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Ecological momentary assessment of mental health in adults at suicide risk: An observational study protocol

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Abstract

Aims: To describe the research protocol for an ecological momentary assessment (EMA) designed to examine patterns of suicidal ideation and relevant psychosocial stress indicators in adults at risk for suicide.

Design: This observational and longitudinal study will collect data for 28 consecutive days.

Methods: A total of 150 adults at risk for suicide will be recruited from a single suicide prevention centre and an outpatient clinic in Korea. Self-report questionnaires will be administrated during weeks 0, 1, 3 and 5. Participants will receive text messages three times a day for 4 weeks prompting them to access an online survey link for daily mood survey including depression, anxiety, stress and suicidal ideation. In addition, for the first 2 weeks, they will wear an actigraphy device designed to collect actigraphic data in terms of sleep patterns and physical activity. Data analyses such as descriptive statistics, independent *t*-tests, one-way ANOVA, chi-squared statistics and time-series and correlation analyses will be performed using IBM SPSS 26.0 and SAS version 9.3. The study received funding from National Research Foundation of Korea in February 2020. Institutional Review Board approval for our study was obtained in April 2021.

Discussions: This study will yield fundamental information about daily patterns of suicide ideation and psychosocial stress indicators to develop preventive interventions for adults at risk for suicide.

Impact: Our study will contribute to the development of EMAs and interventions for adults at risk for suicide aimed at providing timely and individualized mental health services in a community setting.

Trial Registration: The trial is registered with the Clinical Research Information Service (CRIS). CRIS Registration Number: KCT0006165.

KEYWORDS
anxiety, depression, ecological momentary assessment, longitudinal observation, mental health, protocol, psychiatric nursing, suicidal ideation

1 | INTRODUCTION

Suicide is a significant public health problem in Korea. In 2011, South Korea demonstrated the highest suicide rate of 31.7 per 100,000 persons among the member countries of the Organisation for Economic Co-operation and Development (OECD). Since then, Korea's suicide rates have been reported to range between 24 and 28 per 100,000 until 2019, which still remains in the top tier among OECD countries (K-indicator, 2021). According to the Ministry of Health and Welfare in Korea, the lifetime prevalence rate of suicide-related behaviour in the general population is 15.4% for suicidal ideation, 3.0% for suicide plans and 2.4% for suicide attempts (MoHW, 2017). Thus, the Korean government has expended extensive efforts to decrease the suicide rate. It established the 5-year policy road map with 100 strategies in 2017 to prevent suicide at the individual, local and national levels (Korea Suicide Prevention Center, 2020). In 2018, Korea's Ministry of Health and Welfare presented the 'National Action Plans for Preventing Suicide' to lower the suicide rate from 25.6 per 100,000 persons in 2016 to 17.0 by 2022 (Ministry of Health & Welfare [MoHW], 2018). Extensive efforts have been made to formulate research evidence required for preventive policies and programs. Thus, it is vital to track the trends of suicidal behaviours to develop effective suicide prevention strategies (World Health Organization [WHO], 2012).

Recently, ecological momentary assessment (EMA) has been used in suicide research. EMA involves real-time assessment, which is similar to the experience sampling method (Shiffman et al., 2008). The EMA technique is applied via mobile devices, which prompt individuals to complete brief assessments (Shiffman et al., 2008). EMA asks individuals to record real-time data such as specific thoughts, behaviours or cravings, which are recorded on pen–paper diary, electronic record or smartphone application (hereafter, app) instantly (Morgiève et al., 2020; Shiffman et al., 2008). This method allows continuous data recording in seconds or minutes compared with the self-reported questionnaire method, which is inevitably brought recall bias for several days, weeks or months. Suicidal thoughts and behaviours are occasionally impulsive, with a rapid onset and short duration and real-time monitoring enables researchers to capture the data variabilities during specific time (Kleiman & Nock, 2018). Several studies have been conducted using smartphones recently to monitor mental health characteristics and prevent suicidal behaviours (Morgiève et al., 2020; Porras-Segovia et al., 2020). Morgiève et al. (2020) investigated individuals' suicidal ideations or behaviours to provide ecological momentary intervention with EMA app in real-time. Porras-Segovia et al. (2020) used smartphone apps asking about the quality of sleep, negative feelings and appetite to monitor real-time suicide risk. Torous et al. (2015) found that assessing depressive symptoms about suicidality using electronic devices may enhance the chances to capture the construct more accurately compared with the traditional questionnaire self-report method. Thus, the methodological strength of EMA enables researchers and clinicians to understand the real-time changes of suicidal behaviour (Kleiman et al., 2017).

Summary

- This study investigates mental health characteristics among adults in a community setting using an innovatively multidimensional methodology that includes a self-report questionnaire, actigraphy and an ecological momentary assessment.
- This study introduces a new theoretically and empirically derived framework that describes suicidal ideation associated with depression, anxiety and stress levels in daily life among adults living in the community.
- This study will provide fundamental information when developing ecological momentary intervention strategy for clinical mental health professionals or community mental health nurses who care for adults at suicide risk.

However, it is challenging to apply EMA in suicide research for several reasons. First, those exhibiting suicidal behaviours are usually excluded from study participation due to subject protection (Sisti & Joffe, 2018). Second, EMA requires extensive effort on the part of the individuals who have to follow and comply with the protocol direction; however, individuals with mental health problems tend to show low adherence and have high dropout rates when participating in a complicatedly designed project (Landes et al., 2016; Richards & Borglin, 2011). Third, it is necessary to understand the relationships among diverse constructs that interact dynamically and closely with a strong theoretical and conceptual framework. Because only a few studies (Adams et al., 2021; Parrish et al., 2021) employed theoretical frameworks, there is limited comprehensive interpretation of multiple human behaviours despite the complexity of EMA data. Thus, it is necessary to carefully design an EMA research protocol to enhance subject participation and theoretical understanding by emphasising the advantages and features of EMA methodology based on a theoretical framework.

1.1 | Background

1.1.1 | Theoretical framework

The stress-vulnerability model is the theoretical framework for this study. This model explains how relapses of mental illness occur when the personal aspects of vulnerability combined with psychosocial stressors from the environment (Zubin & Spring, 1977). Our study includes intrinsic vulnerability factors related to sociodemographics, general characteristics and mental health characteristics (see Figure 1). These are considered innate, invariant and trait-like factors that individuals possess, and they are essential to understanding the baseline status of those with suicidal ideation. We hypothesise that psychological stressors in daily life including depression, anxiety and stress levels can play various roles to evoke

FIGURE 1 Conceptual framework based on stress-vulnerability model
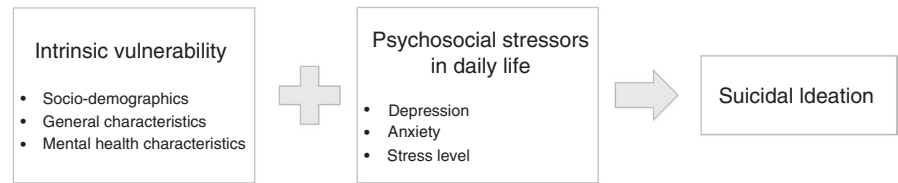
suicidal ideation. These factors are considered to be time-varying, which helps in understanding their correlation with suicidal ideation in a timely manner.

1.1.2 | Mental health characteristics related to suicidal ideation

More studies should investigate suicide-related risk factors over the time in terms of minutes, hours or days, repeatedly or continuously (Franklin et al., 2017). Moreover, Franklin et al. (2017) suggested that time-varying risk factors are stronger predictors of suicidal thoughts and behaviours than are trait-like risk factors. According to the stress-vulnerability framework of this study, psychosocial stressors include depression, anxiety and stress levels in daily life, all of which are regarded to contribute to suicidal ideation. A meta-analysis study focused on suicide attempts and ideation showed that depression is one of the strongest indicators for suicidal ideation and a risk factor for suicide attempts (Ribeiro et al., 2018). Anxiety and its related disorders are weak but still significant predictors for suicidal thoughts and behaviours (Bentley et al., 2016). Additionally, perceived stress is closely associated with suicidal behaviours (Hirsch et al., 2019). Increased vulnerability for suicidal ideation and behaviours is associated with sleep problems (Malik et al., 2014). For example, Littlewood et al. (2018) revealed that short sleep duration and poor sleep quality are predictors for next-day suicidal ideation.

Although there is considerable information about the relationships among depression, anxiety, stress levels and suicidal ideation, there is limited information on whether specific factors predispose an individual to, simultaneously change with or result in suicidal ideation. This highlights the importance of accurate real-time evaluation in a natural setting to address these gaps in the literature. Moreover, a previous study has evaluated sleep parameters using self-reported questionnaires to understand the characteristics of sleep, which are usually inaccurately reported in samples comprising individuals with mental health problems (Biddle et al., 2015). Thus, it is necessary to use an actigraphy device to obtain objective sleep information.

1.1.3 | EMA in suicide research

EMA is a useful strategy to examine the predictors of suicidal behaviours due to its methodological advantages, as it frequently monitors the psychological and behavioural aspects of people in real-life settings (Franklin et al., 2017; Kleiman et al., 2017). Several studies have used the EMA method to examine fluctuations in emotions to predict suicidal ideation and behaviours among psychiatric patients (Ben-Zeev et al., 2017; Porras-Segovia et al., 2020), adolescents (Czyz et al., 2018; Glenn et al., 2020) and adults (Littlewood et al., 2018). In addition, real-time assessment of adolescents using daily electronic surveys over a period of 28 days after hospital discharge is feasible (Czyz et al., 2018). A recent, fully online-based EMA study conducted on community-based adults (Rogers, 2021) revealed that such a methodology is feasible in this new normal, non-face-to-face era in suicide research. Comorbidities with suicidality could be also examined. For example, Littlewood et al. (2018) revealed that suicidal ideation is associated with subjective and objective sleep disturbances using EMA.

Among the several limitations of EMA methodology, the burden on the subject is most obvious because the participants have to complete surveys more than once a day (Shiffman et al., 2008). Repeating alarms and prompts could be disturbing in their daily lives, especially during sleep, daily activities or work. In addition, continuous alarms may increase alarm fatigue, which is the main cause of dropouts and no responses (Shiffman et al., 2008). Moreover, there is some concern about selection bias because EMA studies usually involve information and communications technology devices, which require high levels of adherence. Thus, the researcher may inevitably intend to exclude the ones who have cognitive impairments, hearing or sight disabilities or those who are technologically challenged (Lukasiewicz et al., 2007). Since this study endeavours to observe the variability of mental health characteristics among adults in a community, the scope of the study encompasses individuals regardless of age, sex, mental illness or past suicide attempts, which previous studies have excluded.

1.1.4 | EMA in nursing research

EMA methodology began to be used not only in psychology, but also in nursing science as well. Nursing researchers have made attempts to conduct studies using EMA to measure behavioural and psychological constructs in a multidimensional manner. Vigoureux and Lee (2021) investigated association of well-being with sleep and stress using EMA with smartphone application and actigraphy for hospital nurses. In the study, the nurses were asked to answer EMA surveys four times a day about how they felt stress and well-being in daily life including workplace for 2 weeks. Nam et al. (2020) also evaluated the feasibility and acceptability of EMA study to capture the real-time data about racial discrimination among African Americans in daily life. The study collected data, such as smartphone-based EMA survey, saliva samples and

accelerometers for consecutive 7 days. In spite of small sample size, the study findings show potential to understand how perceived racial discrimination associated with bio-behavioural stress responses that is possibly related to health disparities. Since our study targets people at risk of suicide, this EMA nursing study will improve our understanding when and how often the adults at suicide risk think the suicide in their daily life. Thus, this study will contribute to developing ecological momentary intervention strategies providing immediate interventions in real-time where many nursing professionals are working for.

2 | THE STUDY

2.1 | Aims

This study aims to investigate the characteristics of adults at suicide risk and the mental health indicators related to variabilities in suicidal ideation to develop an ecological momentary intervention in the future. The specific aims are to (a) describe characteristics of mental health and the level of suicidal ideation among adults at risk for suicide; (b) examine the differences in mental health characteristics in relation to general characteristics, health status and levels of suicidal ideation; and (c) identify the correlation in depression, anxiety, stress levels and suicidal ideation over time based on the EMA responses.

2.2 | Design

This is an observational and longitudinal study. Data for this study will be collected over 28 consecutive days.

2.3 | Sample/Participants

Inclusion criteria are: (a) 19 years of age and older; (b) possession of their smartphones; (c) ability to wear an Actigraphy device; (d) self-report suicidal ideation and/or behaviours in the past week (scored one or higher on Korean version of the Beck Scale for Suicide ideation); (e) ability to speak and write in Korean; and (f) ability to understand the study and provide consent to participate in the study voluntarily. Exclusion criteria are: (a) difficulty to participate due to cognitive dysfunction determined by psychiatrist; (b) with moderately severe cognitive impairment in case of those aged 65 and older (scored 23 or lower on the Korean-Mini Mental State Examination, 2nd Edition Standard Version); (c) difficulty to participate due to psychotic symptoms (i.e. auditory hallucination or delusion); and (d) participation in another study.

Statistical software G-power 3.1 (Faul et al., 2009) will be used to calculate the sample size and compare the low risk of suicide group with the high risk of suicide group using independent *t*-test. With an effect size of .5, a two-tailed alpha of .05 and a power of 80%;

a sample size of 128 is required. Considering the dropout rate of 15%, we will recruit at least 150 participants in total. We will recruit the participants who meet the selection criteria through the convenience sampling method from a suicide prevention centre and a psychiatric outpatient clinic in South Korea.

2.4 | Data collection

Data collection includes (a) structured self-report questionnaires at week 0, week 1, week 3 and week 5, (b) a wrist-worn actigraphy device for 2 weeks from week 1 to week 3 and (c) EMA online survey conducted three times a day for 4 weeks from week 1 to week 5. Participants have up to 20 min to complete the questionnaires and will be compensated approximately $60 and $30 at week 3 and week 5, respectively, for their time and effort. Each participant will be provided approximately $30 regardless of the period of participation in our study, even if he/she drops out in the middle. A detailed description of the data collection in chronological order is shown in Figure 2. The recruitment started in May 2021 and the data collection is ongoing.

2.5 | General Characteristics

Sociodemographic information including age, sex, marital status, education and socioeconomic status will also be obtained. Health-related characteristics include perceived health status, smoking, physical exercise, and physical and psychological comorbidities. Suicide-related information includes history of past suicide attempt(s), diagnosis of mental health problems, duration from the first psychiatric diagnosis, usage of psychiatric medication, and difficulties resulting from affective, neurogenic and psychiatric problems.

2.6 | Primary outcomes

2.6.1 | Korean version of the Beck Scale for Suicide Ideation

The Korean version of the Beck Scale for Suicide Ideation (K-BSS) will be used to measure the risk of suicidal ideation (Beck et al., 1988; Choi et al., 2020). It is offered by Korea Psychology, Co., Ltd. and is a self-report instrument asking an individual's wish to live, wish to die, frequency of ideation, perceived capability to carry out an attempt and extent of actual preparation. The first five items serve as screening items to explore an individual's attitude towards suicide and the following 15 items are used to assess suicidal hope and suicidal plans. Since Beck and Steer did not present a cut-off criterion in the original research (Beck & Steer, 1991), whoever reported above 1 in either of the two filter questions assessing the presence of active or passive suicidal ideation
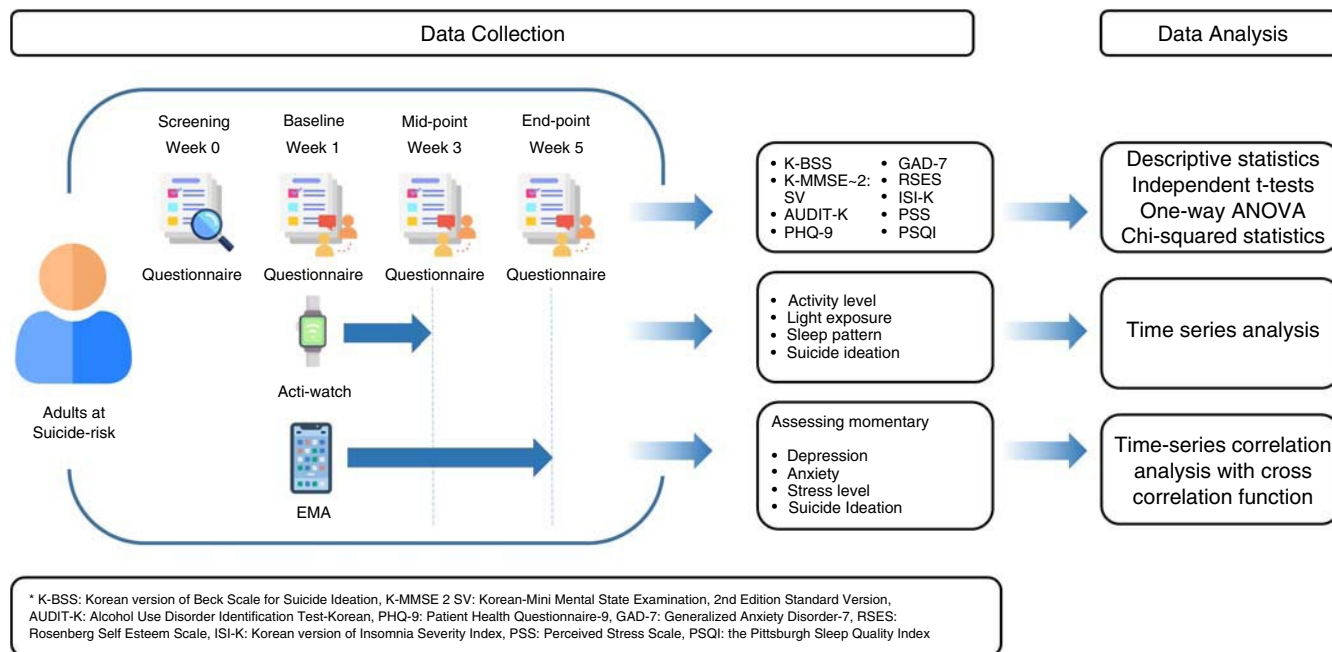
FIGURE 2 Data collection and data analysis process of the study

(4th and 5th questions of the K-BSS) will be selected as a subject of our study.

2.6.2 | Patient Health Questionnaire-9

The Patient Health Questionnaire-9 (PHQ-9, Korean version) will be used to measure the degree of depression in the past 2 weeks (Kroenke et al., 2001; Park et al., 2010). The severity levels include no depression (0–4), mild depression (5–9), moderate depression (10–14), moderately severe depression (15–19) and severe depression (20–27).

2.6.3 | Generalized Anxiety Disorder-7

Generalized Anxiety Disorder-7 (GAD-7, Korean version) will be used to measure the extent of anxiety level. Each item describes one of the typical symptoms of generalised anxiety disorders over the last 2 weeks (Spitzer et al., 2006). The severity levels include no anxiety (0–4), mild anxiety (5–9), moderate anxiety (10–14) and severe anxiety (15–21) in the original study.

2.6.4 | Perceived Stress Scale (PSS, Korean version)

The Perceived Stress Scale (PSS, Korean version) evaluates the degree of the individual's perception of stress in the last 1-month (Cohen et al., 1983; Lee et al., 2012). PSS scores are calculated by computing reversed responses to the four positive items out of 10 items.

2.6.5 | Actigraphy

The Actiwatch Spectrum PRO (Phillips Respironics) collects objective data, such as physical activity, ambient light exposure and sleep patterns while the participants wear it. Researchers will instruct participants to wear the actigraphy device on the non-dominant wrist continuously for 2 weeks including bedtime. Furthermore, they will be instructed to push the event marker button on the actigrapy device whenever they feel the unbearable urge to commit suicide or if they have suicidal ideation. After 2 weeks of wearing the actigraphy device, collected data will be saved via Actiwatch Spectrum PRO program by Phillips Respironics. The case report forms will systematically link, manage and guarantee the anonymity of collected data with the Actiwatch data management protocol.

2.6.6 | Ecological momentary assessment

Using a free Google survey, EMA will be conducted over 4 weeks to assess momentary depression, anxiety, stress levels and suicidal ideation (e.g., 'How would you rate the degree of your perceived depression/anxiety/stress/suicidal ideation at the moment?', based on a five-point Likert type scale, ranging from 1 = not at all to 5 = extremely). The survey link will be sent by text message three times a day (wake up time, bedtime and at the time with the most suicidal ideation). The participants will be instructed to check their text messages and complete the online survey as soon as possible. However, we do not restrict the time limit because of the participants' irregular sleep habits and the unpredictable nature of suicidal ideation.

2.7 | Secondary outcomes

2.7.1 | Korean-Mini Mental State Examination, 2nd Edition Standard Version

Korean-Mini Mental State Examination, 2nd Edition Standard Version (K-MMSE 2 SV) is an examination for screening the opportunity for the risk of cognitive function impairment in adults over 65 years of age (Folstein et al., 2010; Kang et al., 2020). It is offered by Inpsyt, Inc. Although the cut-off point differs depending on age, scores greater than 23 reflect normal cognitive function.

2.7.2 | Alcohol Use Disorder Identification Test-Korean

The Alcohol Use Disorder Identification Test-Korean (AUDIT-K) will be administered to identify hazardous drinking, harmful alcohol consumption and alcohol-related problems (Lee et al., 2000; Saunders et al., 1993). It includes questions to assess the amount and frequency of alcohol intake, alcohol dependence and problems related to alcohol consumption. The categories include normal drinking; 0–9 for men (0–5 for women), hazardous drinking; 10–19 for men (6–9 for women) and alcohol use disorder; 20–40 for men (10–40 for women).

2.7.3 | Rosenberg Self-Esteem Scale

The Rosenberg Self-Esteem Scale (RSES, Korean version) will be used to assess self-esteem during the past 2 weeks (Rosenberg, 1965).

2.7.4 | Pittsburgh Sleep Quality Index and the Korean version of the Insomnia Severity Index

These scales will be used to measure sleep quantity and quality. The Pittsburgh Sleep Quality Index (PSQI, Korean version) translated to Korean, offered by MAPI Research Trust, will be used to assess subjective sleep quality (Buysse et al., 1989). It consists of seven domains including subjective sleep quality, latency, duration, habitual sleep efficiency, disturbance, use of sleep medication and daytime dysfunction over the last 1 month. In addition, the Insomnia Severity Index (ISI-K) will be used to measure the severity of insomnia symptoms during the past 2 weeks (Cho et al., 2014; Morin, 1993). The severity levels include no clinically significant insomnia (0–7), subthreshold insomnia (8–14), moderate insomnia (15–21) and severe insomnia (22–28) in the original study (Morin, 1993).

2.8 | Ethical considerations

We obtained ethical approval from the affiliated Institutional Review Board (IRB No. 4-2021-0219) in April 2021. All data will be de-identified

to protect the confidentiality of participants. Since the participants in the study are expectedly vulnerable due to the risk of suicide attempts, the research team will provide them with 24/7 support, ensuring that there is someone available to contact for their safety and protection. We have partnered with a suicide prevention centre and provide helpline lists and 24/7 contact details to the participants at the baseline study.

Researchers ask the participants during the one-to-one interviews whether they are experiencing any discomfort, have doubts about participating this study or have any other troubles with the study. If safety issues occur in terms of contacting the researchers, we will contact the suicide prevention centre for further help. Participants' suicidal ideation patterns will be monitored and when they have the urge to injure themselves, we will contact the designated staff of the suicide prevention centre for any urgent care or assistance that may be needed for their safety.

2.9 | Data analysis

All statistical analyses will be conducted using IBM SPSS version 26 and SAS version 9.3 with the significance level set at .05, two-tailed. Descriptive statistics in terms of frequencies (percentages), means (standard deviations [SD]) or median will be conducted to describe general characteristics, health-related characteristics, suicide-related characteristics and EMA of participants. Independent t-test, chi-squared statistics and one-way analysis of variance (ANOVA) using the Scheffé method will be conducted to explore any differences of mental health characteristics according to the participants' general, health-related and suicide-related characteristics. To evaluate group differences, the participants will be classified into two groups (high- and low-risk group) based on their past experiences of suicide attempts (WHO, 2021). Time-series correlation analyses with cross correlation function will be conducted to identify any time lagging relationship of suicidal ideation with depression, anxiety and stress levels over time.

2.10 | Validity and reliability/Rigour

In this study, we will use valid instruments whose psychometric properties have been tested on the Korean population to collect data; the validity and reliability of the questionnaires are reported (see Table 1). Actigraphy devices (Phillips Respironics) are widely used in various research areas to investigate the characteristics of sleep, and the validity of its sensitivity has been proved (Marino et al., 2013). All researchers will be trained to conduct research in a systematic and unified way for data collection. For EMA data, to ensure the homogeneity of the raw data cleaning process by different researchers for the numerous responses, a manual will be provided; experts will also evaluate all the obtained data.

3 | DISCUSSION

This study investigates mental health characteristics using an innovative, multidimensional methodology including self-report

TABLE 1 Instruments used in the study

	Instrument	Developed by	Translated by	Item number (each scale)	Range of score	Higher scores means	Reliability	Observation week
Primary outcomes	K-BSS	Beck et al. (1988)	Choi et al. (2020)	21 (0–2)	0–38	Risk of suicide↑	Cronbach's α = .93 (Beck et al., 1988) Cronbach's α = .90 (Choi et al., 2020)	0, 3, 5
	PHQ–9	Kroenke et al. (2001)	Park et al. (2010)	9 (4-point Likert: 0–3)	0–27	Depression ↑	Cronbach's α = .89 (Kroenke et al., 2001) Cronbach's α = .81 (Park et al., 2010)	1, 3, 5
	GAD-7	Spitzer et al. (2006)	Patient Health Questionnaire (PHQ) screeners	7 (4-point Likert: 0–3)	0–21	Anxiety ↑	Cronbach's α = .92 (Spitzer et al., 2006) Cronbach's α = .915 (Seo & Park, 2015)	1, 3, 5
	PSS	Cohen et al. (1983)	Lee et al. (2012)	10 (5-point Likert: 0–4)	0–40	Perceived stress level↑	Cronbach's α = .84–.86 (Cohen et al., 1983) Cronbach's α = .82 (Lee et al., 2012)	1, 5
Secondary outcomes	K-MMSE 2 SV	Folstein et al. (2010)	Kang et al. (2020)	30 (differ by item)	0–30	Cognitive function ↑	Cronbach's α = .66–.79 (Folstein et al., 2010) Cronbach's α = .68 (Kang et al., 2020)	0
	AUDIT-K	Saunders et al. (1987)	Lee et al. (2000)	10 (5-point Likert: 0–4)	0–40	Alcohol problem ↑	Cronbach's α = .93 (Saunders et al., 1993) Cronbach's α = .92 (Lee et al., 2000)	1
	RSES	Rosenberg (1965)	Kang (2014)	10 (5-point Likert: 1–5)	10–50	Self-esteem ↑	Cronbach's α = .85 (Rosenberg, 1965) Cronbach's α = .76 (Kang, 2014)	1, 3, 5
	PSQI	Buysse et al. (1989)	MAPI Trust	19	0–21	Sleep quality ↓	Cronbach's α = .83 (Buysse et al., 1989) Cronbach's α = .84 (Sohn et al., 2012)	3
	ISI-K	Morin (1993)	Cho et al. (2014)	7 (5-point Likert: 0–4)	0–28	Insomnia severity↑	Cronbach's α = .90–.91 (Morin et al., 2011) Cronbach's α = .92 (Cho et al., 2014)	1, 3, 5

Abbreviations: ↑, going up; ↓, going down.; AUDIT-K, Alcohol Use Disorder Identification Test-Korean; GAD-7, Generalized Anxiety Disorder-7; ISI-K, Korean version of Insomnia Severity Index; K-BSS, Korean version of Beck Scale for Suicide Ideation; K-MMSE2 SV, Korean-Mini Mental State Examination, 2nd Edition Standard Version; PHQ-9, Patient Health Questionnaire-9; PSQI, the Pittsburgh Sleep Quality Index; PSS, Perceived Stress Scale; RSES, Rosenberg Self Esteem Scale.

questionnaires, actigraphy and EMA. It is obvious that only relying on self-reported methods to measure psychosocial stress indicators about suicide risk will be inadequate due to the retrospective nature of the data (Shiffman et al., 2008). A multidimensional methodology including actigraphy and EMA will fill out the gaps of evaluation of self-reported measurement due to measurement errors. Specifically, the ubiquity of smartphones allows researchers to investigate the trait of suicidality more closely with enriched information about individuals' daily lives (Millner et al., 2020). Our research investigating suicidal ideation aims to capture individuals' real-time living environments, which is the greatest strength of smartphone-based EMA. The smartphone enables us to conduct real-time, continuous data collection over shorter periods of time, tracking the variability of mental health characteristics at the individual level (Millner et al., 2020). In addition, other psychosocial stress indicators are simultaneously observed along with suicidal ideation and behaviours to understand comorbidities, which may be of use to future researchers.

This empirical study will apply the stress-vulnerability model in suicide research. However, there is an ongoing need to unearth further evidence to support scientific theories of suicide (Millner et al., 2020). Our protocol will focus on the close interaction of suicidal ideation with the daily moods of depression, anxiety and stress levels when adults at risk for suicide live in their natural environment of the community. Based on our expected findings, we will overcome two major limitations of relevant theories, such as (a) underspecified relationships among the constructs and (b) clinical implication to develop theory-driven interventions through rigorously designed, descriptive longitudinal research (Millner et al., 2020). The stress-vulnerability model is very simple, but it is the best one to achieve these goals between research and practice, as recommended by a previous study (Lopez-Castroman et al., 2014).

3.1 | Implications of mental health in adults at risk for suicide

Our study's findings can contribute to the scientific development of indicators for screening in adults at risk for suicide. It is difficult for mental health nurses to complete suicide risk assessments, particularly due to limited psychiatric practice experience and time constraints (Cochrane-Brink et al., 2000). Developing a new measure requires a decrease in intra-rater reliability. Thus, our EMA of suicidal ideation and within-person analyses enables us to identify each person's unique pattern, as in previous studies (Littlewood et al., 2018; Parrish et al., 2021).

This study will provide fundamental information to develop mental health interventions for adults at risk for suicide. Our EMAs, which include other psychosocial stress indicators such as depression, anxiety and daily stress, are also examined continuously because these are strongly correlated with suicide risk (Bentley et al., 2015; Hirsch et al., 2019; Ribeiro et al., 2018). Thus, our study findings will help researchers and clinicians with understanding modifiable factors prior to suicide attempt or relevant consequences

(Turecki et al., 2019). Accurate assessment of suicide risk could be the fundamental evidence necessary to provide patient management in timely manner (Cochrane-Brink et al., 2000; WHO, 2012). Furthermore, we expect that EMA use will facilitate the development of care service for community adults at risk for suicide and provide basic evidence that can contribute to improved mental health interventions or community service for such individuals.

This study will expand our understanding of mental health nursing and assist mental health nursing workforce. First, one of the most notable characteristics of suicidal ideation and behaviours are its rapid fluctuations over the time (Kleiman et al., 2017; Millner et al., 2020), where community nurses cannot address the problems at every single moment. Rather, due to these traits, it has been suggested that timely appropriate and comprehensive interventions to manage suicidal ideation and behaviours using smartphone be devised (Kleiman et al., 2017). Establishing the fundamental body of knowledge based on the descriptive study investigating within-person variabilities of psychosocial stressors will provide cues to develop interventions on time. Second, Korean mental health nurses have faced difficulties with a lack of labour force (Lee, 2020). It is reported that registered mental health nurses in Korea in 2016 were 14.7 per 100,000 populations, demonstrating less than a half of average mental health nurses in high-income countries by World Bank (National Center for Mental Health, 2017). Not only the shortage of labour force, leaving the nursing profession, low job satisfaction and shortage of workforce with long-term experiences are other critical issues in mental health nursing in Korea (Lee, 2020). Meanwhile, it is required to develop complementary tools to assess psychosocial stress indicators about suicidal ideation and behaviours to support mental health nurses with decreasing their burdens for caring individuals with mental health problems.

3.2 | Limitations

This study has some limitations. First, we depend on limited recruiting sites for sampling, so it has limitations related to generalization. Second, we use convenience sampling, which can result in selection bias on the part of participants. Thus, further studies should consider stratified or quota sampling, especially in large studies aimed at replicating this study's results. We were concerned that participants were burdened by continuous participation in the study for a month. In addition, the dropout rate might have been higher due to certain characteristics of the study's participants. We will monitor subject burden carefully and follow-up about compliance. In addition, participants with safety issues will be well linked to the relevant agencies in an emergency situation.

4 | CONCLUSION

Our study will provide the opportunity to discover potential mental health risk factors for suicidal ideation among adults living in the community using a novel multiple-measurement approach. Our

advanced methodology enables us to evaluate real-time mental health conditions at a distance and develop further interventions that reflect the patterns and comprehensive aspects of suicidal ideation. Based on our study's findings, it is important to develop individualized and preventive interventions to provide timely help to adults in high-risk groups living with suicidal ideation.

PEER REVIEW

The peer review history for this article is available at https://publons.com/publon/10.1111/jan.15142.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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