness, depression, hopelessness, positive affect, and anxiety. Rath et al. (2019) then estimated temporal, contemporaneous, and between-persons networks using temporal network analysis.

Rath et al.'s (2019) temporal network structure showed that perceived burdensomeness at one measurement predicted an increase in suicidal ideation at the subsequent measurement. In their contemporaneous network, it was estimated that hopelessness and suicidal ideation were associated within the same measurement. In the between-persons network, hopelessness and suicidal ideation were again positively associated, suggesting that participants who reported high levels of hopelessness also tended to report high suicidal ideation on average (Rath et al., 2019).

Rationale and Aims

To further increase our understanding of the complexity of the relationships between risk factors for suicide and suicidal ideation, and how these variables fluctuate over time, my doctoral

research built upon Rath et al.'s (2019) study by conducting a temporal network analysis of a larger group of risk factors for suicide, with some differences. Rath et al. (2019) did not include some of the common risk factors for suicide that have empirical (and theoretical) associations with suicidality, such as acute alcohol intoxication, social support, and self-esteem. Additionally, their study also only included one symptom of depression – depressed mood – yet there are multiple symptoms of depression that are empirically associated with suicide, including anhedonia, worthlessness, and fatigue. Including these symptoms of depression in a network analysis of suicide risk factors would increase our understanding of the role these symptoms play in altering suicide risk.

This study focused on exploring how dynamic risk factors for suicide were associated over short periods of time, using an ecological momentary assessment design to collect data repeatedly. I also investigated which risk factors were directly associated with suicidal ideation by estimating temporal, contemporaneous, and between-persons networks using temporal network analysis. The dynamic risk factors for suicide that were included in this study were depressed mood, worthlessness, anhedonia, fatigue, alcohol intoxication, hopelessness, perceived burdensomeness, thwarted belongingness, self-esteem, and social support. These risk factors were considered to be acutely dynamic (i.e., potentially changeable over *short* periods of time), and were involved in ideation-to-action theories of suicide or had empirical evidence supporting their association with suicidality. Table 1 and Table 2 below summarise the relevant evidence, as a detailed review is beyond the scope of this case study.

Table 1

Empirical Research Supporting the Association Between Suicide Risk Factors and Suicidal Ideation and Suicide Attempt.

Variable	Suicidal ideation	Suicide attempt
Depression		
Depressed mood		Cameron et al. (2017)
Worthlessness		Wakefield and Schmitz (2016)
Fatigue	Ribeiro et al. (2012)	
Anhedonia	Ducasse et al. (2018)	
Alcohol intoxication		Cherpitel et al. (2004)
Hopelessness	Hallensleben et al. (2019)	
	Roeder & Cole (2019)	
	Sueki (2020)	
	Wolfe et al. (2019)	
Perceived burdensomeness	Duffy et al. (2020)	Hill & Pettit (2014)
	Hallensleben et al. (2019)	
	Hill & Pettit (2014)	
	Kleiman et al. (2017)	
Thwarted belongingness	Hallensleben et al. (2019)	Ma et al. (2016)
	Kleiman et al. (2017)	
	Ma et al. (2016)	
	Roeder & Cole (2019)	
Social support	Richie et al. (2019)	Liu et al. (2017)
	Teismann et al. (2016)	

Table 1 continued

Variable	Suicidal ideation	Suicide attempt
Self-esteem	Fergusson et al. (2003) Wild et al. (2004)	Delam & Bazrafshan (2019) Fergusson et al. (2003) Soto-Sanz et al. (2019) Wild et al. (2004)

Note. This is not an exhaustive list of relevant literature.

Table 2

Theoretical Involvement of Risk Factors Included in the Present Study.

Interpersonal psychological theory of suicide	Integrated motivational-volitional model of suicide	Three step theory of suicide
Perceived burdensomeness Thwarted belongingness	Perceived burdensomeness Thwarted belongingness Social support	Perceived burdensomeness Thwarted belongingness Social support Hopelessness Self-esteem

Note. There are additional variables associated with each of these theories that are not listed here as they were not included in the present study.

Hypotheses

There were seven hypotheses for this research which were based on the findings of previous suicide network analysis research, including Rath et al. (2019) and Holman and

Williams (2022) as well as ideation-to-action theories of suicide (e.g., Joiner, 2005; O'Connor, 2011; and Van Orden et al., 2010).

H1 In the temporal network, depressed mood will be positively associated with suicidal ideation at the subsequent time point.

H2 In the temporal network, perceived burdensomeness will be positively associated with suicidal ideation at the subsequent time point.

H3 In the temporal network, thwarted belongingness will be positively associated with suicidal ideation at the subsequent time point.

H4 In the temporal network, hopelessness will be positively associated with suicidal ideation at the subsequent time point.

H5 In the contemporaneous network, hopelessness will be positively associated with suicidal ideation.

H6 In the between-persons network, hopelessness will be positively associated with suicidal ideation.

H7 In the between-persons network, self-esteem will be negatively associated with suicidal ideation.

Research Questions

In addition to having specific hypotheses, this research had four broad research questions. These are listed below.

RQ1 To what degree does suicidal ideation fluctuate from measurement to measurement?

RQ2 To what degree do risk factors for suicide fluctuate from measurement to measurement?

RQ3 What nodes are directly associated with increased suicidal ideation in each network (temporal, contemporaneous, and between-persons)?

RQ4 What nodes have the highest strength centrality in each network (temporal, contemporaneous, and between-persons)?

Method

Procedure and Participants

This study utilised an ecological momentary assessment design, where an online survey was used to collect data repeatedly over time from one sample of participants. This data was then analysed using temporal network analysis. Currently there is no consensus or guide for how to calculate the sample size required for a temporal network analysis. After consulting previous temporal network literature with a similar number of nodes to this study (e.g., Greene et al., 2020; Levinson et al., 2018), a target sample size of 75 to 85 participants was decided on. In addition, I used Kleiman's (2017) *EMAtools* package in R (R Core Team, 2021) to estimate a multi-level power curve based on a sample size of 75 participants, with 5 surveys per day for a total of 10 days. The results of the power curve suggested there would be adequate power to detect large effects at a 75% completion rate, similar to previous suicide ecological momentary assessment research (Hallensleben et al., 2019). Though having enough power to detect small

effects would be the ideal scenario, the multi-level power curve estimated that the participants would have to complete approximately 500 surveys *each* for this to be the case. This was deemed unethical and unfeasible for this study, given the high level of burden it would place on participants.

To recruit participants for the study, a screening survey was distributed online using both paid and unpaid advertising through Facebook. The screening survey included items which reflected the eligibility criteria for the main study. To be eligible to participate in the main study, participants had to be over 18 years old, live in New Zealand, have experienced suicidal ideation in the previous six months, own an internet-capable smartphone, and be interested in participating after reading a short description of the main study. In total, 314 people completed the screening survey, of which 149 were eligible to participate in the main study.

A random sample of 85 the 149 eligible participants were invited to participate in the study, and 49 provided consent. A further 36 eligible participants were randomly selected and invited to participate in order to try meet the minimum desired sample size of 75 participants. Of these additional participants, 19 consented to participate, totalling a sample of 68 participants for the study. Although this was a lower number than the target sample size of 75 participants, the preregistration for this study specified that data collection would begin after two rounds of invitations, regardless of the sample size.

All participants began completing surveys for the study on Tuesday 13th April 2021. For a period of ten consecutive days, participants were sent an email notification five times per day asking them to complete a brief survey including 11 quantitative items. The median time it took participants to complete the survey was 33 seconds. Participants were able to opt out of the study

at any point. Of the 68 participants, 63 completed at least one survey, and 39 completed the minimum number of surveys required to run the analysis (i.e., 35 out of the 50 possible surveys).

Participant age ranged from 19 to 66 years, with an average age of 41.2 years. One participant did not provide their age in the main study demographics survey, but in the initial screening survey they signalled that they were in the 25 to 34 year old age bracket. The majority of participants identified as Pākehā, while 3 participants identified as Māori and 1 as Pacific Islander. Four participants reported other ethnicities. Two participants identified as gender diverse, five as male, and 32 as female.

Measures

The online survey used for this study contained eleven items, with each item corresponding to one of the eleven variables of interest. The response scale for all items ranged from 1 *not at all* to 5 *extremely*. The eleven survey items are listed in Table 3 below.

The survey was created specifically for the purpose of this study, as thus far there are no known measures designed and validated for use in temporal network analysis research using an ecological momentary assessment design. Adapting measures that are used in cross-sectional studies would have been impractical and inappropriate as such measures often contain numerous items for one variable, and the survey for this study needed to be very brief so as to cause minimal burden to the participants who had to repeatedly complete the survey. In addition, I designed this study in a way that would uphold open science practices, which included sharing the research materials online on the Open Science Framework to increase research transparency and reproducibility (Tackett et al., 2019). When researching what measures to use, I found that many had restricted permissions. If I had chosen to use these measures I would not have been

able to openly share the survey materials online along with the other resources required to replicate or review the study. By creating and adapting the survey items specifically for use in this study, I was able to share my research materials openly online.

Table 3

Variables and Corresponding Survey Items

Variable	Survey Item
Suicidal ideation	At the moment I am thinking about taking my own life
Depressed mood	At the moment I feel depressed
Fatigue	At the moment I feel tired
Anhedonia	At the moment I feel like nothing I am doing is enjoyable or pleasurable
Worthlessness	At the moment I feel worthless
Hopelessness	At the moment I feel hopeless
Perceived burdensomeness	At the moment I feel like a burden to others
Thwarted belongingness	At the moment I feel like I don't belong
Self-esteem	At the moment I feel good about myself
Social support	At the moment I feel supported by the people around me
Alcohol intoxication	At the moment I feel drunk

The items used to measure depressed mood, hopelessness, self-esteem, and suicidal ideation were adapted from the items used in a cross-sectional network analysis of risk factors for suicide by Holman and Williams (2022). The items measuring perceived burdensomeness and thwarted belongingness were adapted from items used in ecological momentary assessment studies by Forkmann et al. (2018) and Hallensleben et al. (2019). The items measuring fatigue, worthlessness, social support, and alcohol intoxication were not adapted from previous studies or

existing validated measures and were instead created by me. These items were all reviewed by my supervision panel and refined multiple times. This process involved looking at definitions in current literature and reviewing items used in previous studies about suicide risk factors.

Data Analysis

All statistical analyses were completed using R version 4.0.2 (R Core Team, 2021). Research questions 1 and 2 were addressed by computing a descriptive statistic called the root mean square successive difference (RMSSD) for every variable. RMSSD is a measure of an item's variability over time, with a larger value reflecting more variability from measurement to measurement (E. M. Kleiman et al., 2017). RMSSD in this study ranged between 0 and 4 for each variable.

All seven hypotheses as well as research question 3 were addressed by conducting a temporal network analysis using the *mlVAR* package (Epskamp et al., 2019), which estimates temporal, contemporaneous, and between-persons networks. Detrended data were used in the network analysis. The temporal network had a specified lag of 1, such that each survey was regressed on the previous survey. An exception to this was that the first survey of each day was not regressed on the last survey of the previous day, as the interval between these surveys was longer than the interval that occurred between all other consecutive surveys (12 hours overnight versus 3 hours between surveys during the day). Similarly, in cases where there was a missing response to a survey, the next completed survey was not regressed on the last completed survey due to the different lag interval.

Research question 4, which was concerned with finding out which nodes had the highest strength centrality in each network, was addressed by completing a strength centrality analysis for each of the three networks, using the *qgraph* package (Epskamp et al., 2012).

Ethics

Approval for this study (Application NOR 20/44) was granted by the Massey University Human Ethics Committee: Northern. When designing this study, the primary ethical consideration was that the survey may precipitate increased suicidality for some participants. This was anticipated to be a low likelihood outcome as research suggests that asking people about their thoughts of suicide does not increase the occurrence of such thoughts, even when asked repeatedly (Blades et al., 2018; Dazzi et al., 2014; Law et al., 2015). To mitigate the possibility of the survey increasing participants' thoughts of suicide, support services were listed at the end of every survey, with additional messages at the end of surveys where participants had signalled extremely low mood or strong thoughts of suicide. Participants were also given the option to discontinue participation at any point, with an opt out link included in every survey notification email. Only one participant chose to opt out of the study.

Results

Research Question 1

Participants' experience of suicidal ideation varied a small amount over time in this study, as shown by the average RMSSD value of 0.37. The suicidal ideation item had an RMSSD range of 0.00 to 1.01, meaning that sometimes a participant's experience of suicidal ideation remained the same from measurement to measurement, whereas for other participants

their suicidal ideation rating fluctuated a small amount from measurement to measurement. For a visual representation of these fluctuations over time for each participant, see Figure 1 below.

Figure 1

Graph of Each Participant's Raw Suicidal Ideation Scores Over Time

Note. For suicidal ideation, 1 = not at all, 2 = a little bit, 3 = moderate, 4 = a lot, 5 = extremely. Time represents each survey.

Research Question 2

All ten of the risk factors for suicide that were measured in this study showed some variability over time. Fatigue showed the highest average variability (RMSSD = 0.87), followed by thwarted belongingness (RMSSD = 0.76), anhedonia (RMSSD = 0.72), perceived

burdensomeness (RMSSD = 0.69), and hopelessness (RMSSD = 0.68). Alcohol intoxication had the lowest mean RMSSD value at 0.10.

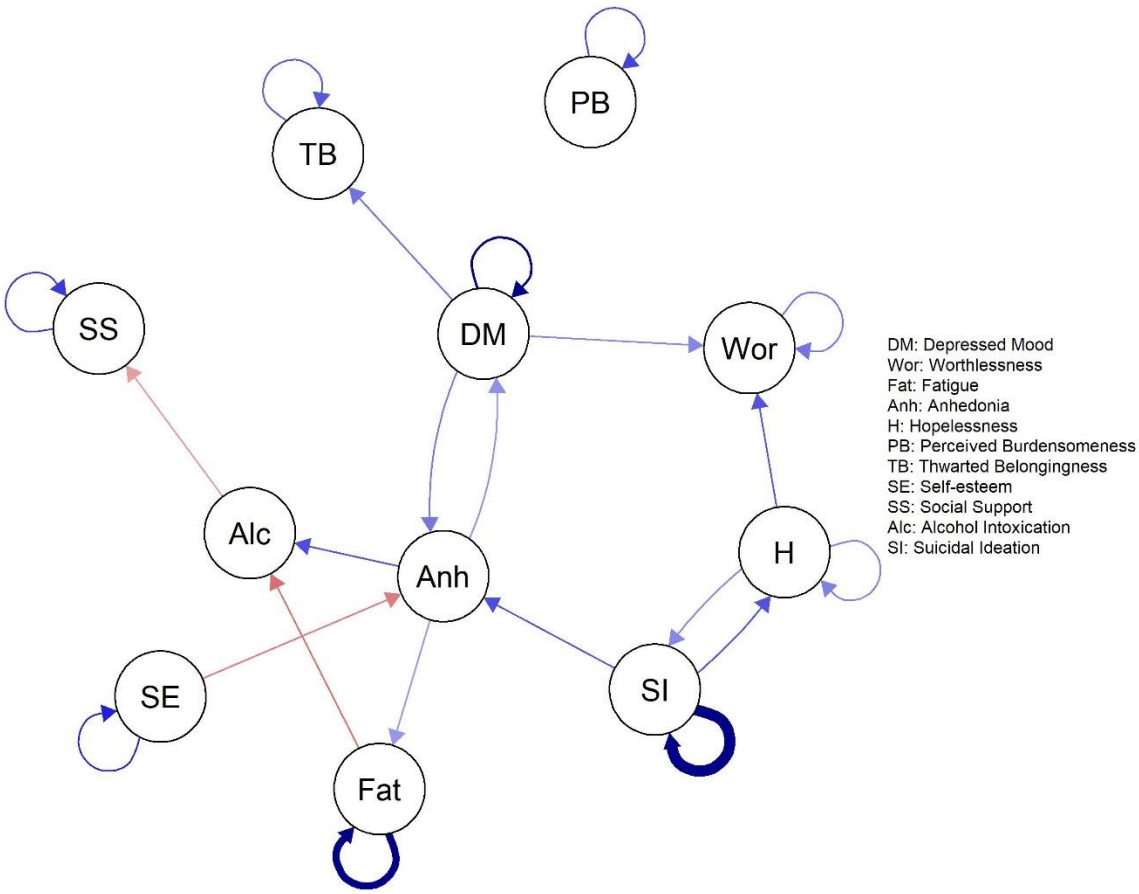
Network Estimation

Temporal Network

The temporal network of risk factors for suicide is depicted in Figure 2. This network shows associations between nodes over time.

Figure 2

The Temporal Network of Risk Factors for Suicide



Note. Thicker, more opaque edges represent stronger associations between two nodes. Negative associations are depicted by a red edge, and positive associations by a blue edge.

Of the four hypotheses for temporal network, just Hypothesis 4 was supported. Hopelessness at one time was significantly associated with an increase in suicidal ideation at the subsequent measurement. Regarding Hypotheses 1, 2, and 3, depressed mood, perceived burdensomeness, and thwarted belongingness did not have a statistically significant positive association with suicidal ideation over time.

Research question 3 was concerned with finding out what nodes were directly associated with increased suicidal ideation in each network. In the temporal network, hopelessness was the only node that had an edge with an arrowhead pointing towards suicidal ideation, suggesting that a high level of hopelessness at one time point was associated with a higher levels of suicidal ideation at the subsequent time point in the temporal network.

Contemporaneous Network

The contemporaneous network of risk factors for suicide is depicted in Figure 3. This network shows associations between nodes within the same measurement.

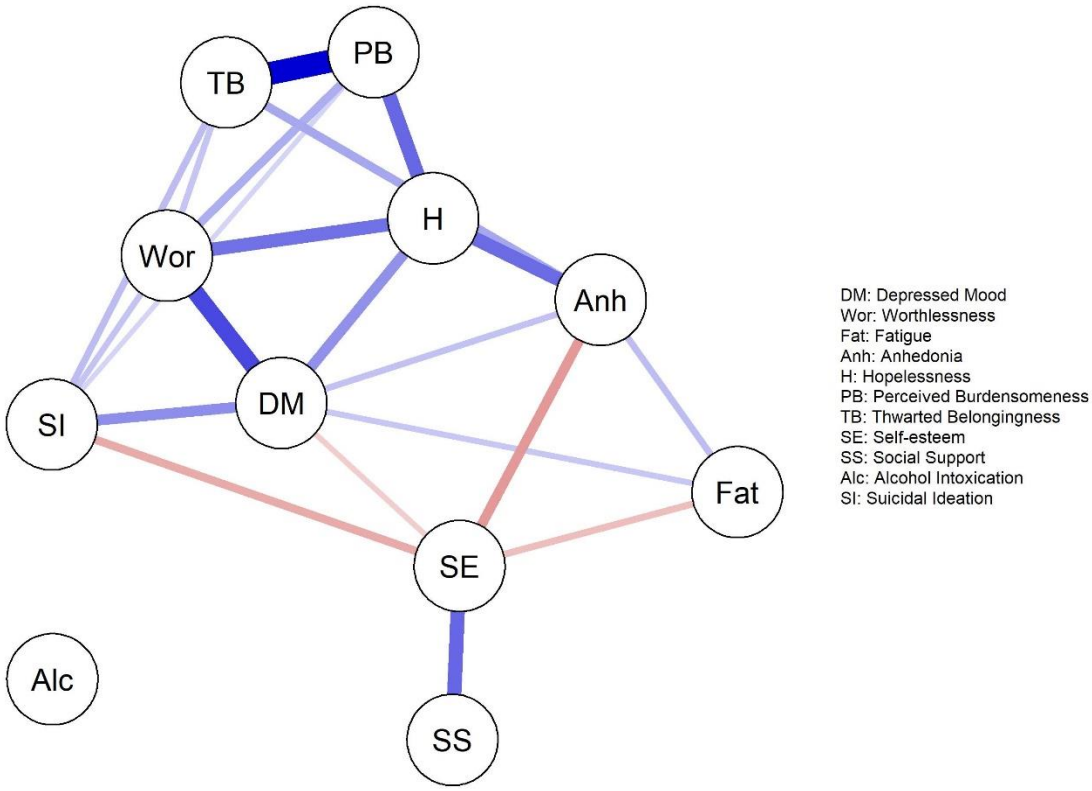
Hypothesis 5, that hopelessness would be positively associated with suicidal ideation, was not supported. As depicted in Figure 3 below, there is not an edge between these two nodes.

Regarding research question 3, there were numerous direct, positive associations with suicidal ideation in the contemporaneous network. The node with the strongest positive association with suicidal ideation was depressed mood, followed by thwarted belonging, worthlessness, and perceived burdensomeness. Higher levels of these variables was associated

with higher levels of suicidal ideation within the same measurement. In addition, there was a negative association between self-esteem and suicidal ideation in this network, suggesting that lower levels of self-esteem were associated with higher levels of suicidal ideation.

Figure 3

The Contemporaneous Network of Risk Factors for Suicide



Between-Persons Network

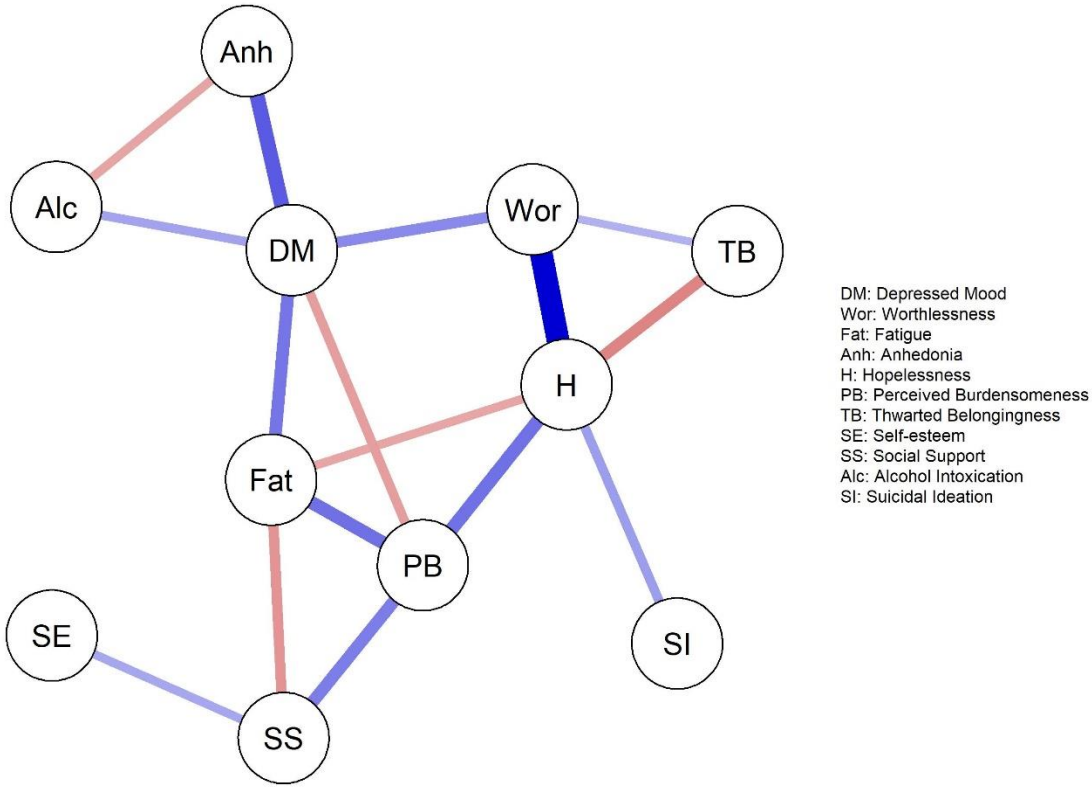
The between-persons network of risk factors for suicide is depicted in Figure 4. This network displays the relationships between mean levels of each node across individuals.

Hypothesis 6, that hopelessness would be positively associated with suicidal ideation, was supported, suggesting that individuals who experienced higher levels of hopelessness tended to experience higher levels of suicidal ideation on average. Hypothesis 7, that self-esteem would be negatively associated with suicidal ideation, was not supported.

In relation to research question 3, hopelessness was the only node that was significantly associated with suicidal ideation in this network.

Figure 4

The Between-Persons Network of Risk Factors for Suicide



Centrality

In the temporal network, depressed mood had the highest out-strength centrality, followed by anhedonia and suicidal ideation. The nodes with the lowest out-strength centrality in this network were worthlessness, thwarted belonging, social support, and perceived burdensomeness. The node with the highest in-strength centrality in the temporal network was anhedonia, followed by alcohol intoxication and worthlessness. Self-esteem and perceived burdensomeness had the lowest in-strength centrality in the temporal network. In the contemporaneous network, the node with the highest strength centrality was depressed mood. Hopelessness, perceived burdensomeness, and worthlessness has similarly high strength centrality in this network. The node with the lowest strength centrality in the contemporaneous network was alcohol intoxication. In the between-persons network, hopelessness had the highest strength centrality. Depressed mood and perceived burdensomeness were also central to this network. The nodes with the lowest strength centrality in the between-persons network were self-esteem and suicidal ideation.

Conclusion

The present study demonstrated how network analysis can be used to explore the temporal associations between suicidal ideation and risk factors for suicide, and how these variables change over short periods of time. Of particular note was the role of hopelessness in predicting future suicidal ideation. Hopelessness was the only variable estimated to have a significant association with suicidal ideation in the temporal network of the present study, with level of hopelessness at one measurement predicting an increase in suicidal ideation at the subsequent measurement just three hours later. In contrast, numerous variables were associated with suicidal ideation within the same measurement, including depressed mood, thwarted

belongingness, worthlessness, perceived burdensomeness, and self-esteem. Overall, the findings suggest hopelessness may be an especially important risk factor to assess given its temporal association with increased suicidal ideation, but the presence of other risk factors should also be assessed for. The results of this study further highlight the importance of continuously assessing changes in suicide risk factors, given their dynamic nature.

Reflections

My doctoral research has influenced my practice as an Intern Psychologist in multiple ways. Firstly, it has improved my understanding of the scientist-practitioner role. In the beginning stages of my research, I came across numerous articles about how poor the current suicide risk prediction methods are – especially those that involve the categorisation of suicide risk. Research suggests that this method has poor predictive validity, sensitivity, and specificity in predicting whether someone will take their own life (de Beer et al., 2018). Using a person's category of suicide risk to predict their likelihood of future suicide produces many false positives – individuals *are* deemed at risk of suicide when they actually are *not* – and false negatives – individuals are *not* deemed at risk of suicide when they actually *are* (Berman & Silverman, 2014; Schiepek et al., 2011). At the Child and Adolescent Mental Health Service in Palmerston North (and presumably other Te Whatu Ora mental health services), it is a service requirement to document a client's risk to self, including specifying whether this risk is categorically low, moderate, or high. The category chosen for each client is based on clinical judgement of information gathered during an assessment (Ministry of Health, 2003), and in my experience this is somewhat subjective. Risk categorisation presents a conflict for me, as a Clinical Psychologist is expected to practice as a scientist-practitioner, and the science is largely against the utility of risk categorisation. Being unable to alter this aspect of my practice to match the research felt

uncomfortable to begin with. However, a benefit of this discomfort is that my documentation of a suicide risk assessment tends to be detailed as a result, to ensure that other clinicians can better understand my decision making.

New Zealand has the second highest youth suicide rate in the OECD (Mental Health Foundation, n.d.; UNICEF, 2020), and typically clients who are referred to the Child and Adolescent Mental Health Service have previously experienced or are currently experiencing suicidality. As such, assessing the suicide risk of the clients I see at this service is especially important, given the high likelihood of this experience. My doctoral research highlighted for me how important it is to assess for suicidal ideation frequently, as a person's risk of suicide can fluctuate over very short periods of time. This has been apparent for the clients I have seen during my internship, with some clients having very brief experiences of suicidal ideation and other clients having chronic suicidal ideation that fluctuates in intensity throughout the day. Assessing suicidality at each appointment provides an opportunity to identify early warning signs and high risk situations for clients as they are occurring. If a client expresses suicidality we typically explore what triggered this, what thoughts and feelings are arising, and what the possible function of the suicidal behaviour is. This occurs in addition to the assessment of frequency and intensity of the suicidal ideation and whether there is a suicide plan, intent, and access to means. Frequent suicide risk assessment also provides an opportunity to provide timely interventions such as safety planning (with the newly recognised triggers), distress tolerance skills, and problem-solving skills.

During my internship I have also noticed that the variety of factors that contribute to suicidality for youth are much wider than what was encapsulated by my doctoral research, which did not include any triggering events for suicidality, such as relationship break ups, bullying, and

trauma. As a result I have also been reflecting back on research I completed during my Honours degree (Holman & Williams, 2019), which explored what youth believed were the causes of New Zealand's high youth suicide rate. Factors raised by youth within that study included bullying, loneliness, and pressure to do well or fit in. These factors, along with many others, have been implicated in the experience of suicidality for the clients I have seen during my internship. Anecdotally, I have noticed that bullying as well as interpersonal conflicts more broadly have been the most prominent precursors to increased suicidality within this client group. Both research projects serve as a reminder for me of the complexity of suicidality, and the variety of aspects which can and should be assessed. It would be interesting to build on my doctoral research later in my career, possibly by adding situational triggers to the network analysis, to see how these events directly affect the emotions and experiences that are associated with suicidality.

References

Aaltonen, K. I., Isometsä, E., Sund, R., & Pirkola, S. (2019). Risk factors for suicide in depression in Finland: First-hospitalized patients followed up to 24 years. *Acta Psychiatrica Scandinavica*, *139*(2), 154–163. https://doi.org/10.1111/acps.12990

Ali, B., Staniforth, B., & Adamson, C. (2021). Qualitative research: Reflecting on lived experience: Suicide prevention and the importance of social work in mental health. *Aotearoa New Zealand Social Work*, *33*(2), 6–18. https://doi.org/10.11157/anzswj-vol33iss2id861

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders (5th ed.)*. American Psychiatric Publishing.

Assing Hvidt, E., Ploug, T., & Holm, S. (2016). The impact of telephone crisis services on suicidal users: A systematic review of the past 45 years. *Mental Health Review Journal*, *21*(2), 141–160. https://doi.org/10.1108/MHRJ-07-2015-0019

Baumeister, R. F. (1990). Suicide as escape from self. *Psychological Review*, *97*(1), 90–113. https://doi.org/10.1037/0033-295X.97.1.90

Beard, C., Millner, A. J., Forgeard, M. J. C., Fried, E. I., Hsu, K. J., Treadway, M. T., Leonard, C. V., Kertz, S. J., & Björgvinsson, T. (2016). Network analysis of depression and anxiety symptom relationships in a psychiatric sample. *Psychological Medicine*, *46*(16), 3359–3369. https://doi.org/10.1017/S0033291716002300

Beautrais, A. L. (2000). *Restricting access to means of suicide in New Zealand*. https://www.moh.govt.nz/notebook/nbbooks.nsf/0/53172E5F2B55B4F04C2569300071DBF9/$file/Methodsofsuicide.pdf

Beautrais, A. L., & Fergusson, D. M. (2006). Indigenous suicide in New Zealand. *Archives of Suicide Research, 10*(2), 159–168. https://doi.org/10.1080/13811110600556913

Beautrais, A. L., Fergusson, D. M., & Horwood, L. J. (2006). Firearms legislation and reductions in firearm-related suicide deaths in New Zealand. *Australian & New Zealand Journal of Psychiatry*, *40*(3), 253–259. https://doi.org/10.1080/j.1440-1614.2006.01782.x

Beautrais, A. L., Wells, J. E., McGee, M. A., & Oakley Browne, M. A. (2006). Suicidal Behaviour in Te Rau Hinengaro: The New Zealand Mental Health Survey. *Australian & New Zealand Journal of Psychiatry*, *40*(10), 896–904. https://doi.org/10.1080/j.1440-1614.2006.01909.x

Beck, A. T., Weissman, A., Lester, D., & Trexler, L. (1974). The measurement of pessimism: The Hopelessness Scale. *Journal of Consulting and Clinical Psychology*, *42*(6), 861–865. https://doi.org/10.1037/h0037562

Berman, A. L., & Silverman, M. M. (2014). Suicide risk assessment and risk formulation part II: Suicide risk formulation and the determination of levels of risk. *Suicide and Life-Threatening Behavior*, *44*(4), 432–443. https://doi.org/10.1111/sltb.12067

Blades, C. A., Stritzke, W. G. K., Page, A. C., & Brown, J. D. (2018). The benefits and risks of asking research participants about suicide: A meta-analysis of the impact of exposure to suicide-related content. *Clinical Psychology Review*, *64*, 1–12. https://doi.org/10.1016/j.cpr.2018.07.001

Bolton, J. M., Belik, S.-L., Enns, M. W., Cox, B. J., & Sareen, J. (2008). Exploring the correlates of suicide attempts among individuals with major depressive disorder: Findings from the national epidemiologic survey on alcohol and related conditions. *The Journal of Clinical Psychiatry*, *69*(7), 1139–1149. https://doi.org/10.4088/jcp.v69n0714

Bolton, J. M., Pagura, J., Enns, M. W., Grant, B., & Sareen, J. (2010). A population-based longitudinal study of risk factors for suicide attempts in major depressive disorder. *Journal of Psychiatric Research*, *44*(13), 817–826. https://doi.org/10.1016/j.jpsychires.2010.01.003

Borges, G., Bagge, C., Cherpitel, C. J., Conner, K., Orozco, R., & Rossow, I. (2017). A meta-analysis of acute alcohol use and the risk of suicide attempt. *Psychological Medicine*, *47*(5), 949–957. https://doi.org/10.1017/S0033291716002841

Borsboom, D. (2008). Psychometric perspectives on diagnostic systems. *Journal of Clinical Psychology*, *64*(9), 1089–1108. https://doi.org/10.1002/jclp.20503

Borsboom, D., & Cramer, A. O. J. (2013). Network analysis: An integrative approach to the structure of psychopathology. *Annual Review of Clinical Psychology*, *9*(1), 91–121. https://doi.org/10.1146/annurev-clinpsy-050212-185608

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. https://doi.org/10.1016/j.jpsychires.2019.07.007

Bringmann, L., Elmer, T., Epskamp, S., Krause, R., Schoch, D., Wichers, M., Wigman, J., & Snippe, E. (2019). What do centrality measures measure in psychological networks? *Journal of Abnormal Psychology*, *128*(8), 892–903. https://doi.org/10.1037/abn0000446

Bringmann, L. F., Lemmens, L. H. J. M., Huibers, M. J. H., Borsboom, D., & Tuerlinckx, F. (2014). Revealing the dynamic network structure of the Beck Depression Inventory-II. *Psychological Medicine*, *45*(04), 747–757. https://doi.org/10.1017/s0033291714001809

Brown, S. L., Marshall, A. J., Mitchell, S. M., Roush, J. F., Mumma, G. H., Jahn, D. R., Ribeiro, J. D., Joiner, T. E., & Cukrowicz, K. C. (2021). Suicide ideation and thwarted interpersonal needs among psychiatric inpatients: A network approach. *Clinical Psychological Science*, *9*(6), 1080–1094. https://doi.org/10.1177/21677026211000670

Bryan, C. J., & Rudd, M. D. (2016). The importance of temporal dynamics in the transition from suicidal thought to behavior. *Clinical Psychology: Science and Practice*, *23*(1), 21–25. https://doi.org/10.1111/cpsp.12135

Cameron, S., Brown, V. J., Dritschel, B., Power, K., & Cook, M. (2017). Understanding the relationship between suicidality, current depressed mood, personality, and cognitive factors. *Psychology and Psychotherapy: Theory, Research and Practice*, *90*(4), 530–549. https://doi.org/10.1111/papt.12123

Carmichael, V., & Whitley, R. (2019). Media coverage of Robin Williams' suicide in the United States: A contributor to contagion? *PLOS ONE*, *14*(5), e0216543. https://doi.org/10.1371/journal.pone.0216543

Carter, G., Page, A., Large, M., Hetrick, S., Milner, A. J., Bendit, N., Walton, C., Draper, B., Hazell, P., Fortune, S., Burns, J., Patton, G., Lawrence, M., Dadd, L., Dudley, M., Robinson, J., & Christensen, H. (2016). Royal Australian and New Zealand College of Psychiatrists clinical practice guideline for the management of deliberate self-harm. *Australian & New Zealand Journal of Psychiatry*, *50*(10). https://doi.org/10.1177/0004867416661039

Carter, G., & Spittal, M. J. (2018). Risk stratification is not accurate enough to be clinically useful and alternative approaches are needed. *Crisis*, *39*(4), 229–234. https://doi.org/10.1027/0227-5910/a000558

Cerel, J., Brown, M. M., Maple, M., Singleton, M., Venne, J. van de, Moore, M., & Flaherty, C. (2019). How many people are exposed to suicide? Not six. *Suicide and Life-Threatening Behavior*, *49*(2), 529–534. https://doi.org/10.1111/sltb.12450

Cerel, J., Maple, M., van de Venne, J., Moore, M., Flaherty, C., & Brown, M. (2016). Exposure to suicide in the community: Prevalence and correlates in one U.S. state. *Public Health Reports*, *131*(1), 100–107. https://doi.org/10.1177/003335491613100116

Cherpitel, C. J., Borges, G. L. G., & Wilcox, H. C. (2004). Acute alcohol use and suicidal behavior: A review of the literature. *Alcoholism: Clinical and Experimental Research*, *28*(5), S18–S28. https://doi.org/10.1097/01.ALC.0000127411.61634.14

Chiang, A., Paynter, J., Edlin, R., & Exeter, D. J. (2021). Suicide preceded by health services contact – A whole-of-population study in New Zealand 2013-2015. *PLOS ONE*, *16*(12), e0261163. https://doi.org/10.1371/journal.pone.0261163

Conner, K. R., Huguet, N., Caetano, R., Giesbrecht, N., McFarland, B. H., Nolte, K. B., & Kaplan, M. S. (2013). Acute use of alcohol and methods of suicide in a US national sample. *American Journal of Public Health*, *104*(1), 171–178. https://doi.org/10.2105/AJPH.2013.301352

Conner, K. R., Langley, J., Tomaszewski, K. J., & Conwell, Y. (2003). Injury hospitalization and risks for subsequent self-Injury and suicide: A national study From New Zealand. *American Journal of Public Health*, *93*(7), 1128–1131. https://doi.org/10.2105/AJPH.93.7.1128

Conner, T. (2015). *Experience sampling and ecological momentary assessment with mobile phones*. University of Otago. https://www.otago.ac.nz/psychology/otago047475.pdf

Coppersmith, D. D. L., Fortgang, R. G., Kleiman, E. M., Millner, A. J., Yeager, A. L., Mair, P., & Nock, M. K. (2022). Effect of frequent assessment of suicidal thinking on its incidence and severity: High-resolution real-time monitoring study. *The British Journal of Psychiatry*, *220*(1), 41–43. https://doi.org/10.1192/bjp.2021.97

Coppersmith, D. D. L., 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. https://doi.org/10.1016/j.brat.2018.11.016

Coronial Services of New Zealand. (2020). *2020 annual provisional suicide statistics*. https://coronialservices.justice.govt.nz/assets/Documents/Publications/2020-Annual-Provisional-Suicide-Statistics.pdf

Cramer, A. O. J., van Borkulo, C. D., Giltay, E. J., van der Maas, H. L. J., Kendler, K. S., Scheffer, M., & Borsboom, D. (2016). Major depression as a complex dynamic system. *PLOS ONE*, *11*(12), e0167490. https://doi.org/10.1371/journal.pone.0167490

Crossin, R., Cleland, L., Beautrais, A. L., Witt, K., & Boden, J. M. (2022). Acute alcohol use and suicide deaths: An analysis of New Zealand coronial data from 2007–2020. *New Zealand Medical Journal*, *135*(1558). https://journal.nzma.org.nz/journal-articles/acute-alcohol-use-and-suicide-deaths-an-analysis-of-new-zealand-coronial-data-from-2007-2020

Crowe, E., Daly, M., Delaney, L., Carroll, S., & Malone, K. M. (2019). The intra-day dynamics of affect, self-esteem, tiredness, and suicidality in Major Depression. *Psychiatry Research*, *279*, 98–108. https://doi.org/10.1016/j.psychres.2018.02.032

Czyz, E. K., King, C. A., & Nahum-Shani, I. (2018). Ecological assessment of daily suicidal thoughts and attempts among suicidal teens after psychiatric hospitalization: Lessons

about feasibility and acceptability. *Psychiatry Research*, *267*, 566–574. https://doi.org/10.1016/j.psychres.2018.06.031

Davidson, C. L., Anestis, M. D., & Gutierrez, P. M. (2016). Ecological momentary assessment is a neglected methodology in suicidology. *Archives of Suicide Research*, *21*(1), 1–11. https://doi.org/10.1080/13811118.2015.1004482

Dazzi, T., Gribble, R., Wessely, S., & Fear, N. T. (2014). Does asking about suicide and related behaviours induce suicidal ideation? What is the evidence? *Psychological Medicine*, *44*(16), 3361–3363. https://doi.org/10.1017/S0033291714001299

de Beer, W., de Witt, B., Schofield, J., Clark, H., & Gibbons, V. (2018). An audit of risk assessments for suicide and attempted suicide in ED: A retrospective review of quality. *New Zealand Medical Journal*, *131*(1470), 14–21.

de Beurs, D., Fried, E., Wetherall, K., Cleare, S., O'Connor, D., Ferguson, E., O'Carroll, R., & O'Connor, R. (2019). Exploring the psychology of suicidal ideation: A theory driven network analysis. *Behaviour Research and Therapy*, *120*. https://doi.org/10.1016/j.brat.2019.103419

de Beurs, Derek., van Borkulo, C. D., & O'Connor, R. C. (2017). Association between suicidal symptoms and repeat suicidal behaviour within a sample of hospital-treated suicide attempters. *BJPsych Open*, *3*(3), 120–126. https://doi.org/10.1192/bjpo.bp.116.004275

Delam, H., & Bazrafshan, M. R. (2019). Anxiety and self-esteem score in adults with a suicide attempt history. *Journal of Health Sciences & Surveillance System*, *7*(4), 5. https://doi.org/10.30476/JHSSS.2020.85615.1071

Dhingra, K., Klonsky, E. D., & Tapola, V. (2019). An empirical test of the Three-Step Theory of Suicide in U.K. university students. *Suicide and Life-Threatening Behavior*, *49*(2), 478–487. https://doi.org/10.1111/sltb.12437

Dobson, E. T., Croarkin, P. E., Schroeder, H. K., Varney, S. T., Mossman, S. A., Cecil, K., & Strawn, J. R. (2021). Bridging anxiety and depression: A network approach in anxious adolescents. *Journal of Affective Disorders*, *280*, 305–314. https://doi.org/10.1016/j.jad.2020.11.027

Dong, M., Zeng, L.-N., Lu, L., Li, X.-H., Ungvari, G. S., Ng, C. H., Chow, I. H. I., Zhang, L., Zhou, Y., & Xiang, Y.-T. (2019). Prevalence of suicide attempt in individuals with major depressive disorder: A meta-analysis of observational surveys. *Psychological Medicine*, *49*(10), 1691–1704. https://doi.org/10.1017/S0033291718002301

Ducasse, D., Loas, G., Dassa, D., Gramaglia, C., Zeppegno, P., Guillaume, S., Olié, E., & Courtet, P. (2018). Anhedonia is associated with suicidal ideation independently of depression: A meta-analysis. *Depression and Anxiety*, *35*(5), 382–392. https://doi.org/10.1002/da.22709

Duffy, M. E., Mueller, N. E., Cougle, J. R., & Joiner, T. E. (2020). Perceived burdensomeness uniquely accounts for suicidal ideation severity in social anxiety disorder. *Journal of Affective Disorders*, *266*, 43–48. https://doi.org/10.1016/j.jad.2020.01.116

Durkheim, E. (2006). *On suicide*. Penguin.

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). https://doi.org/10.1177/1073191120957102

Elliott, H., Jones, P. J., & Schmidt, U. (2020). Central symptoms predict posttreatment outcomes and clinical impairment in Anorexia Nervosa: A network analysis. *Clinical Psychological Science*, *8*(1), 139–154. https://doi.org/10.1177/2167702619865958

Epskamp, S. (2020). *graphicalVAR: Graphical VAR for Experience Sampling Data* (0.2.4) [R]. https://CRAN.R-project.org/package=graphicalVAR

Epskamp, S., Borsboom, D., & Fried, E. I. (2018). Estimating psychological networks and their accuracy: A tutorial paper. *Behavior Research Methods*, *50*(1), 195–212. https://doi.org/10.3758/s13428-017-0862-1

Epskamp, S., Cramer, A. O. J., Waldorp, L. J., Schmittmann, V. D., & Borsboom, D. (2012). qgraph: Network visualizations of relationships in psychometric data. *Journal of Statistical Software*, *48*(4), 1–18. https://doi.org/10.18637/jss.v048.i04

Epskamp, S., Deserno, M. K., & Bringmann, L. F. (2019). *mlVAR: Multi-level vector autoregression* (0.4.4) [R]. https://CRAN.R-project.org/package=mlVAR

Epskamp, S., & Fried, E. I. (2018). A tutorial on regularized partial correlation networks. *Psychological Methods*, *23*(4), 617–634. https://doi.org/10.1037/met0000167

Epskamp, S., Maris, G. K. J., Waldorp, L. J., & Borsboom, D. (2018). Network Psychometrics. In P. Irwing, T. Booth, & D. J. Hughes (Eds.), *The Wiley Handbook of Psychometric Testing: A Multidisciplinary Reference on Survey, Scale and Test Development*.

Epskamp, S., van Borkulo, C., van der Veen, D. C., Servaas, M. N., Isvoranu, A.-M., Riese, H., & Cramer, A. O. J. (2018). Personalized network modeling in psychopathology: The importance of contemporaneous and temporal connections. *Clinical Psychological Science*, *6*, 416–427. https://doi.org/10.1177/2167702617744325

Epskamp, S., Waldorp, L. J., Mõttus, R., & Borsboom, D. (2018). The Gaussian graphical model in cross-sectional and time-series data. *Multivariate Behavioral Research*, *53*(4), 453–480. https://doi.org/10.1080/00273171.2018.1454823

Feigelman, W., Cerel, J., McIntosh, J. L., Brent, D., & Gutin, N. (2018). Suicide exposures and bereavement among American adults: Evidence from the 2016 General Social Survey. *Journal of Affective Disorders*, *227*, 1–6. https://doi.org/10.1016/j.jad.2017.09.056

Ferguson, M., Rhodes, K., Loughhead, M., McIntyre, H., & Procter, N. (2022). The effectiveness of the safety planning intervention for adults experiencing suicide-related distress: A systematic review. *Archives of Suicide Research*, *26*(3), 1022–1045. https://doi.org/10.1080/13811118.2021.1915217

Fergusson, D. M., Beautrais, A. L., & Horwood, L. J. (2003). Vulnerability and resiliency to suicidal behaviours in young people. *Psychological Medicine*, *33*(1), 61–73. https://doi.org/10.1017/S0033291702006748

Fink, D. S., Santaella-Tenorio, J., & Keyes, K. M. (2018). Increase in suicides the months after the death of Robin Williams in the US. *PLOS ONE*, *13*(2), e0191405. https://doi.org/10.1371/journal.pone.0191405

Finlayson, M., & Simmonds, J. G. (2018). Impact of client suicide on psychologists in Australia. *Australian Psychologist*, *53*(1), 23–32. https://doi.org/10.1111/ap.12240

Fonseca-Pedrero, E. (2018). Network analysis in psychology. *Papeles Del Psicólogo - Psychologist Papers*, *39*(1), 1–12. https://doi.org/10.23923/pap.psicol2018.2852

Forkmann, T., Spangenberg, L., Rath, D., Hallensleben, N., Hegerl, U., Kersting, A., & Glaesmer, H. (2018). Assessing suicidality in real time: A psychometric evaluation of self-report items for the assessment of suicidal ideation and its proximal risk factors using

ecological momentary assessments. *Journal of Abnormal Psychology*, *127*(8), 758–769. https://doi.org/10.1037/abn0000381

Forrest, L. N., Jones, P. J., Ortiz, S. N., & Smith, A. R. (2018). Core psychopathology in anorexia nervosa and bulimia nervosa: A network analysis. *International Journal of Eating Disorders*, *51*(7), 668–679. https://doi.org/10.1002/eat.22871

Fortune, S., & Hetrick, S. (2022). Suicide risk assessments: Why are we still relying on these a decade after the evidence showed they perform poorly? *Australian & New Zealand Journal of Psychiatry*, *56*(12), 1529–1534. https://doi.org/10.1177/00048674221107316

Fox, K. R., Huang, X., Guzmán, E. M., Funsch, K. M., Cha, C. B., Ribeiro, J. D., & Franklin, J. C. (2020). Interventions for suicide and self-injury: A meta-analysis of randomized controlled trials across nearly 50 years of research. *Psychological Bulletin*, *146*(12), 1117–1145. https://doi.org/10.1037/bul0000305

Franklin, J. C., Ribeiro, J. D., Fox, K. R., Bentley, K. H., Kleiman, E. M., Huang, X., Musacchio, K. M., Jaroszewski, A. C., Chang, B. P., & Nock, M. K. (2017). Risk factors for suicidal thoughts and behaviors: A meta-analysis of 50 years of research. *Psychological Bulletin*, *143*(2), 187–232. https://doi.org/10.1037/bul0000084

Fried, E. I., Epskamp, S., Nesse, R. M., Tuerlinckx, F., & Borsboom, D. (2016). What are 'good' depression symptoms? Comparing the centrality of DSM and non-DSM symptoms of depression in a network analysis. *Journal of Affective Disorders*, *189*, 314–320. https://doi.org/10.1016/j.jad.2015.09.005

Ftanou, M., Cox, G., Nicholas, A., Spittal, M. J., Machlin, A., Robinson, J., & Pirkis, J. (2017). Suicide prevention public service announcements (PSAs): Examples from around the

world. *Health Communication*, *32*(4), 493–501. https://doi.org/10.1080/10410236.2016.1140269

Gibb, S. J., Beautrais, A. L., & Fergusson, D. M. (2005). Mortality and further suicidal behaviour after an index suicide attempt: A 10 year study. *Australian and New Zealand Journal of Psychiatry*, *39*(1), 95–100. https://doi.org/10.1080/j.1440-1614.2005.01514.x

Glenn, C. R., Kleiman, E. M., Kearns, J. C., Santee, A. C., Esposito, E. C., Conwell, Y., & Alpert-Gillis, L. J. (2022). Feasibility and acceptability of ecological momentary assessment with high-risk suicidal adolescents following acute psychiatric care. *Journal of Clinical Child & Adolescent Psychology*, *51*(1), 32–48. https://doi.org/10.1080/15374416.2020.1741377

Greene, T., Gelkopf, M., Fried, E. I., Robinaugh, D. J., & Pickman, L. L. (2020). Dynamic network analysis of negative emotions and DSM-5 posttraumatic stress disorder symptom clusters during conflict. *Journal of Traumatic Stress*, *33*(1), 72–83. https://doi.org/10.1002/jts.22433

Gunn, J. F., & Lester, D. (2015). *Theories of Suicide: Past, Present and Future*. Charles C Thomas Publisher.

Hains, A., Janackovski, A., Deane, F. P., & Rankin, K. (2019). Perceived burdensomeness predicts outcomes of short-term psychological treatment of young people at risk of suicide. *Suicide and Life-Threatening Behavior*, *49*(2), 586–597. https://doi.org/10.1111/sltb.12452

Hallensleben, N., Glaesmer, H., Forkmann, T., Rath, D., Strauss, M., Kersting, A., & Spangenberg, L. (2019). Predicting suicidal ideation by interpersonal variables, hopelessness and depression in real-time. An ecological momentary assessment study in

psychiatric inpatients with depression. *European Psychiatry*, *56*, 43–50. https://doi.org/10.1016/j.eurpsy.2018.11.003

Hallensleben, N., Spangenberg, L., Forkmann, T., Rath, D., Hegerl, U., Kersting, A., Kallert, T. W., & Glaesmer, H. (2017). Investigating the dynamics of suicidal ideation. *Crisis*, *39*(1), 65–69. https://doi.org/10.1027/0227-5910/a000464

Harter, S. (2012). *Self-perception profile for adolescents: Manual and questionnaires*. University of Denver, Department of Psychology.

Hawes, M., Galynker, I., Barzilay, S., & Yaseen, Z. S. (2018). Anhedonia and suicidal thoughts and behaviors in psychiatric outpatients: The role of acuity. *Depression and Anxiety*, *35*(12), 1218–1227. https://doi.org/10.1002/da.22814

Hawton, K., Casañas i Comabella, C., Haw, C., & Saunders, K. (2013). Risk factors for suicide in individuals with depression: A systematic review. *Journal of Affective Disorders*, *147*(1), 17–28. https://doi.org/10.1016/j.jad.2013.01.004

Head, M. L., Holman, L., Lanfear, R., Kahn, A. T., & Jennions, M. D. (2015). The extent and consequences of p-hacking in science. *PLoS Biology*, *13*(3), e1002106. https://doi.org/10.1371/journal.pbio.1002106

Heeren, A., Jones, P. J., & McNally, R. J. (2018). Mapping network connectivity among symptoms of social anxiety and comorbid depression in people with social anxiety disorder. *Journal of Affective Disorders*, *228*, 75–82. https://doi.org/10.1016/j.jad.2017.12.003

Hill, R. M., & Pettit, J. W. (2014). Perceived burdensomeness and suicide-related behaviors in clinical samples: Current evidence and future directions. *Journal of Clinical Psychology*, *70*(7), 631–643. https://doi.org/10.1002/jclp.22071

Hoffart, A., Johnson, S. U., & Ebrahimi, O. V. (2021). The network of stress-related states and depression and anxiety symptoms during the COVID-19 lockdown. *Journal of Affective Disorders*, *294*, 671–678. https://doi.org/10.1016/j.jad.2021.07.019

Holman, M. S., & Williams, M. N. (2019). *Young New Zealanders' Beliefs About Youth Suicide and How It Can Be Prevented* [Preprint]. PsyArXiv. https://psyarxiv.com/wgmp4/

Holman, M. S., & Williams, M. N. (2020). Young New Zealanders' beliefs about youth suicide and how it can be prevented. *New Zealand Journal of Psychology*, *49*(1). https://www.psychology.org.nz/application/files/7615/9538/4266/Holman_and_Williams_22-28.pdf

Holman, M. S., & Williams, M. N. (2022). Suicide risk and protective factors: A network approach. *Archives of Suicide Research*, *26*(1), 137–154. https://doi.org/10.1080/13811118.2020.1774454

Howson, M. A., Yates, K. M., & Hatcher, S. (2008). Re-presentation and suicide rates in emergency department patients who self-harm. *Emergency Medicine Australasia*, *20*(4), 322–327. https://doi.org/10.1111/j.1742-6723.2008.01104.x

Hufford, M. R. (2007). Special methodological challenges and opportunities in ecological momentary assessment. In A. Stone, S. Shiffman, A. Atienza, & L. Nebeling (Eds.), *The Science of Real-Time Data Capture: Self-Reports in Health Research*. Oxford University Press.

Humphry, S. M., & McGrane, J. A. (2010). Is there a contradiction between the network and latent variable perspectives? *Behavioral and Brain Sciences*, *33*(2–3), 160–161. https://doi.org/10.1017/S0140525X10000786

Husky, M., Olié, E., Guillaume, S., Genty, C., Swendsen, J., & Courtet, P. (2014). Feasibility and validity of ecological momentary assessment in the investigation of suicide risk. *Psychiatry Research, 220*(1), 564–570. https://doi.org/10.1016/j.psychres.2014.08.019

ilumivu. (n.d.). *mEMA App*. Ilumivu. Retrieved 30 July 2021, from https://ilumivu.com/solutions/ecological-momentary-assessment-app/

Jenkins, B. N., Hunter, J. F., Richardson, M. J., Conner, T. S., & Pressman, S. D. (2020). Affect variability and predictability: Using recurrence quantification analysis to better understand how the dynamics of affect relate to health. *Emotion, 20*(3), 391–402. https://doi.org/10.1037/emo0000556

Johnson, B. D. (1965). Durkheim's one cause of suicide. *American Sociological Review, 30*(6), 875–886. https://doi.org/10.2307/2090966

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

Jones, P. J., Ma, R., & McNally, R. J. (2021). Bridge centrality: A network approach to understanding comorbidity. *Multivariate Behavioral Research, 56*(2), 353–367. https://doi.org/10.1080/00273171.2019.1614898

Kerr, N. L. (1998). HARKing: Hypothesizing after the results are known. *Personality and Social Psychology Review, 2*(3), 196–217. https://doi.org/10.1207/s15327957pspr0203_4

Kim, K. M., Kim, H., Kim, D., & Kim, J.-W. (2021). The analysis of network structure among the depressive symptoms in a clinical sample of children and adolescents. *Asian Journal of Psychiatry, 62*, 102748. https://doi.org/10.1016/j.ajp.2021.102748

Kirtley, O. J., Lafit, G., Achterhof, R., Hiekkaranta, A. P., & Myin-Germeys, I. (2020). *A template and tutorial for (pre-)registration of studies using experience sampling methods (ESM)*. https://doi.org/10.17605/OSF.IO/2CHMU

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. https://doi.org/10.1177/2515245920924686

Kleiman, E. (2017). *Package 'EMAtools'*. https://cran.r-project.org/web/packages/EMAtools/EMAtools.pdf

Kleiman, E. M., & Liu, R. T. (2013). Social support as a protective factor in suicide: Findings from two nationally representative samples. *Journal of Affective Disorders*, *150*(2), 540–545. https://doi.org/10.1016/j.jad.2013.01.033

Kleiman, E. M., Turner, B. J., Chapman, A. L., & Nock, M. K. (2018). Fatigue moderates the relationship between perceived stress and suicidal ideation: Evidence from two high-resolution studies. *Journal of Clinical Child & Adolescent Psychology*, *47*(1), 116–130. https://doi.org/10.1080/15374416.2017.1342543

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), 726–738. https://doi.org/10.1037/abn0000273

Klonsky, E. D., & May, A. M. (2014). Differentiating suicide attempters from suicide ideators: A critical frontier for suicidology research. *Suicide and Life-Threatening Behavior*, *44*(1), 1–5. https://doi.org/10.1111/sltb.12068

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. https://doi.org/10.1521/ijct.2015.8.2.114

Knowles, R., Tai, S., Jones, S. H., Highfield, J., Morriss, R., & Bentall, R. P. (2007). Stability of self-esteem in bipolar disorder: Comparisons among remitted bipolar patients, remitted unipolar patients and healthy controls. *Bipolar Disorders*, *9*(5), 490–495. https://doi.org/10.1111/j.1399-5618.2007.00457.x

Kuo, W. H., Gallo, J. J., & Eaton, W. W. (2004). Hopelessness, depression, substance disorder, and suicidality—A 13-year community-based study. *Social Psychiatry and Psychiatric Epidemiology*, *39*(6), 497–501. https://doi.org/10.1007/s00127-004-0775-z

Kyron, M. J., Hooke, G. R., & Page, A. C. (2019). Assessing interpersonal and mood factors to predict trajectories of suicidal ideation within an inpatient setting. *Journal of Affective Disorders*, *252*, 315–324. https://doi.org/10.1016/j.jad.2019.04.029

Lakens, D. (2019). *The Value of Preregistration for Psychological Science: A Conceptual Analysis*. https://doi.org/10.31234/osf.io/jbh4w

Large, M., Sharma, S., Cannon, E., Ryan, C., & Nielssen, O. (2011). Risk factors for suicide within a year of discharge from psychiatric hospital: A systematic meta-analysis. *Australian & New Zealand Journal of Psychiatry*, *45*(8), 619–628. https://doi.org/10.3109/00048674.2011.590465

Law, M. K., Furr, R. M., Arnold, E. M., Mneimne, M., Jaquett, C., & Fleeson, W. (2015). Does assessing suicidality frequently and repeatedly cause harm? A randomized control study. *Psychological Assessment*, *27*(4), 1171–1181. https://doi.org/10.1037/pas0000118

Levinson, C. A., Vanzhula, I., & Brosof, L. C. (2018). Longitudinal and personalized networks of eating disorder cognitions and behaviors: Targets for precision intervention a proof of concept study. *International Journal of Eating Disorders*, *51*(11), 1233–1243. https://doi.org/10.1002/eat.22952

Liu, Y., Zhang, J., & Sun, L. (2017). Who are likely to attempt suicide again? A comparative study between the first and multiple timers. *Comprehensive Psychiatry, 78*, 54–60. https://doi.org/10.1016/j.comppsych.2017.07.007

Luoma, J. B., Martin, C. E., & Pearson, J. L. (2002). Contact with mental health and primary care providers before suicide: A review of the evidence. *The American Journal of Psychiatry, 159*(6), 909–916. https://doi.org/10.1176/appi.ajp.159.6.909

Lynch, T. R., Johnson, C. S., Mendelson, T., Robins, C. J., Krishnan, K. R. R., & Blazer, D. G. (1999). Correlates of suicidal ideation among an elderly depressed sample. *Journal of Affective Disorders*, *56*(1), 9–15. https://doi.org/10.1016/S0165-0327(99)00022-1

Ma, J., Batterham, P. J., Calear, A. L., & Han, J. (2016). A systematic review of the predictions of the Interpersonal–Psychological Theory of Suicidal Behavior. *Clinical Psychology Review*, *46*, 34–45. https://doi.org/10.1016/j.cpr.2016.04.008

Machado, C. dos S., Ballester, P. L., Cao, B., Mwangi, B., Caldieraro, M. A., Kapczinski, F., & Passos, I. C. (2022). Prediction of suicide attempts in a prospective cohort study with a nationally representative sample of the US population. *Psychological Medicine*, *52*(14), 2985–2996. https://doi.org/10.1017/S0033291720004997

Madsen, T., Erlangsen, A., Hjorthøj, C., & Nordentoft, M. (2020). High suicide rates during psychiatric inpatient stay and shortly after discharge. *Acta Psychiatrica Scandinavica*, *142*(5), 355–365. https://doi.org/10.1111/acps.13221

Mates in Construction New Zealand. (n.d.). *MATES*. https://mates.net.nz/

McNally, R. J. (2016). Can network analysis transform psychopathology? *Behaviour Research and Therapy*, *86*, 95–104. https://doi.org/10.1016/j.brat.2016.06.006

Melbourne eResearch Group. (n.d.). *SEMA3*. Retrieved 30 July 2021, from https://sema3.com/

Mental Health Foundation. (2014). *Mental Health Foundation: Quick facts and stats 2014*. Mental Health Foundation. https://www.mentalhealth.org.nz/assets/Uploads/MHF-Quick-facts-and-stats-FINAL-2016.pdf

Mental Health Foundation. (n.d.). *Suicide statistics*. https://mentalhealth.org.nz/suicide-prevention/suicide-statistics

Ministry of Health. (1998). *Guidelines for clinical risk assessment and management in mental health services*. Ministry of Health. https://www.moh.govt.nz/notebook/nbbooks.nsf/0/2fe380c25ed2f1b34c25668600741eba/$FILE/mentalra.pdf

Ministry of Health. (2003). *The assessment and management of people at risk of suicide: For emergency departments and mental health service acute assessment settings.* New Zealand Guidelines Group : Ministry of Health. https://www.health.govt.nz/publication/assessment-and-management-people-risk-suicide

Ministry of Health. (2011). *Reporting suicide: A resource for the media*. https://www.health.govt.nz/system/files/documents/publications/reporting-suicide-a-resource-for-media-dec2011.pdf

Ministry of Health. (2019). *Every Life Matters – He Tapu te Oranga o ia tangata: Suicide Prevention Strategy 2019–2029 and Suicide Prevention Action Plan 2019–2024 for Aotearoa New Zealand.* Ministry of Health. https://www.health.govt.nz/system/files/documents/publications/suicide-prevention-strategy-2019-2029-and-plan-2019-2024-v2.pdf

Ministry of Health. (2022). *Self-harm hospitalisations and short stay ED presentations—September 2022*. https://nsfl.health.govt.nz/dhb-planning-package/system-level-measures-framework/data-support-system-level-measures/youth-slm--2

Ministry of Justice. (2021). *Request for Statistics Regarding Alcohol and Suicides*.

Nadorff, M. R., Ellis, T. E., Allen, J. G., Winer, E. S., & Herrera, S. (2014). Presence and persistence of sleep-related symptoms and suicidal ideation in psychiatric inpatients. *Crisis*, *35*(6). https://doi.org/10.1027/0227-5910/a000279

National Institute for Health and Care Excellence. (2022). *Self-harm: Assessment, management and preventing recurrence*. NICE. https://www.nice.org.uk/guidance/ng225

Nock, M. K., Prinstein, M. J., & Sterba, S. K. (2010). Revealing the form and function of self-injurious thoughts and behaviors: A real-time ecological assessment study among adolescents and young adults. *Journal of Abnormal Psychology*, *118*(4), 816–827. https://doi.org/10.1037/a0016948

Nosek, B. A., Ebersole, C. R., DeHaven, A. C., & Mellor, D. T. (2018). The preregistration revolution. *Proceedings of the National Academy of Sciences*, *115*(11), 2600. https://doi.org/10.1073/pnas.1708274114

O'Connor, R. C. (2011). Towards an integrated motivational–volitional model of suicidal behaviour. In *International Handbook of Suicide Prevention* (pp. 181–198). John Wiley & Sons, Ltd. https://doi.org/10.1002/9781119998556.ch11

O'Connor, R. C., & Portzky, G. (2018). Looking to the future: A synthesis of new developments and challenges in suicide research and prevention. *Frontiers in Psychology, 9*. https://doi.org/10.3389/fpsyg.2018.02139

O'Dea, D., & Tucker, S. (2005). *The cost of suicide to society*. https://www.health.govt.nz/system/files/documents/publications/thecostofsuicidetosociety.pdf

Papini, S., Rubin, M., Telch, M. J., Smits, J. A. J., & Hien, D. A. (2019). Pre-treatment post-traumatic stress disorder symptom network metrics predict the strength of the association between node change and network change during treatment. *Journal of Traumatic Stress*, *0*(0). https://doi.org/10.1002/jts.22379

Park, S.-C., & Kim, D. (2020). The centrality of depression and anxiety symptoms in Major Depressive Disorder determined using a network analysis. *Journal of Affective Disorders*, *271*, 19–26. https://doi.org/10.1016/j.jad.2020.03.078

Pearl, J. (2000). *Causality: Models, reasoning and inference* (Vol. 29). Cambridge University Press.

Pereira-Morales, A. J., Adan, A., & Forero, D. A. (2019). Network analysis of multiple risk factors for mental health in young Colombian adults. *Journal of Mental Health*, *28*(2), 153–160. https://doi.org/10.1080/09638237.2017.1417568

Pirkis, J., & Blood, W. (2010). *Suicide and the news and information media*. http://www.mindframe-media.info/__data/assets/pdf_file/0016/5164/Pirkis-and-Blood-2010,-Suicide-and-the-news-and-information-media.pdf

Pirkis, J., Currier, D., Too, L. S., Bryant, M., Bartlett, S., Sinyor, M., & Spittal, M. J. (2020). Suicides in Australia following media reports of the death of Robin Williams. *Australian & New Zealand Journal of Psychiatry*, *54*(1), 99–104. https://doi.org/10.1177/0004867419888297

Pisani, A. R., Murrie, D. C., & Silverman, M. M. (2016). Reformulating suicide risk formulation: From prediction to prevention. *Academic Psychiatry*, *40*, 623–629. https://doi.org/10.1007/s40596-015-0434-6

Pitman, A., Khrisna Putri, A., De Souza, T., Stevenson, F., King, M., Osborn, D., & Morant, N. (2018). The impact of suicide bereavement on educational and occupational functioning: A qualitative study of 460 bereaved adults. *International Journal of Environmental Research and Public Health*, *15*(4), 643. https://doi.org/10.3390/ijerph15040643

Pitman, A., Osborn, D., Rantell, K., & King, M. (2016). Bereavement by suicide as a risk factor for suicide attempt: A cross-sectional national UK-wide study of 3432 young bereaved adults. *BMJ Open*, *6*(1), e009948. https://doi.org/10.1136/bmjopen-2015-009948

Pokorny, A. D. (1983). Prediction of suicide in psychiatric patients: Report of a prospective study. *Archives of General Psychiatry*, *40*(3), 249. https://doi.org/10.1001/archpsyc.1983.01790030019002

Pompili, M., Innamorati, M., Di Vittorio, C., Sher, L., Girardi, P., & Amore, M. (2014). Sociodemographic and clinical differences between suicide ideators and attempters: A study of mood disordered patients 50 years and older. *Suicide and Life-Threatening Behavior*, *44*(1), 34–45. https://doi.org/10.1111/sltb.12051

Pūtaiora Writing Group. (2010). *Te ara tika guidelines for Māori research ethics: A framework for researchers and ethics committee members*. Health Research Council of New Zealand on behalf of the Pūtaiora Writing Group. http://www.hrc.govt.nz/assets/pdfs/publications/Te%20Ara%20Tika%20R21Jul10.pdf

R Core Team. (2021). *R: A language and environment for statistical computing* [Computer software]. R Foundation for Statistical Computing. https://www.R-project.org/

Rath, D., de Beurs, D., Hallensleben, N., Spangenberg, L., Glaesmer, H., & Forkmann, T. (2019). Modelling suicide ideation from beep to beep: Application of network analysis to ecological momentary assessment data. *Internet Interventions*, *18*. https://doi.org/10.1016/j.invent.2019.100292

Ren, L., Wang, Y., Wu, L., Wei, Z., Cui, L.-B., Wei, X., Hu, X., Peng, J., Jin, Y., Li, F., Yang, Q., & Liu, X. (2021). Network structure of depression and anxiety symptoms in Chinese female nursing students. *BMC Psychiatry*, *21*(1), 279. https://doi.org/10.1186/s12888-021-03276-1

Revelle, W. (2019). *psych: Procedures for Personality and Psychological Research* (2.0.12) [R]. https://cran.r-project.org/web/packages/psych/index.html

Ribeiro, J. D., Pease, J. L., Gutierrez, P. M., Silva, C., Bernert, R. A., Rudd, M. D., & Joiner, T. E. (2012). Sleep problems outperform depression and hopelessness as cross-sectional and longitudinal predictors of suicidal ideation and behavior in young adults in the military. *Journal of Affective Disorders*, *136*(3), 743–750. https://doi.org/10.1016/j.jad.2011.09.049

Richie, F. J., Bonner, J., Wittenborn, A., Weinstock, L. M., Zlotnick, C., & Johnson, J. E. (2019). Social support and suicidal ideation among prisoners with major depressive disorder. *Archives of Suicide Research*, 1–8. https://doi.org/10.1080/13811118.2019.1649773

Robins, J. E., Kalk, N. J., Ross, K. R., Pritchard, M., Curtis, V., & Morley, K. I. (2021). The association of acute alcohol use and dynamic suicide risk with variation in onward care after psychiatric crisis. *Drug and Alcohol Review*, *40*(3), 499–508. https://doi.org/10.1111/dar.13231

Rodebaugh, T. L., Tonge, N. A., Piccirillo, M. L., Fried, E., Horenstein, A., Morrison, A. S., Goldin, P., Gross, J. J., Lim, M. H., Fernandez, K. C., Blanco, C., Schneier, F. R., Bogdan, R., Thompson, R. J., & Heimberg, R. G. (2018). Does centrality in a cross-sectional network suggest intervention targets for social anxiety disorder? *Journal of Consulting and Clinical Psychology*, *86*(10), 831–844. https://doi.org/10.1037/ccp0000336

Roeder, K. M., & Cole, D. A. (2019). Simultaneous longitudinal examination of hopelessness, thwarted belongingness, and perceived burdensomeness as predictors of suicide ideation. *Suicide and Life-Threatening Behavior*, *49*(4), 1058–1071. https://doi.org/10.1111/sltb.12508

Rogers, M. L., & Joiner, T. E. (2019). Exploring the temporal dynamics of the interpersonal theory of suicide constructs: A dynamic systems modeling approach. *Journal of Consulting and Clinical Psychology*, *87*(1), 56–66. https://doi.org/10.1037/ccp0000373

Schiepek, G., Fartacek, C., Sturm, J., Kralovec, K., Fartacek, R., & Plöderl, M. (2011). Nonlinear Dynamics: Theoretical Perspectives and Application to Suicidology. *Suicide and Life-Threatening Behavior*, *41*(6), 661–675. https://doi.org/10.1111/j.1943-278X.2011.00062.x

Schönfelder, A., Rath, D., Forkmann, T., Paashaus, L., Lucht, L., Teismann, T., Stengler, K., Juckel, G., & Glaesmer, H. (2021). Child abuse and suicidality in the context of the Interpersonal Psychological Theory of Suicide: A network analysis. *British Journal of Clinical Psychology*, *60*(4), 425–442. https://doi.org/10.1111/bjc.12293

Shepherd, D., Taylor, S., Csako, R., Liao, A.-T., & Duncan, R. (2022). Predictors of suicide ideation and attempt planning in a large sample of New Zealand help-seekers. *Frontiers in Psychiatry*, *13*, 794775. https://doi.org/10.3389/fpsyt.2022.794775

Sher, L. (2020). Suicide in men: An underappreciated public health challenge. *European Archives of Psychiatry and Clinical Neuroscience*, *270*(2), 277–278. https://doi.org/10.1007/s00406-019-01041-w

Shiffman, S., Stone, A. A., & Hufford, M. R. (2008). Ecological momentary assessment. *Annual Review of Clinical Psychology*, *4*(1), 1–32. https://doi.org/10.1146/annurev.clinpsy.3.022806.091415

Shiratori, Y., Tachikawa, H., Nemoto, K., Endo, G., Aiba, M., Matsui, Y., & Asada, T. (2014). Network analysis for motives in suicide cases: A cross-sectional study. *Psychiatry and Clinical Neurosciences*, *68*(4), 299–307. https://doi.org/10.1111/pcn.12132

Shneidman, E. (1972). Foreword. In A. Cain (Ed.), *Survivors of Suicide* (pp. ix–xi). Charles C. Thomas.

Shneidman, E. S. (1993). *Suicide as psychache: A clinical approach to self-destructive behavior*. Jason Aronson.

Short, N. A., Stentz, L., Raines, A. M., Boffa, J. W., & Schmidt, N. B. (2019). Intervening on thwarted belongingness and perceived burdensomeness to reduce suicidality among veterans: Subanalyses from a randomized controlled trial. *Behavior Therapy*, *50*(5), 886–897. https://doi.org/10.1016/j.beth.2019.01.004

Simmons, J. P., Nelson, L. D., & Simonsohn, U. (2011). False-positive psychology: Undisclosed flexibility in data collection and analysis allows presenting anything as significant. *Psychological Science*, *22*(11), 1359–1366. https://doi.org/10.1177/0956797611417632

Simons, J. S., Simons, R. M., Walters, K. J., Keith, J. A., O'Brien, C., Andal, K., & Stoltenberg, S. F. (2019). Nexus of despair: A network analysis of suicidal ideation among veterans. *Archives of Suicide Research*, 1–23. https://doi.org/10.1080/13811118.2019.1574689

Soto-Sanz, V., Piqueras, J. A., Rodríguez-Marín, J., Pérez-Vázquez, M. T., Rodríguez-Jiménez, T., Castellvi, P., Miranda-Mendizábal, A., Parés-Badell, O., Almenara, J., Blasco, M. J., Cebrià, A., Gabilondo, A., Gili, M., Roca, M., Lagares, C., & Alonso, J. (2019). Self-esteem and suicidal behaviour in youth: A meta-analysis of longitudinal studies. *Psicothema*, *31.3*, 246–254. https://doi.org/10.7334/psicothema2018.339

Spangenberg, L., Glaesmer, H., Hallensleben, N., Rath, D., & Forkmann, T. (2019). (In)stability of capability for suicide in psychiatric inpatients: Longitudinal assessment using ecological momentary assessments. *Suicide and Life-Threatening Behavior*, *49*(6), 1560–1572. https://doi.org/10.1111/sltb.12547

Stack, S. (2005). Suicide in the media: A quantitative review of studies based on nonfictional stories. *Suicide and Life-Threatening Behavior*, *35*(2), 121–133. https://doi.org/10.1521/suli.35.2.121.62877

Statistics New Zealand. (2020). *Ethnic group summaries reveal New Zealand's multicultural make-up*. https://www.stats.govt.nz/news/ethnic-group-summaries-reveal-new-zealands-multicultural-make-up

Sueki, H. (2020). Relationship between Beck Hopelessness Scale and suicidal ideation: A short-term longitudinal study. *Death Studies*, 1–6. https://doi.org/10.1080/07481187.2020.1740833

Summers, B. J., Aalbers, G., Jones, P. J., McNally, R. J., Phillips, K. A., & Wilhelm, S. (2020). A network perspective on body dysmorphic disorder and major depressive disorder. *Journal of Affective Disorders, 262*, 165–173. https://doi.org/10.1016/j.jad.2019.11.011

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*(1), 579–604. https://doi.org/10.1146/annurev-clinpsy-050718-095710

Te Whatu Ora. (2022). *Suicide Web Tool*. https://minhealthnz.shinyapps.io/suicide-web-tool/

Teismann, T., Forkmann, T., Glaesmer, H., Egeri, L., & Margraf, J. (2016). Remission of suicidal thoughts: Findings from a longitudinal epidemiological study. *Journal of Affective Disorders, 190*, 723–725. https://doi.org/10.1016/j.jad.2015.09.066

Thom, K., McKenna, B., Edwards, G., O'Brien, A., & Nakarada-Kordic, I. (2012). Reporting of suicide by the New Zealand media. *Crisis*. https://econtent.hogrefe.com/doi/abs/10.1027/0227-5910/a000133

Torous, J., Staples, P., Shanahan, M., Lin, C., Peck, P., Keshavan, M., & Onnela, J.-P. (2015). Utilizing a personal smartphone custom app to assess the Patient Health Questionnaire-9 (PHQ-9) depressive symptoms in patients with Major Depressive Disorder. *JMIR Mental Health*, *2*(1), e8. https://doi.org/10.2196/mental.3889

Trimble, L., Jackson, K., & Harvey, D. (2000). Client suicidal behaviour: Impact, interventions, and implications for psychologists. *Australian Psychologist*, *35*(3), 227–232. https://doi.org/10.1080/00050060008257483

Tsai, M., Lari, H., Saffy, S., & Klonsky, E. D. (2020). Examining the Three-Step Theory (3ST) of suicide in a prospective study of adult psychiatric inpatients. *Behavior Therapy*. https://doi.org/10.1016/j.beth.2020.08.007

UNICEF. (2020). *New Report Card shows that New Zealand is failing its children*. https://www.unicef.org.nz/stories/new-report-card-shows-that-new-zealand-is-failing-its-children

Vaccarino, A. L., Sills, T. L., Evans, K. R., & Kalali, A. H. (2008). Prevalence and association of somatic symptoms in patients with Major Depressive Disorder. *Journal of Affective Disorders*, *110*(3), 270–276. https://doi.org/10.1016/j.jad.2008.01.009

Van Orden, K. A., Witte, T. K., Cukrowicz, K. C., Braithwaite, S. R., Selby, E. A., & Joiner, T. E. (2010). The interpersonal theory of suicide. *Psychological Review*, *117*(2), 575–600. https://doi.org/10.1037/a0018697

Veale, J., Byrne, J., Tan, K., Guy, S., Yee, A., Nopera, T., & Bentham, R. (2019). *Counting Ourselves: The Health and Wellbeing of Trans and Non-Binary People in Aotearoa New Zealand*. Transgender Health Research Lab, University of Waikato.

Wakefield, J. C., & Schmitz, M. F. (2016). Feelings of worthlessness during a single complicated major depressive episode predict postremission suicide attempt. *Acta Psychiatrica Scandinavica*, *133*(4), 257–265. https://doi.org/10.1111/acps.12521

Wei, Z., Ren, L., Wang, X., Liu, C., Cao, M., Hu, M., Jiang, Z., Hui, B., Xia, F., Yang, Q., Liu, Y., & Deng, Y. (2021). Network of depression and anxiety symptoms in patients with epilepsy. *Epilepsy Research*, *175*, 106696. https://doi.org/10.1016/j.eplepsyres.2021.106696

Wetherall, K., Cleare, S., Eschle, S., Ferguson, E., O'Connor, D. B., O'Carroll, R. E., & O'Connor, R. C. (2018). From ideation to action: Differentiating between those who think about suicide and those who attempt suicide in a national study of young adults. *Journal of Affective Disorders*, *241*, 475–483. https://doi.org/10.1016/j.jad.2018.07.074

Wickham, H. (2011). The split-apply-combine strategy for data analysis. *Journal of Statistical Software, 40*(1), 1–29. https://doi.org/10.18637/jss.v040.i01

Wickham, H., & Bryan, J. (2019). *readxl: Read Excel Files* (1.3.1) [R]. https://CRAN.R-project.org/package=readxl

Wild, L. G., Flisher, A. J., & Lombard, C. (2004). Suicidal ideation and attempts in adolescents: Associations with depression and six domains of self-esteem. *Journal of Adolescence, 27*(6), 611–624. https://doi.org/10.1016/j.adolescence.2004.03.001

Wolfe, K. L., Nakonezny, P. A., Owen, V. J., Rial, K. V., Moorehead, A. P., Kennard, B. D., & Emslie, G. J. (2019). Hopelessness as a predictor of suicide ideation in depressed male and female adolescent youth. *Suicide and Life-Threatening Behavior, 49*(1), 253–263. https://doi.org/10.1111/sltb.12428

Wolford-Clevenger, C., Stuart, G. L., Elledge, L. C., McNulty, J. K., & Spirito, A. (2020). Proximal correlates of suicidal ideation and behaviors: A test of the Interpersonal-Psychological Theory of Suicide. *Suicide and Life-Threatening Behavior, 50*(1), 249–262. https://doi.org/10.1111/sltb.12585

World Health Organisation. (2018). *Depression*. https://www.who.int/news-room/fact-sheets/detail/depression

World Health Organisation. (2021). *Suicide*. https://www.who.int/news-room/fact-sheets/detail/suicide

World Health Organization. (2008). *Preventing suicide: A resource for media professionals.* World Health Organization. https://www.who.int/mental_health/prevention/suicide/resource_media.pdf

World Health Organization. (2019). *Suicide in the world. Global health estimates.* https://apps.who.int/iris/bitstream/handle/10665/326948/WHO-MSD-MER-19.3-eng.pdf

Yang, X., Yuan, X., Liu, G., & Harrision, P. (2020). The specific roles of loss of interest and loss of pleasure in recent suicidal ideation. *Archives of Suicide Research: Official Journal of the International Academy for Suicide Research*, 1–10. https://doi.org/10.1080/13811118.2020.1838981