Family economic status and adolescent resilience to suicidal ideation in the face of psychosocial trauma

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Abstract

What is the relationship between socioeconomic adversity and vulnerability to suicidal ideation among adolescents? This is the key substantive research question pursued by this dissertation. The dissertation proposes contributions in three areas: empirical research, social-epidemiological theory, and statistical methods relevant to the study of the social determinants of psychiatric vulnerability.

Empirically, the dissertation starts with exploratory research that finds a U-shaped pattern of interactions between recent psychosocial trauma and measures of student life adversity (namely, family economic status and perceived stress) for predicting suicidal ideation. The results are contrary to the prevailing understanding in social studies of health that associates adverse or stressful living conditions with worse mental health outcomes. I propose both stress inoculation theory and generalized strain theory as potential explanations for these findings. In a follow-up confirmatory study, I use a different dataset to see whether the counterintuitive patterns of stress-diathesis interactions can be replicated.

While the design of the empirical studies is broadly guided by the theoretical framework of the stress-diathesis model of suicide, I note some deficiencies in the way that this framework has been traditionally interpreted and suggest a possible modification of this framework. This modification considers and integrates two insights from the psychological literature on resilience: stress inoculation theory and the "bi-dimensional" framework of resilience. The resulting interpretation of the stress-diathesis model is not only more theoretically robust but also seamlessly accommodates the counterintuitive results of the empirical analyses.

Finally, this dissertation offers a thorough conceptual analysis of contextual effects commonly used in social-epidemiological studies. The existing literature on the social

determinants of psychological resilience has a broad tendency of trying to hypothesize and estimate “neighborhood effects” of a certain social variable, whether it be religion, exposure to violence, poverty, SES, or residential quality. I argue that it is often difficult to understand what these “neighborhood effects” mean and I present a robust account of the concept of contextual effects, extending it to an interaction setting, and suggesting ways to estimate these settings empirically. I then demonstrate that most existing research efforts that argue for a “contextual” or “neighborhood” effect on psychopathological vulnerability are inherently flawed and provide little information about the distinct importance of the “context” or “neighborhood.”

Resumé

Quelle est la relation entre l'adversité socio-économique et la vulnérabilité aux idées suicidaires chez les adolescents ? C'est la question de recherche fondamentale poursuivie par cette thèse. La thèse propose des contributions dans trois domaines : la recherche empirique, la théorie socio-épidémiologique et les méthodes statistiques pertinentes pour l'étude des déterminants sociaux de la vulnérabilité psychiatrique.

Empiriquement, la thèse commence par une recherche exploratoire qui trouve un modèle d'interactions en forme de « U » entre les facteurs de stress proximaux et les mesures de l'adversité de la vie étudiante (c'est-à-dire, le statut économique familial et le stress perçu) pour prédire les idées suicidaires. Les résultats sont contraires à la compréhension dominante dans les études sociales de la santé qui associe des conditions de vie défavorables ou stressantes comme généralement préjudiciables à la santé mentale. La théorie de l'inoculation du stress et la Generalized Strain Theory sont proposées comme explication potentielle des découvertes surprenantes. Une étude de confirmation de suivi utilise un ensemble de données différent pour voir si les schémas contre-intuitifs des interactions stress-diathèse peuvent être reproduits.

Bien que la conception des études empiriques soit largement guidée par le cadre théorique du modèle de stress-diathèse du suicide, je note certaines lacunes dans la manière dont ce cadre a été traditionnellement interprété et suggère une modification appropriée de celui-ci. Deux idées issues de la littérature psychologique sur la résilience : la théorie de l'inoculation du stress et le cadre « bidimensionnel » de la résilience sont prises en compte et intégrées au modèle stress-diathèse. L'interprétation résultante du modèle stress-diathèse est non seulement plus robuste sur le plan théorique, mais s'adapte également de manière transparente aux résultats contre-intuitifs des analyses empiriques.

Enfin, cette thèse propose une analyse conceptuelle approfondie des effets contextuels couramment utilisés dans les études socio-épidémiologiques. La littérature existante sur les déterminants sociaux de la résilience psychologique a largement tendance à essayer d'émettre des hypothèses et d'estimer les « effets de quartier » d'une certaine variable sociale, qu'il s'agisse de la religion, de l'exposition à la violence, de la pauvreté, du SSE ou de la qualité résidentielle. Partant de l'intuition qu'il est souvent à la fois difficile de comprendre ce que ces « effets de voisinage » signifient, je présente une explication robuste du concept d'effets contextuels, l'étends à un contexte d'interaction et suggère des façons de les estimer empiriquement. Je démontre ensuite que la plupart des recherches existantes qui plaident pour une sorte d'effet «contextuel» ou «de voisinage» sur la vulnérabilité psychopathologique sont intrinsèquement erronées et fournissent peu d'informations sur l'importance distincte du «contexte» ou du «quartier».

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Introduction

Theoretical background

Resilience can be understood as "the capacity of individuals to cope successfully with significant change, adversity, or risk" (Lee and Cranford 2008, p.213). The concept of resilience is key to explaining individual variations in psychopathological outcomes even when confronted with the same type of episodic stress (Lee et al. 2013). Resilience is an "interactive concept" (Rutter 2006) that describes the degree to which various background factors interact with episodic stress to amplify or buffer its effect. For example, if loneliness increases the effect of negative life events on suicidal behavior (Chang et al. 2009), then it can be called a resilience factor. The opposite pole of resilience is called vulnerability (Ingram et al. 1998).

In social studies of mental health, the concept of resilience or vulnerability has received much attention for its potential to explain observed variations in mental health between different social classes and status groups (Kessler and Cleary 1980; McLeod and Kessler 1979). The "differential vulnerability hypothesis" (Andersen et al. 2022; Elliot 2000) holds that "members of disadvantaged social groups are especially vulnerable or emotionally reactive to stressors" (Thoits 1995, 55). This hypothesis has received broad empirical and theoretical support in sociological studies of mental health at least since the 1970s (Kessler and Cleary 1980; McLeod and Kessler 1990; Pearlin and Schooler 1978; Thoits 1995; 2010; Turner and Roszell 1994; Ulbrich et al. 1989). Many studies have tested the differential vulnerability hypothesis with special attention to SES, and despite occasional reports of "null" results (Berchick et al. 2012), the existing scientific literature has been largely supportive of this hypothesis (Cutrona et al. 2005; Dupéré et al. 2009; Elliott 2000; Kessler and Clearly 1980; 2019; Zimmerman 2013).

The main rationale for the differential vulnerability hypothesis is the belief that socioeconomic deprivation entails a deprivation of coping resources (McLeod and Kessler 1979; Thoits 2010). There is some debate as to what types of coping resources play a role. Some pointed to the role of financial difficulties (Liem and Liem 1978), while others found that lower-status individuals lack social support (Myers et al. 1978; Turner and Marino 1994). In addition to these "external" factors, research has also paid attention to "internal" coping resources and argued that that lower-SES individuals tend to have deficient psychological coping skills when faced with stressful events (Pearlin and Schooler 1978). Despite these variations, the basic idea that there is usually (although not universally) an inverse relationship between SES and mental resilience is a commonly accepted hypothesis in social studies of mental health.

The differential vulnerability thesis has also been reinforced by a related theoretical framework in medical psychology, the stress-diathesis model of psychopathology. The stress-diathesis model follows a long tradition in medical psychology of understanding mental disorders as a result of excessive stress. According to this model, individuals who are already under a lot of stress lack the psychological buffer to absorb additional stress before developing psychiatric symptoms (Zimmerman 2013). There may be some debate on whether the association of stressful background conditions with lower resilience is an inherent theoretical feature of the stress-diathesis model, considering that many theoretical discussions of the stress-diathesis model focus on expounding the concept of vulnerability that interacts with a proximal stressor to generate mental disorders rather than ascribe specific properties (such as high background stress) that constitute a condition of high vulnerability (Zubin and Spring 1979; Ingram and Luxton 2005). In any case, such has been a common interpretation in applied research (Barzilay et al. 2021; Chang et al. 2010; Liu 2015), and some sociological studies of psychological vulnerability

used the stress-diathesis model to support the differential vulnerability hypothesis (Zimmerman 2013).

Despite the strong support that the differential vulnerability thesis receives from the sociological and psychological literature, there are also reasons to think that an opposite relationship may hold between psychological resilience and SES. Most importantly, the psychological literature on stress inoculation has repeatedly found that moderate exposure to stressors may foster long-term resilience. In particular, a substantial body of research has found that a moderate amount of childhood adversity produces inoculating effects for adolescents and young adults. Empirical evidence for stress inoculation has been found for a wide range of mental outcomes from physiological reactivity to experimental stressors (Shakiba et al. 2020) to real-world mental health issues such as depressive symptoms (Mortimer and Staff 2004; Seery et al. 2011; Shapero et al. 2015), self-esteem (Mortimer and Staff 2004), and life satisfaction (Seery et al. 2011). An especially influential hypothesis is that psychological resilience draws a U- or J-curve by increasing levels of cumulative childhood adversity (Boyce and Ellis 2005; Seery et al. 2011; 2013). The main reasoning is that there is an optimal level of adversity that fosters a thriving and resilient psychological profile (Rutter 1993). Too little exposure to stress during childhood results in oversensitive psychological profiles, and too much exposure that cannot be successfully coped with also reduces a person's ability to cope with stress.

If the stress inoculation mechanism is powerful enough to offset the effect of unfavorable coping resources, there may even be cases where the proposed relationship socioeconomic adversity and mental resilience is reversed contrary to the expectation of the differential vulnerability hypothesis. Indeed, multiple recent studies independently reported such cases, especially for suicidal ideation or depression. Kim and Chun (2020), who studied adolescents in

developing countries, reported that the effect of bullying victimization was diminished in schools where bullying was prevalent. Gaylord-Harden et al. (2016) found that African American youth with a higher level of exposure to violence are less likely to develop depressive symptoms. More pertinently for the present research that focuses on SES, Barzilay et al. (2021) found that lower socioeconomic status associates with increased resilience to suicidal ideation among American young adults in the face of assaultive trauma. While not about suicidal or depressive symptoms, Ellis et al.'s (2017) four-class latent profile analysis of Dutch adolescents found that the class with the highest stress responsivity also had the highest SES, while the class with buffered stress responsivity had moderate SES.

The idea that socioeconomic deprivation may have the unintended effect of "immunizing" individuals against stressful events was actually proposed in early sociological research on mental health as a tentative explanation for the unexpected observation that Mexican Americans are less psychologically vulnerable to acute stressors than Anglo-Americans (Kessler 1979; Wheaton 1982). This counterpoint to the differential vulnerability hypothesis had been largely neglected in sociological studies of mental health in subsequent decades, but the recent studies just mentioned, motivated by advances in the psychological literature on stress inoculation, recently brought renewed attention to this issue. The present situation is therefore one in which a theoretically informed revision to a dominant hypothesis has been made, but the proposed revision is still at a relatively underdeveloped with only a handful of papers supporting it empirically. The first two chapters of this dissertation aim to contribute additional empirical analysis to this emerging challenge to the differential vulnerability hypothesis.

Methods

This dissertation will use public health survey data from South Korea to study how family economic background moderates the association between recent trauma and suicidal ideation among adolescents. The focus on adolescents is motivated by two reasons. First, most existing research on the social determinants of psychological resilience focuses on either adolescents or young adults. Second, large-scale survey data is more readily available for adolescents or young adults since they can be relatively easily targeted by school or university administrators and teachers. The focus on adolescents make this dissertation more consistent with previous studies but also reduces its generalizability to the broader adult population.

Given that resilience is an interactive concept, observational studies of resilience typically explore interaction effects between two variables. The choice of variables for interaction follows certain principles derived from the stress-diathesis model: Psychological disorders occur through a combination of a proximal stressor that "triggers" the disorder and background conditions that predispose individuals to the disorder. This dissertation follows the theoretical assumption of the stress-diathesis model and examines the interaction effect between recent trauma and the diathesis of interest for predicting suicidal ideation. The substantive studies in Chapters 1 and 2 will use regression methods with a particular focus on the interaction between recent trauma and family economic status. In Chapter 1, in addition to family economic status, I also explore perceived stress as the diathesis variable.

The final substantive chapter of this dissertation (Chapter 3) is a methodological contribution regarding an issue that repeatedly comes up in social studies of psychological resilience. A major theme in social studies of health is so-called "neighborhood effects" or "contextual effects," which can be intuitively understood as the "unique" (Farkas 1974, p.346) or

"independent" (Firebaugh 1979) effect of a group-level construct on the outcome over and beyond the effect of individual-level factors. A long tradition of research on suicide (as well as other mental health disorders), dating back to the work of Emile Durkheim, stresses the role of individuals' social environment. Indeed, many highly visible studies on the social determinants of resilience emphasize neighborhood effects (Cutrona et al. 2005; Dupéré et al. 2009; Kim and Chang 2018; Maimon and Kuhl 2008). According to this approach, when analyzing the role of a certain socioeconomic variable, such as SES, one must not only consider the individual level but also the aggregated level, whether it be class, school, neighborhood, or some other meaningfully demarcated group context.

One problem with analyzing "neighborhood" or "contextual" effects in studies of resilience is that these concepts are not formally defined in the existing literature. Existing theoretical discussions of contextual effects exclusively focus on cases with a monadic outcome variable and are completely silent about cases where the outcome variable can by itself be operationalized as the effect of one variable on another. The lack of theoretical discussions is naturally accompanied by a lack of a suitable methodology for estimating contextual effects empirically for cases with a dyadic outcome variable. I contribute to the study of the social determinants of resilience not only by empirically studying the association between SES and resilience but also by theorizing contextual effects for dyadic outcome variables and proposing a method for estimating them. In Chapter 3, based on the theoretical and methodological proposals, I review several influential past articles that claim to identify a contextual effect of a certain variable on psychopathological resilience and examine whether they successfully support their stated arguments with an empirical analysis. I also apply the method to my own analyses of

new datasets and check whether and how individual-level and group-level SES interacts with recent stressful events to predict suicidal ideation among adolescents.

Structure of the dissertation and original contributions

This dissertation follows a manuscript-based format and is comprised of three article-length manuscripts. All manuscripts were written as standalone journal articles, but the three articles, each of which constitutes a chapter, also form a coherent structure. Below, I briefly introduce the content of each article-chapter, together with a description of its contributions to original knowledge.

The first chapter, published in 2021 in *Plos One* is titled "Do more stress and lower family economic status increase vulnerability to suicidal ideation? Evidence of a U-shaped relationship in a large cross-sectional sample of South Korean adolescents." It presents exploratory research that examines how family economic status moderates the effect of a proximal stressor on adolescent suicidal ideation using a very large cross-sectional sample of South Korean adolescents. Two types of proximal stressors, namely, victimhood of violence (of the kind that requires medical treatment) and the experience of severe grief or despair, are used in the analysis. The results show that family economic status interacts with each type of proximal stressor in a U-shaped pattern. I repeat the same analysis with perceived global stress instead of family economic status and find similar results. I suggest Stress Inoculation Theory and Generalized Strain Theory as two potential explanations for these counterintuitive findings.

This first empirical chapter constitutes one of the very first studies to provide preliminary empirical support for the thesis that socioeconomic or psychological adversity may sometimes strengthen adolescents' resilience to suicidal ideation in the face of episodic stress. In particular, it provides the very first and still only (to the best of my knowledge) case in which the association of adolescents' SES and resilience to mental disorders takes the form of a J- or U-shape relationship (Jeong 2021). Such quadratic patterns have been reported multiple times in the

past ten to fifteen years regarding the association between cumulative life adversity and psychological resilience, and the results of Chapter 1 complement this body of literature. In addition, I found no distinct role of group-level SES in determining adolescents' resilience over and above individual-level SES. Together with the methodological critique offered in Chapter 3, this challenges a popular view within social studies of psychological resilience that assigns a leading role to "contextual" or "neighborhood" deprivation when explaining adolescent resilience.

Chapter 2 is titled "Family economic status and resilience to suicidal ideation among adolescents: A reexamination of recent findings." In this chapter, I conduct a confirmatory study of Jeong's (2021) (i.e., of the study presented in Chapter 1) and Barzilay et al.'s (2021), finding that high levels of SES may increase vulnerability to suicidal ideation among young people. Using nationally representative panel data from South Korea, this article examines how the interaction between bullying victimization and family income might be associated with suicidal ideation. I find a positive linear interaction, in which those from an affluent family background experience a substantial increase in the risk of suicidal ideation in the face of past-year bullying victimhood but those from modest backgrounds do not experience any increase. However, not all robustness checks were successful, and the results should be interpreted with caution. I suggest that more research, including qualitative research, is needed for a better understanding of the relationship between socioeconomic status and resilience to suicidal ideation among adolescents.

Chapter 3 is titled "Contextual fallacy in MLMs with cross-level interaction: A critical review of neighborhood effects on psychiatric resilience." This chapter was published in *Social Science and Medicine* in 2022. In this chapter, I examine the concept of contextual effects, extend it to an interaction setting that is relevant for social studies of psychological resilience,

and conduct a focused review of past influential research that claimed to have identified a "neighborhood" effect of a certain risk factor on psychopathological resilience. Contextual effect in an interaction setting is a theme that often comes up in research on the social determinants of psychological resilience, but it has never been explicitly discussed or defined. The first chapter of the dissertation began to address this gap, and Chapter 3 delves deeper into it. The main argument of this chapter is that merely adding a cross-level interaction between a proximal stressor (which is nearly always measured at the individual level) and a neighborhood-level variable does not offer any insight into the distinct moderating role of the neighborhood-level variable in cases where the neighborhood-level variable has valid individual-level counterparts. In such cases, one must at least include a relevant L1-L1 interaction in addition to the L1-L2 interaction to avoid a specific type of ecological fallacy that I refer to as "contextual fallacy." I also show that virtually all existing research on the "contextual" or "neighborhood" determinants of psychological resilience suffers from this fallacy due to the omission of an appropriate L1-L1 interaction term.

To conclude, the main argument of this dissertation is that the relationship between socioeconomic adversity and psychological resilience is more complex than what is commonly assumed in the existing literature. I show that in *some* cases adolescents from affluent backgrounds are less resilient to suicidal ideation in the face of recent trauma. While seemingly counterintuitive and contrary to previously known results, such an association is consistent with recent developments in the study of resilience and stress inoculation. Based on the results, I propose that intervention programs for mental health and suicide prevention should pay greater attention not only to the socially marginalized but also to youth from a higher socioeconomic background.

Author Contributions and the Current State of the Dissertation Chapters

The dissertation follows a manuscript format and is comprised of three standalone articles that contribute to the overall agenda of the dissertation. The student is the sole author of all three articles. Two of the chapters have already been published:

(Article 1)

Jeong, T. 2021 “Do more stress and lower family economic status increase vulnerability to suicidal ideation? Evidence of a U-shaped relationship in a large cross-sectional sample of South Korean adolescents”, *PloS one* 16(4). e0250794.

(Article 3)

Jeong, T. 2022. “Contextual fallacy in MLMs with cross-level interaction: A critical review of neighborhood contextual effects on psychiatric resilience.” *Social Science and Medicine* 310.

As of August 2, 2023, Article 2 is currently undergoing revise and resubmit at *Child Abuse and Neglect*.

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Article 1. Do more stress and lower family economic status increase vulnerability to suicidal ideation? Evidence of a U-shaped relationship in a large cross-sectional sample of South Korean adolescents.

Abstract

It is widely held in socio-behavioral studies of suicide that higher levels of stress and lower levels of economic status amplify suicidal vulnerability when confronted with a proximal stressor, reflecting the traditionally prevalent understanding in health psychology and sociology that associates adverse life circumstances with undesirable mental health outcomes. However, upon reflection, there are strong theoretical reasons to doubt that having more stress or being in a more stressful environment always increases suicidal vulnerability given the occurrence of a crisis. Using large nationally representative public survey data on South Korean adolescents, I show that the association between recent psychosocial crisis and suicidal ideation often gets stronger with more favorable levels of perceived stress and improving levels of family economic status. Overall, the increase in the probability of suicidal ideation from recent exposure to a psychosocial crisis is consistently the smallest around medium levels of stress or family economic status and larger at low or high levels. A supplementary exercise suggests that the identified moderation effects operate mainly in virtue of individual-level stress or family economic status in the relative absence of contextual influences at the school level. The findings present preliminary evidence of the stress inoculation hypothesis with regard to suicidal ideation. Research on suicidal vulnerability could benefit from increased attentiveness to the mechanisms through which being in an adverse or unfavorable life situation could protect against the suicide-inducing effects of proximal stressors.

1.1. Introduction

Traditionally, suicide research tended to study the effect of risk factors one by one, and a wide variety of risk factors have been identified and confirmed across multiple domains. In the past couple of decades, however, there has been an increasing interest in interactions between risk factors of suicidal behavior (O'Connor and Nock 2014). The stress-diathesis model is an influential theoretical framework that guides research on interactions between risk factors of psychiatric outcomes and has been widely adopted in the study of suicide (Rubinstein 1986; Chang et al. 2010; Zimmerman 2013; Shang et al. 2014). The stress-diathesis model in suicidology posits that suicidal outcomes are triggered by proximal stressors, which can be a psychosocial crisis or psychiatric disorder (Hawton and van Heeringen 2009; van Heeringen 2012). Whether being affected by such proximal stressors leads to suicide or related outcomes depends on a range of predisposing conditions that constitute a person's vulnerability or "diathesis" to suicide (Mann and Haas 1999; Mann 2002). While diathesis is sometimes conceptualized dichotomously (i.e. it was present if it jointly brought about the outcome, absent if it did not), many studies work with a continuous concept of diathesis, assuming that predisposing conditions come in grades rather than breaks (i.e. as yes-or-no conditions) (van Heeringen 2012. As such, a background risk factor can be conceptualized as a diathesis (or vulnerability, or predisposing condition) if it amplifies the effect of a proximal stressor on a suicidal outcome measured on a probabilistic or graded scale. In a regression context, diathesis or vulnerability is often operationalized as interaction effects between an explanatory variable of interest and a proximal stressor for predicting a suicidal outcome.

Although the concept of a medical diathesis originally focused on biological traits produced by genetic expression, the concept has been expanded to include psychological and

social dispositions (van Heeringen 2012). Studies of psychological dispositions to suicidal thought or behavior have frequently targeted specific psychometric constructs that measure a person's ability to overcome or endure a crisis. Diverse measures such as problem-solving skills (Adams and Adams 1996; Grover et al. 2009), coping skills (Tang et al. 2015), enhancing attributional style (Kleiman et al. 2012), optimistic explanatory style (Hirsh et al. 2009), grit (Blalock et al. 2015), emotional intelligence (Cha and Nock 2009), and cognitive vulnerability (Hankin and Abramson 2002) have been found to affect a person's vulnerability to suicidal ideation, attempt, or depression so that a better score on these cognitive or personality traits is associated with a milder association between psychosocial crisis and suicide-related outcomes. In a similar vein, research generally reported that various forms of social support that offer relief in times of episodic stress decrease diathesis to suicidal outcomes. Support from family (Au et al. 2009), friends, schoolmates (Miller et al. 2015), and local religious organizations (Maimon and Kuhl) have been found or argued to mitigate the suicide-inducing effects of recent negative life events. These psychological attitudes/dispositions and social environments are sometimes called "internal" and "external" protective factors, respectively (Rutter 2008).

Other research on vulnerability to suicide-related outcomes takes interest in aspects of well-being or living circumstances rather than psychological or social traits specifically intended to measure a person's psychological or emotional durability. Contemporary studies of this orientation have commonly reported that people living in a more stressful state are more prone to suicide-related symptoms following recent negative life events or other important risk factors. It has been reported that the association between exposure to school bullying and suicidal ideation is increased with higher levels of perceived stress (Lee and Choi 2016); higher life stress amplifies the effect of loneliness and irrational beliefs on suicidal ideation among inmates

(Bonner and Rich 1990), and the association between negative life events and suicidal attempt is increased in neighborhoods with higher levels of poverty (Dupéré et al. 2009). It was also found that the effect of depression – a major correlate of suicidal ideation and a proximal stressor of suicide – on suicide attempt is stronger in neighborhoods where violence is prevalent (Zimmerman 2013). Analogous patterns have been reported with depression as the outcome: Higher perceived stress was associated with a stronger association between recent negative life event and depression (Kuiper et al. 1986); the effect of negative life events on depression was stronger among people with a lower SES (Verbeek et al.2019) and living in a poorer neighborhood (Cutrona et al. 2005).

It should be noted that stress plays an important role in the existing literature for interpreting the relationship between(socio)economic status and vulnerability to suicidal outcomes. Most existing research of this type relies on the understanding that a person already under more stress or duress is less able to stave off the suicide-inducing effects of proximal stressors as can be seen in Kuiper, Olinger, and Lyons' (2005, p.153) statement that "individuals with a high level of global stress may perceive a general inability to cope with additional negative events and may view these events as completely overwhelming." Dupéré, Leventhal, and Lacourse (2009, p.1303), in their theoretical explanation of the positive interaction effect between neighborhood poverty and recent negative life event for predicting suicidal attempt, argued that "[y]outh who are otherwise at risk for suicide could be more likely to exhibit suicidal thoughts and to attempt suicide when they are exposed daily to a stressful environment that is less likely to provide strong emotional, social and institutional resources in the face of a crisis." The common idea is that being under a lot of stress depletes one's mental resources to cope successfully with a sudden increase in stress from a traumatic episode. Such an understanding is

consistent with the traditionally prevalent view in psychology that negative life circumstances entail undesirable mental health outcomes while well-being protects against them (Fletcher and Sarkar 2013; Liu 2015). Reflecting such an understanding, Zimmerman (2013) even interpreted the stress-diathesis model in suicidology as a framework that holds that "a risk factor (e.g. depression) has a greater likelihood of causing suicide under a condition of high stress" (p.362).

It is hard to deny in terms of theory as well as empirical data that being in a stressful or undesirable life circumstance *may* work as a diathesis to suicidal thought or behavior. However, there are strong theoretical reasons to think that this may not always be the case. The prevalent understanding that more stress or adversity leads to higher suicidal vulnerability pays little attention to the former's cumulative effect on the latter. In particular, the large accumulation of evidence for the *stress inoculation hypothesis* in recent one to two decades provides a strong theoretical reason to rethink the monotonic relationship described above.

It is now well-established that repeated exposure to stress and adversity not only leads to mental attrition and but possibly to resilience (Liu 2015; Diensbier 1989; Carver 2010; Rutter 1993; Lyons and Parker 2007; Stein et al. 2018; Eysenck 1983). Such a "steeling" effect has been found for a wide range of adverse mental health outcomes among young adults or adolescents. For example, higher levels of work stress during adolescence mitigated the deleterious effect of work stress on self-esteem, self-efficacy, and depressed mood among young adults (Mortimer and Staff 2004). Notably, it has been repeatedly (but not always) found that psychological resilience draws a U-curve by childhood adversity: A nurturing and stable rearing environment as well as a deprived and stressful one leads to low resilience, while moderate exposure to adversity results in high resilience due to steeling effects. Such a quadratic pattern in stress inoculation among adolescents or young adults is reported for global distress, functional

impairment, life satisfaction, post-traumatic stress symptoms (Seery et al. 2010), and depressive symptoms (Shapero et al. 2015). These findings are consistent with repeated findings from laboratory studies of dampened physiological reactivity among adolescents with moderate childhood adversity and heightened reactivity among those with low or high childhood adversity (Schweizer et al. 2016; Seery et al. 2013; Hagan et al. 2014; Shakiba et al. 2020). The effect of psychological steeling through life adversity has not yet been systematically explored for suicidality, but its known applicability to a wide range of adverse mental health outcomes demands that it be seriously considered in the study of suicidal vulnerability.

Stress inoculation theory in developmental and health psychology provides the most developed and proximate support for the possibility of a non-conventional relationship between psychological or economic adversity and suicidal vulnerability in the face of a crisis, but a related insight is also present in General Strain Theory from criminology (Agnew 1992). General Strain Theory identifies the gap between expectation and reality as an important source of strain, which causes a range of negative emotions such as anger, depression, disappointment, and fear, ultimately precipitating delinquent behavior (Ibid.). The thesis that a gap between expected and actual outcomes may cause delinquent behavior has been supported in empirical studies (Rebellon et al. 2009).

In general, better life circumstances tend to be associated with higher expectations of the positive states or the absence of negative states that one is entitled to in life. For example, people who have experienced a lot of stress and adversity will be less likely to expect a life with few negative events, and socioeconomic status among adolescents is positively associated with their expectation of general life success (Johnson and Hitlin 2017). It can therefore be conjectured that having had a life with fewer/milder adversity and accordingly having better expectations

sometimes increases strain when confronted with a major crisis that at least temporarily reduces reality to a very adverse state. This is especially so considering that the negative emotions caused by strain such as depression and anger not only explain deviance and crime but are also known to affect certain psychopathological outcomes including suicide. These insights are already visible in (an oft-neglected part of) Durkheim's writing on anomic suicide, which, contrary to most recent research, stated that "poverty protects against suicide because it is a restraint in itself," and the rich are more prone to suicide than the poor in an economic disaster because "something like a declassification occurs which suddenly casts certain individuals into a lower state than their previous one" (Durkheim [1897] 2002, p.214).

In sum, both stress inoculation theory and General Strain Theory provide potential reasons for which people in adverse life circumstances may at least in some cases be more mentally resilient in the face of severe episodic stress. The former posits that people living a (moderately) rough life may have had more opportunities to grow resilience through repeated exposure; the latter posits that they are likely to have lower life expectations and would therefore be less likely to be emotionally overwhelmed even when life suddenly falls to a very adverse state. It is a largely unexplored question how much these two separate strains of theory from psychology and criminology can be reduced to the same principle. At present, the stress inoculation hypothesis arguably provides a more developed challenge to the prevalent understanding on suicidal vulnerability and stress/adversity since it is backed by a substantial volume of empirical research on various psychiatric outcomes including depression, contrary to General Strain Theory that has rarely seen any empirical application beyond explaining crime and deviance.

The above review of theory and previous research suggests that the relationship between stress and vulnerability to suicidal outcomes in the face of a crisis is likely governed by multiple mechanisms, some of which may exert opposite effects. Since stress inoculation theory has never been seriously explored for suicidal outcomes, and as the U-curve model is not always identified even in stress inoculation research, it is hard to posit any particular relationship (e.g. increasing, decreasing, U-shape, И-shape (Ellis et al. 2017)) with confidence at a purely theoretical level. Still, it would not be surprising to find systematic deviations from the conventional understanding that adolescents with higher levels of stress or living in a worse ecological environment would in general be more vulnerable to suicidal outcomes in the face of proximal stressors. Based on a very large nationally representative sample of South Korean adolescents, this article explores how people with different levels of perceived stress and family economic status vary in their association between recent psychosocial crisis and suicidal ideation with special attention to identifying non-monotonic interaction effects—something that previous studies of the same kind did not take into consideration. The analysis is intended to present a theory-backed empirical challenge to the prevalent but insufficiently substantiated understanding that those living in more stressful or underprivileged conditions are generally more vulnerable to suicidal outcomes in the face of a psychosocial crisis.

1.2. Materials and Methods

1.2.1. Data

The statistical analysis is based on the Korea Youth Risk Behavior Survey (KYRBS), a nationally representative annual cross-sectional survey of middle and high school students in South Korea published by Korea Center for Disease Control and Prevention. The sampling has a stratified cluster design, in which the nation is divided into 110 strata, and each stratum is

allocated a sampling quota based on the number of secondary schools and classes. This way, a total of 800 schools are sampled each year from a little more than 5600 schools in the population. Within each sampled school, one class is sampled from each of the three grades, and the entire class gets to fill out an online survey in the school computer room. The average response rate in each class was around 95%. For increased power, I combine the data for 2017-2019, which produces a dataset with 179619 students nested in 2399 schools. The median number of students sampled in a school was 75, with 56 and 92 representing the .1 and .9 quantiles, respectively. Most variables in the dataset, including all those that were used for the statistical analysis of this paper, had no missing values since students were required to answer all questions in the online survey except in 2019 when students were allowed to skip a handful of highly confidential questions. Given the excellent data availability, variable choice was not affected by concerns about missing data.

1.2.2. Variables

Recent Suicidal Ideation: The dependent variable is a dichotomous measure of recent suicidal ideation based on the survey question, "In the past 12 months, have you ever seriously thought of committing suicide?" with a yes/no response.

Perceived usual stress: This variable is based on a five-point Likert-scale response to the survey question, "Normally, how much stress do you feel?", with possible responses being "do not feel any," "not much," "some," "high", and "very high." Despite the word "normally" (or "usually"), responses to this question are most likely strongly affected by the adolescent's *recent* perceived stress at the time of the survey; yet, psychological well-being, of which stress is a major component, is known to have a strong diachronic continuity (Kokko et al. 2013), and this

variable is likely indicative of the cumulative psychological adversity experienced by each adolescent.

Self-rated family economic status: This variable is based on a five-point Likert-scale response to the survey question, "How is the economic status of your family?", with possible responses being "low," "mid-low," "mid," "mid-high," and "high." This will be only a rough indicator of the objective amount of wealth possessed by the family, but it is expected that it would more closely reflect the quality of the ecological environment that the adolescent had been brought up in.

Recent experience of severe grief or despair: This variable is based on the survey question, "In the past 12 months, have you ever experienced grief or despair severe enough to stop you from having a normal life for two weeks?" with a yes/no response.

Recent experience of receiving clinical treatment after exposure to violence: This variable is based on the survey question, "In the past 12 months, have you ever received treatment in a clinic or hospital due to violence from friends, senior students, or adults?" In the survey, there are seven possible responses to choose from, each indicating the number of times of receiving treatment, ranging from *never* to *six times or more*. I transform this into a dummy variable with zero indicating the absence of such an experience and one the presence thereof. Despite some loss of information, several reasons justify the binary coding: The log-odds of suicidal ideation soar going from *never* to *once* but increases slowly thereafter; sample size rapidly decreases as the number of times increases; the statistical interaction with stress or family economic status—each coded as a categorical variable with four dummies—calls for a relatively simple coding of the proximal stressor. This variable can be expected to measure relatively

traumatic cases of being affected by violence since receiving medical treatment indicates nontrivial physical injury and likely incurs considerable social stress for adolescents.

It is unlikely that there is any important class discrepancy in access to medical treatment in South Korean society, especially concerning the kind of treatment one would need for most cases of violence. Universal healthcare and a series of equalizing policies implemented over the past couple of decades greatly increased healthcare accessibility for lower classes (Kim et al. 2018). A 2014 study found a high degree of class equality in the frequency of receiving medical treatment even after adjusting for need (Kim et al. 2014).

Four additional variables are used as covariates in all regression models. *Self-rated health* is a five-point Likert-scale item ranging from "very bad" to "very good." As the effects were roughly linear, it was coded as a continuous variable and standardized. *Female* is a dummy variable with zero indicating boys and one indicating girls. The sex ratio was nearly even in the overall sample. *Grade* has six levels in total (grades 7-12, typically 13-18 years old). Although the effects of grade were not linear or even strictly monotonic, there were negligible differences in model fit or the coefficients of the focal independent variables depending on whether grade is included as a continuous variable or as a categorical variable, so the former coding was chosen for simplicity. There were minimal differences in the number of students in each grade. Finally, *residential type* – coded as a four-category nominal variable with possible values being "living with family," "living away from home in a dormitory/studio," "living in a relative's house," and "living in a nursery/orphanage" was included as a covariate. Living with family, which was set as the reference category, was by far the most common residential type applicable to around 95 percent of the respondents (dorm/studio 4.48%; relative's house 0.67%; nursery/orphanage 0.26%). Additional individual- and group-level control variables were explored such as academic

performance, school type by vocational curricula, school urbanicity, short-term sleep deprivation, and physical exercise but excluded from the final presentation due to very small effect sizes and the lack of change in the coefficients of the independent variables of theoretical interest.

1.2.3. Analytical Strategy

A series of logit regressions are conducted with particular attention to the interaction between perceived usual stress and each type of psychosocial crisis. The results of population-averaged models are first presented, followed by analogous multilevel models. The population-averaged models identify the associations that hold across the national adolescent population and establish the main finding of this paper. The multilevel models are a supplementary exercise that checks whether the same pattern also holds within more local groupings and whether stress has any "contextual" effects on suicidal vulnerability at the school level. The same analyses are repeated with self-rated family economic status instead of stress, and the results are presented side-by-side for easy comparison at each stage of the analysis. A supplementary file contains an annotated, fully replicable R script displaying the output for all quantitative analyses included in this paper starting from raw data.

1.3. Results

Fig 1.1. Distribution of key variables

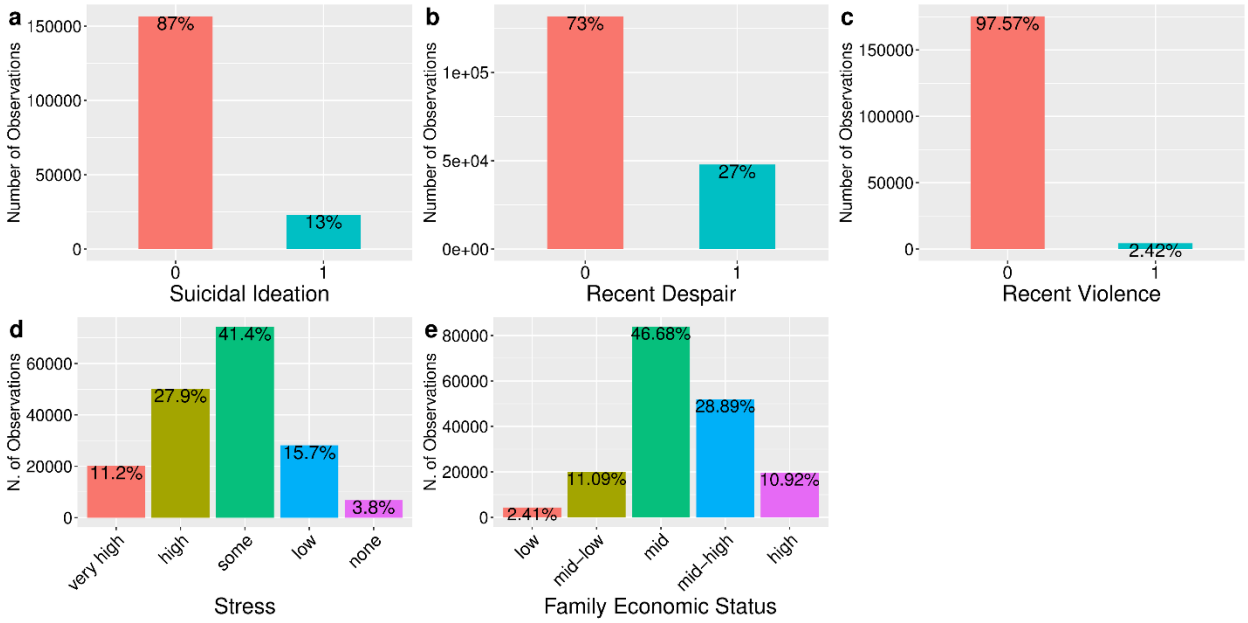


Table 1.1. Polychoric correlation among key variables

Variables	(1)	(2)	(3)	(4)	(5)
(1). (DV) Suicidal Ideation	1				
(2). Recent Despair/Grief	0.698	1			
(3). Recent Violence	0.352	0.286	1		
(4). Perceived Stress	0.538	0.532	0.107	1	
(5). Self-rated Family Economic Status	-0.124	-0.099	-0.004	-0.142	1

1.3.1. Population-averaged models

Table 1.1 and Fig 1.1 summarize the distribution of and correlations among the key variables. Using this data, five population-averaged models were fitted with the svyglm() command in the "survey" package for R (Lumney 2020). Model (1) contains all independent variables with no interaction term; model (2) adds interaction terms between perceived usual stress and experience

of severe despair in the past 12 months; model (3) repeats the previous one but uses recent experience of violence as the type of crisis; models (4)-(5) repeat the previous two models using family economic status in lieu of stress. Stress and economic status were entered into the regressions as categorical variables with the middle category ("some" stress and "mid" economic status) as the reference. This coding choice results from the theoretical postulation that it is currently impossible to assume with confidence any particular shape of the interaction effects – I am leaving it as an open question that is to be determined by the large data (because of the very large sample size, there was an ample number of observations in each cross-section. Even the smallest cross-section—recent experience of violence and no stress—had 333 observations). The equation for, for example, model (3), which involves an interaction between violence in the past 12 months and usual stress, can be written as:

$$\begin{aligned}\text{logit}(\text{P}(\text{Y}=1)) = {} & \beta_0 + \beta_1 VIOLENCE + \beta_2 STRESSveryhigh + \\ & \beta_3 STRESShigh + \beta_4 STRESSlow + \beta_5 STRESSnone + \\ & \beta_6 VIOLENCE * STRESSveryhigh + \beta_7 VIOLENCE * \\ & STRESShigh + \beta_8 VIOLENCE * STRESSlow + \\ & \beta_9 VIOLENCE * STRESSnone + \text{other covariates}\end{aligned} \tag{1.1}$$

The right-hand side of Equation 1.1 can be rearranged to highlight the "slope" of violence more clearly:

$$\begin{aligned}&\text{logit}\big(\text{P}(\text{Y}=1)\big) \\ &= (\beta_1 + \beta_6 STRESSveryhigh + \beta_7 STRESShigh + \beta_8 STRESSlow \\ &+ \beta_9 STRESSnone) * VIOLENCE + \beta_2 STRESSveryhigh \\ &+ \beta_3 STRESShigh + \beta_4 STRESSlow + \beta_5 STRESSnone \\ &+ \text{other covariates}\end{aligned} \tag{1.2}$$

Table 1.2. Population-averaged models, output

	Dependent variable: logit(P(Suicidal Ideation=1))				
	(1)	(2)	(3)	(4)	(5)
Recent despair/grief	1.90***	2.20***	1.88***	1.87***	1.90***
	(1.86, 1.93)	(2.14, 2.27)	(1.85, 1.92)	(1.82, 1.92)	(1.86, 1.93)
Recent violence	1.14***	1.05***	1.41***	1.13***	1.03***
	(1.05, 1.22)	(0.97, 1.13)	(1.27, 1.56)	(1.05, 1.22)	(0.89, 1.17)
STRESS "none"	-0.15*	-0.80***	-0.46***	-0.14*	-0.16*
	(-0.28, -0.03)	(-1.04, -0.56)	(-0.63, -0.28)	(-0.27, -0.01)	(-0.29, -0.04)
STRESS "low'	-0.61***	-0.92***	-0.72***	-0.60***	-0.61***
	(-0.70, -0.52)	(-1.05, -0.79)	(-0.82, -0.62)	(-0.69, -0.52)	(-0.70, -0.52)
STRESS "high"	0.87***	1.17***	0.90***	0.87***	0.87***
	(0.83, 0.91)	(1.11, 1.24)	(0.86, 0.94)	(0.83, 0.91)	(0.83, 0.91)
STRESS "very high"	1.58***	1.94***	1.63***	1.58***	1.58***
	(1.53, 1.63)	(1.86, 2.02)	(1.58, 1.68)	(1.53, 1.63)	(1.53, 1.63)
Econ Status "low"	0.47***	0.45***	0.46***	0.41***	0.45***
	(0.38, 0.56)	(0.36, 0.54)	(0.37, 0.55)	(0.26, 0.57)	(0.35, 0.54)
Econ Status "mid-low"	0.31***	0.30***	0.31***	0.40***	0.31***
	(0.26, 0.36)	(0.25, 0.35)	(0.26, 0.35)	(0.32, 0.48)	(0.26, 0.36)
Econ Status "mid-high"	0.01	0.01	0.01	-0.06+	0.01
	(-0.03, 0.05)	(-0.03, 0.05)	(-0.03, 0.05)	(-0.12, 0.01)	(-0.03, 0.04)
Econ Status "high"	0.07*	0.07*	0.07*	-0.06	0.04
	(0.01, 0.13)	(0.01, 0.12)	(0.01, 0.13)	(-0.16, 0.04)	(-0.02, 0.10)
Perceived health	-0.24***	-0.24***	-0.24***	-0.24***	-0.24***
	(-0.26, -0.22)	(-0.25, -0.22)	(-0.25, -0.22)	(-0.26, -0.22)	(-0.26, -0.22)
School grade	-0.11***	-0.11***	-0.11***	-0.11***	-0.11***
	(-0.12, -0.10)	(-0.12, -0.10)	(-0.12, -0.10)	(-0.12, -0.10)	(-0.12, -0.10)
Female	0.22***	0.22***	0.22***	0.22***	0.22***
	(0.18, 0.26)	(0.18, 0.25)	(0.18, 0.25)	(0.18, 0.26)	(0.18, 0.25)
Living in relative's house	0.48***	0.43***	0.39***	0.48***	0.50***
	(0.31, 0.65)	(0.26, 0.60)	(0.23, 0.56)	(0.31, 0.65)	(0.33, 0.67)

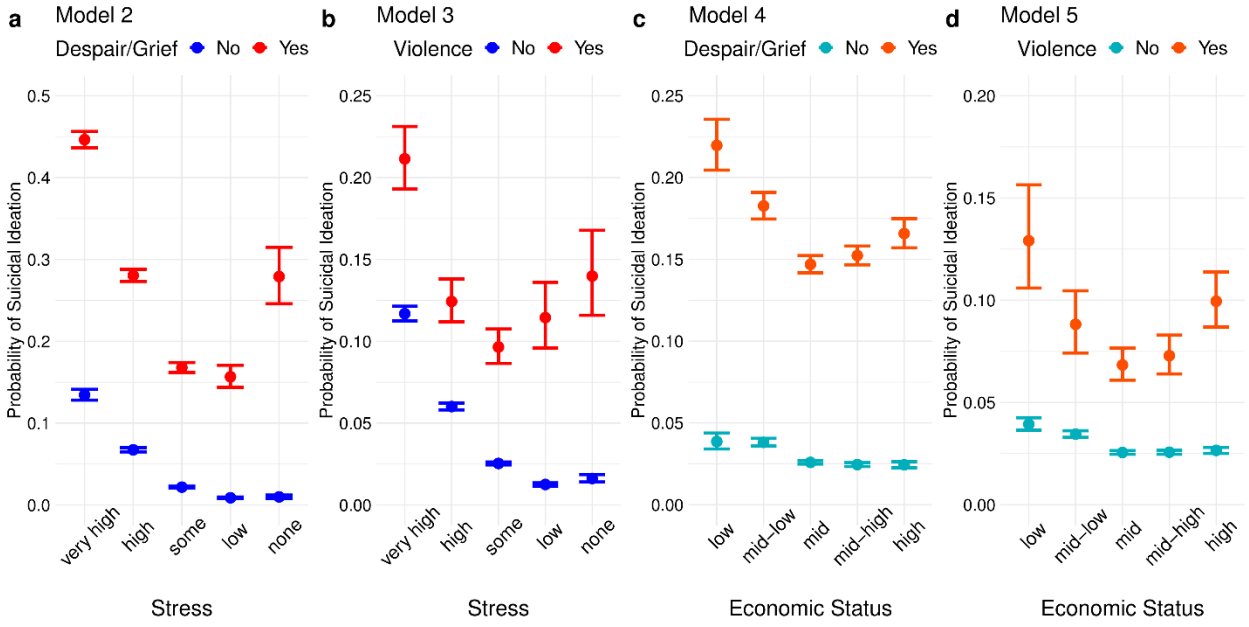
Living in a dorm/studio	0.14***	0.12**	0.12**	0.14***	0.14***
	(0.06, 0.22)	(0.04, 0.20)	(0.04, 0.20)	(0.06, 0.22)	(0.06, 0.22)
Living in a nursury/orphange	0.26+	0.20	0.24+	0.25+	0.23+
	(-0.002, 0.53)	(-0.06, 0.46)	(-0.01, 0.49)	(-0.01, 0.52)	(-0.04, 0.50)
Despair x stress "none"		1.45***			
		(1.12, 1.78)			
Despair x stress "low"		0.83***			
		(0.65, 1.01)			
Despair x stress "high"		-0.52***			
		(-0.60, -0.43)			
Despair x stress "very high"		-0.56***			
		(-0.65, -0.46)			
Violence x stress "none"			0.88***		
			(0.53, 1.22)		
Violence x stress "low"			0.91***		
			(0.62, 1.20)		
Violence x stress "high"			-0.61***		
			(-0.82, -0.41)		
Violence x stress "very high"			-0.70***		
			(-0.90, -0.51)		
Despair x Econ Status "low"				0.08	
				(-0.11, 0.26)	
Despair x Econ Status "mid-low"				-0.14**	
				(-0.24, -0.04)	
Despair x Econ Status "mid-high"				0.10*	
				(0.01, 0.18)	
Despair x Econ Status "high"				0.20***	
				(0.08, 0.32)	
Violence x Econ Status "low"					0.26+
					(-0.04, 0.55)
					-0.03

Violence x Econ Status "mid-low"					(-0.29, 0.23)
Violence x Econ Status "mid-high"					0.06 (-0.16, 0.28)
Violence x Econ Status "high"					0.37** (0.14, 0.60)
Constant	-3.65*** (-3.69, -3.60)	-3.80*** (-3.86, -3.75)	-3.65*** (-3.69, -3.60)	-3.63*** (-3.68, -3.58)	-3.64*** (-3.68, -3.60)
Observations	179,619	179,619	179,619	179,619	179,619
Akaike Inf. Crit.	101,007.60	100,505.80	100,810.50	100,988.00	101,003.30
Note:			+ p<0.1; * p<0.05; ** p<0.01; *** p<0.001		

The regression results are presented in Table 1.2. The model without any interactions (model 1) had the worst fit but provides a simple model that allows easy comparison with previous research. The results of model 1 (main effects only) reveal that experience of severe grief or despair and receiving medical treatment due to violence in the past 12 months, *qua* proximal stressors, strongly increase the odds of suicidal ideation as is consistent with theoretical expectations as well as previous research (Zimmerman 2013; Wang et al. 2012). In addition, there is a nearly monotonically positive relationship between stress and suicidal ideation, confirming the common understanding that higher stress is a risk factor for suicidal thought (Shang et al. 2014; Kuiper et al. 1986). Likewise, lower perceived economic status was generally associated with higher odds of suicidal ideation (Shang et al. 2015), although there were negligible differences among the top three categories ("mid," "mid-high," and "high"). This is consistent with previous research that identified poverty as a risk factor for suicidal outcomes (Dupéré et al. 2009, Hoffman et al. 2020; Bantjes et al. 2018). Overall, the main-effects-only model presents no surprise and repeats conventional knowledge.

When interaction effects are added to the base model, however, the results start to appear more surprising. Models 2-3 show that, when either type of psychosocial crisis occurs, having a higher level of perceived stress does not necessarily lower the odds of suicidal ideation, and models 4-5 show similar results for self-rated economic status (The regression coefficients of the interaction terms, analogous to β_6-β_9 in Equations 1 and 2, are visualized in S1 Fig in the online supplementary material). Fig 1.2 visualizes the predicted probability of suicidal ideation for each category of stress or economic status, in the presence and absence of crisis exposure in the past 12 months, with all non-interacted covariates set to zero or the reference category. For model 2, for example, this amounts to a hypothetical student with no experience of receiving medical treatment due to violence in the past 12 months, "mid" perceived family economic status, average perceived health, male, living with family, and in 9th or 10th grade (15-16 years of age). In all four models, what looks like a slightly bent downward-sloping line in the absence of severe despair in the past 12 months is transformed into a clear quadratic shape in the presence thereof. It is to be noted that, in all four models, the absolute probability of suicidal ideation is still the highest among those with the highest stress and lowest economic status.

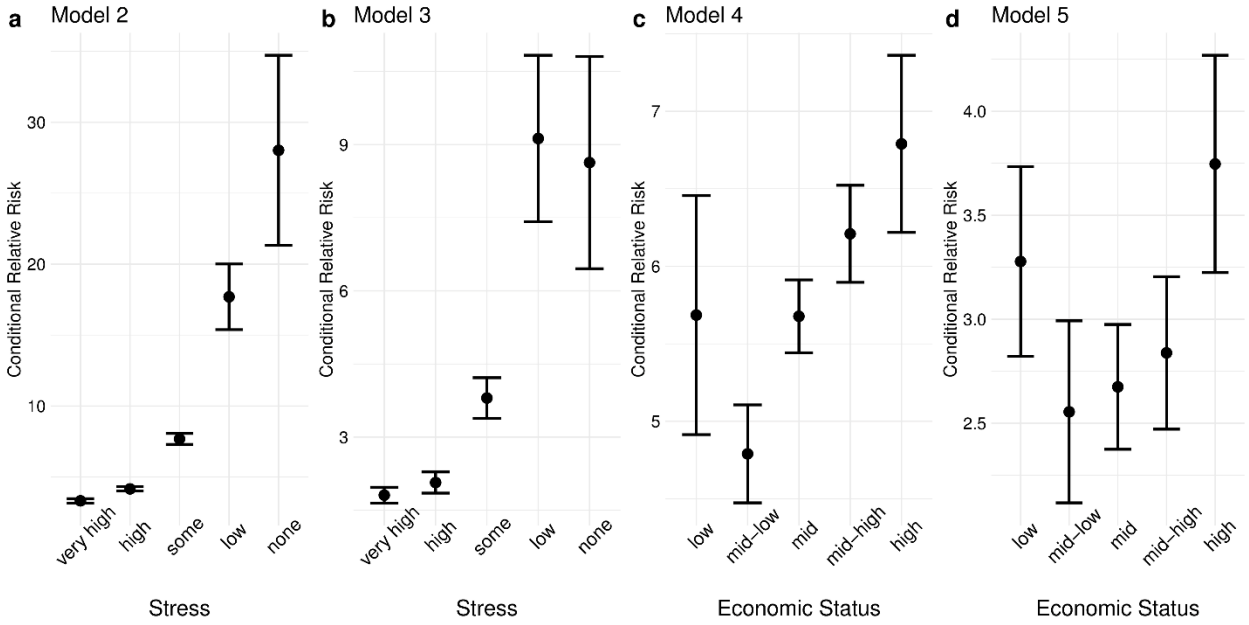
Fig 1.2. Predicted probabilities for each category of stress and economic status



Note: All variables not involved in the interaction were set to zero or the reference category. Error bars indicate 90% confidence intervals.

Figs 1.3 and 1.4 directly visualize additive and multiplicative interaction effects in a probability scale using the results shown in Fig 1.2. Insofar as suicidal vulnerability can be operationalized as interaction effects, Figs 1.3 and 1.4 represent two alternative conceptions of suicidal vulnerability. Fig 1.3 repeats Fig 1.2 but with relative rather than absolute risk. It shows the ratio of the dot below to the dot above in Fig 1.2 and represents multiplicative interaction effects in a probability scale. Relative risk increases strongly and nearly monotonically as one goes from the highest to the lowest level of stress, indicating that exposure to either type of crisis, compared to non-exposure, multiplies the probability of suicidal ideation by a larger number at lower levels of usual stress. A similar pattern is seen for family economic status, although there is an abrupt reversal in the worst (lowest) category. Note that the pattern in relative risk is similar to the pattern in the regression coefficients of the interaction terms presented in Table 1.1 and S1 Fig.

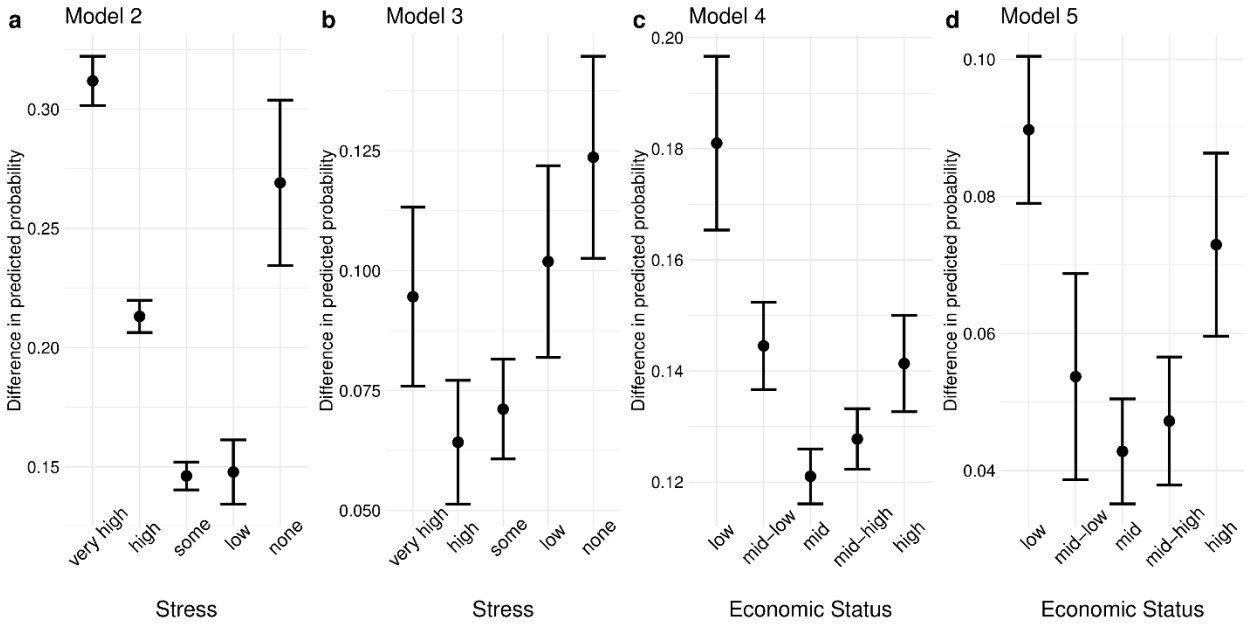
Fig 1.3. Relative risk for each category of stress and economic status



Note: All covariates not involved in the interaction were set to zero or the reference category. Standard errors were estimated with the delta method. The error bars indicate 90% confidence intervals.

Fig 1.4 plots the *difference* in the predicted probabilities shown in Fig 1.2, i.e. the distance between the dot above and the dot below. This represents additive interaction effects in a probability scale. The difference tends to be the smallest at or near the middle category and gets wider towards the extremes, indicating that exposure rather than non-exposure to a crisis increases the probability of suicidal ideation by the smallest margin at or near the middle category and by larger margins at the lowest and highest categories.

Fig 1.4. Risk difference for each category of stress and economic status



Note: All covariates not involved in the interaction were set to zero or the reference category. Standard errors were estimated with the delta method. Error bars indicate 90% confidence intervals.

Several diagnostics were conducted to check the robustness of the findings. First, two additional models that interact each type of crisis with *both* stress and economic status were run and plotted (plot shown in S2 Code). The patterns presented so far remained largely unchanged. Second, the above-visualized interaction effects were checked by dropping control variables one at a time. The general shape of the interaction graphs remained largely similar throughout the variation in the controls. In addition, an examination of variance inflation factors (VIF) revealed low levels of data-based collinearity, and even most interaction terms had unproblematic levels of VIF (<5). The interaction terms between the two highest categories of perceived usual stress and severe despair in the past 12 months had a VIF that slightly exceeded 5 (5.6 and 5.9, respectively).

1.3.2. Multilevel Models

The above analysis reveals how the association between crisis and suicidal ideation varies by different levels of stress and by different levels of economic status across the national population. Does the same pattern also hold within more local groupings? When a population is divided into clusters, the variation in a raw individual-level variable is a conflation of within-cluster and between-cluster variation, and the corresponding regression coefficient will also reflect a blend of within-group and between-group relationships (Enders and Tofighi 2007). For example, it is conceivable that the above population-averaged analysis found adolescents with high perceived economic status to be especially vulnerable to a crisis at the national level because adolescents going to schools with a high proportion of students who think they are well-off are more vulnerable to a crisis than those going to schools where lots of students feel poor, without there being the same kind of association within each school or neighborhood.

To examine how much the pattern observed in the national population is repeated within schools, I rerun models 2-5 as multilevel models. In each, the binary crisis variable is cluster-mean centered to reflect within-cluster variation screened off from between-cluster variation (Enders and Tofighi 2007; Snijders and Bosker 2012). The coefficient of the cluster-mean-centered variable for recent violence, for example, now represents the within-school association between suicidal ideation and recent violence. The five-category moderating variables, on the other hand, were entered into the regressions as raw dummies together with the school mean. Model (2), which was expressed by Equation 1.2 in the previous section, is now modified as:

$$
\begin{aligned}
&\text{logit}\big(\text{P}(\text{Y}=1)\big) \\
&\quad = \big(\beta_1 + \beta_7 STRESSveryhigh + \beta_8 STRESShigh + \beta_9 STRESSlow \\
&\quad + \beta_{10} STRESSnone + \beta_{11} STRESSsch.mean + u_{1j}\big) \\
&\quad * VIOLENCE_{within} + \beta_2 STRESSveryhigh + \beta_3 STRESShigh \\
&\quad + \beta_4 STRESSlow + \beta_5 STRESSnone + \beta_6 STRESSsch.mean \\
&\quad + \text{other covariates} + u_{0j}
\end{aligned}
\tag{1.3}
$$

The "slope" *S* of within-cluster centered violence, i.e. the part within parentheses, is now a function of not just individual-level stress but also school-mean stress (plus the school-specific slope random effect u_{1j}). β_7 through β_{10} represent the moderating effect of each stress category (vis-à-vis the reference category) on the within-school association between exposure to violence and suicidal ideation. β_{11} – the interaction coefficient between school mean stress and within-cluster centered violence – represents the moderating effect of school mean stress above and beyond the moderating effect of individual-level stress (Enders 2013), analogous to what is often called "contextual effect" in multilevel modeling, except that it is now applied to a moderation context. The school mean was computed by treating stress as a continuous variable (and likewise for economic status).

This modeling strategy marks a contrast with many previous works that employed multilevel regression to analyze the effect of "contextual" variables (such as group-mean stress) on suicidal vulnerability. Virtually all previous research of this kind examines the moderating effect of a contextual or climate variable by allowing the slope of the proximal stressor to vary as a function of the group-mean of the moderator variable but *not* the disaggregated individual-level moderator variable, that is, by having a cross-level interaction between the aggregated moderator variable and the individual-level proximal stressor without a corresponding individual-level

interaction term (Maimon and Kuhl 2008; Dupéré et al. 2009; Cutrona et al. 2005; Kim and Chang 2018). In Equation 1.3, this would correspond to omitting the four individual-level dummies for stress from the interaction with violence, i.e. fixing $\beta_7 - \beta_{10}$ to zero, and making inferences about the school-level contextual effect of stress on suicidal vulnerability based on β_{11}. Such a modeling strategy is completely unable to discriminate between the scenario in which the association between suicidal ideation and the proximal stressor varies in response to individual-level stress while remaining indifferent to the climate measured by group-mean stress and an alternative scenario in which it varies in response to such a climate while remaining indifferent to individual-level stress. Equation 1.3 is designed to capture the moderating effect of group-mean stress while accounting for the moderating effect of individual-level stress: If β_{11} in Equation 1.3 is nonzero, it would indicate that two adolescents who have the same individual-level perceived stress but who differ in the average stress of their schoolmates would systematically differ in their strength of the association (as operationalized by the "slope" in Equation 3) between the recent occurrence of the proximal stressor and suicidal ideation.

The group means (required for group-mean centering) of the dummy variables for each type of crisis were estimated under partial pooling rather than computed as an arithmetic average under no pooling to avoid bias (Lüdtke et al. 2008). One way to estimate them under partial pooling is to run an intercept-only two-level logit regression and take the group-level residuals u_j (Maimon and Kuhl 2008; Shin and Raudenbush 2008; McElreath 2020).

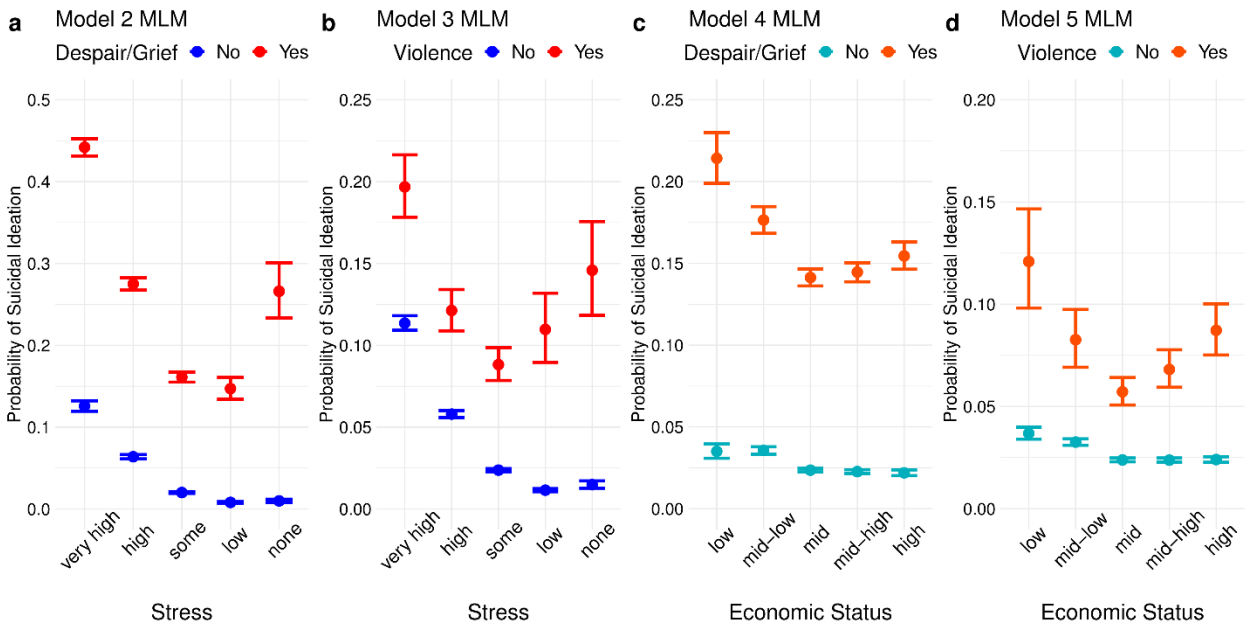
For individual *i* in school *j*,

$$\begin{aligned} \text{Crisis}_{ij} &\sim \text{Bernoulli}(p_{ij}) \\ \text{logit}(p_{ij}) &= \alpha_j = \overline{\alpha} + u_j \\ u_j &\sim \text{Normal}(0, \sigma) \end{aligned} \tag{1.4}$$

Likewise, the cluster means of stress and economic status were estimated by coding them as continuous variables and running a two-level intercept-only mixed-effects regression similar to Equation 1.4 but with an identity link instead of logit. The cluster means of stress and economic status were standardized to have a standard deviation of 1.

Each crisis variable was allowed a random slope, which is represented by the random effect u_{1j} in Equation 3. Estimation was implemented with the "brms" package, a convenient R interface to Stan (Bürkner 2018; Carpenter et al. 2017). Convergence was not an issue, with all R-hat values well under 1.05. Weakly regularizing priors were used for all regression parameters.

Fig 1.5. Predicted probability by each category of stress and economic status, multilevel models



Note: All covariates not involved in the interaction terms were set to zero or the reference category. Random effects were set to zero. Error bars indicate 90% credible intervals

Fig 1.5 shows the predicted probabilities for each crisis-stress and crisis-economic status interaction. There is little difference between Fig 1.5 and Fig 1.2, indicating that the unexpected interaction effects seen in the national population also hold within local groupings. Indeed, the regression coefficient of the interaction term involving school mean stress or school mean economic status (analogous to β_{11} in Equation 1.3), as well as the corresponding main effects (analogous to β_6 in Equation 1.3), were close to zero in all four models. The full results of the multilevel models are shown in S2 Code.

Overall, the above population-averaged and multilevel analysis suggests that stress, and to a lesser but still considerable extent economic status, statistically interact with psychosocial crisis and moderate its association to suicidal ideation. Contra Durkheim, their moderating effects seem to be operating mainly in virtue of individual-level perceived stress and economic status, and school-average perceived stress or economic status provides relatively little information on an adolescent's vulnerability to suicidal ideation once the corresponding individual-level variable is taken into account.

1.4. Discussion

Previous research on suicidal vulnerability largely worked under the assumption that adolescents living in adverse psychosocial circumstances are generally more vulnerable to the suicide-inducing effects of a crisis. Within suicidology, this paper presents a first attempt to pose a theoretical and empirical challenge to such an assumption. Starting from the theoretical intuition that such a relationship may not always hold, using a large nationally representative sample of South Korean adolescents, I ran a series of logit regressions with a special focus on exploring non-linear interactions between a proximal stressor and self-rated stress or self-rated family economic status for predicting suicidal ideation. The most basic model without any interaction

terms reconfirmed the conventional knowledge that higher stress and lower family economic status increase the risk of adolescent suicidal ideation. Yet, an exploration of complex and nonlinear interaction effects showed that *lower* usual stress *strengthens* the association between exposure to severe despair or violence in the past 12 months and suicidal ideation when the association is conceptualized in terms of relative risk (Fig 1.3). A largely similar pattern was observed with self-rated family economic status in lieu of stress except for the sudden reversal in the lowest category. Speaking in terms of absolute probability, for both stress and economic status, the predicted probability of suicidal ideation made a clear U- or J-shape given the occurrence of either type of crisis (Figs 1.2 and 1.5). This is in stark contrast with the predicted probabilities in the absence of a crisis that (nearly) monotonically decreases with improving levels of stress or economic status. The difference in the predicted probabilities is the smallest somewhere around the middle category of stress and economic status and gets wider closer to the extremes, indicating a U-shaped additive interaction effect (Fig 1.4). In sum, both in terms of relative risk and risk difference, it is not necessarily the case (or, it is often not the case) that being in a higher stress category or having a lower perceived family economic status strengthens the association between recent crisis and suicidal ideation.

These results may potentially be explained by the burgeoning psychological literature on stress inoculation: Having been exposed to considerable psychological or ecological life adversity results in mental resilience in the face of adverse stimuli, except at sufficiently high levels of exposure that tend to result in vulnerability rather than resilience. The general upward trend in relative risk by improving levels of stress or economic status (Fig 1.3) is consistent with the theory that having lived a life with low levels of adversity and few opportunities for steeling leads to vulnerability for adolescents. The sudden reversal at the lowest category of economic

status is indicative of mental attrition for adolescents who are continuously exposed to the worst socioeconomic circumstances that do not allow for steeling, a finding that is especially salient considering the high base rate of suicidal ideation in this category. The pattern in risk difference (Fig 1.4) is also consistent with the insight that moderate levels of life adversity lead to steeling, while extremities in either direction result in weakness.

These findings unmistakably go against the prevalent understanding of suicidal vulnerability, but its discrepancy with the existing empirical literature should not be overstated. As for stress, there is a paucity of empirical research that directly examines the relationship between stress and vulnerability to suicide-related outcomes in the face of a crisis, and the widespread understanding of a monotonically positive association appears to be an assumption rather than knowledge with a thorough empirical justification. There is a slightly more sizable accumulation of research on how one's vulnerability to suicidal outcomes (or depression) in the face of proximal stressors are moderated by one's (socio)economic status. However, these works either focus on poverty (Dupéré et al. 2009; Cutrona et al. 2005) or study the effect of economic status across its entire range but model interaction effects linearly (Verbeek et al. 2019). The finding that a low (when measured in relative risk/odds) or low and medium-low (when measured in risk difference) level of self-rated family economic status strengthens the association between recent crisis and suicidal ideation is consistent with previous research that found that poverty is positively associated with suicidal vulnerability.

Finally, a mention should be made about the KYRBS dataset used for this study. It has a clear advantage over most other public health surveys in terms of size, response rate, and missing values. The large size enabled fitting a complicated regression model without having to assume any particular shape of the main and interaction effects *ex-ante*. However, it is also the source of

many of the limitations of this paper. The most conspicuous problem is that it lacks the precise and/or time-varying measurements compared to many other public health datasets and offers relatively rough measurements at the individual level. Notably, some variables such as family suicide and previous suicide attempt were unavailable. Although the stability of the U-shaped pattern through a large variety of controls suggests this is a robust relationship, the lack of certain controls leaves room for additional verification. As a related issue, the proposed causal mechanisms responsible for the rather surprising findings are speculative and will require a dataset with more purposefully designed variables for verification. All these limitations call for further research using different datasets collected from other populations. Still, the clarity and consistency of the patterns in the absolute and relative probabilities of suicidal ideation for each category of perceived stress and economic status reported above strongly suggests that the relationship between psychological or economic adversity and vulnerability to suicidal outcomes is more complex than is often assumed in the existing literature.

Supplementary material

S1 Fig. Logit regression coefficients of interaction terms

S1 Code. Annotated R script presentation in .html format for replication

https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0250794

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Foreword to Chapter 2

In Chapter 1, I provided preliminary empirical evidence, showing that lower family socioeconomic status may in some cases be associated with higher resilience to traumatic events. This finding challenges conventional scholarly wisdom, and I suggested Stress Inoculation Theory and Generalized Strain Theory as potential explanations for this contrast.

A paper by Barzilay et al. (2021), published in the same year as the first chapter of this dissertation, presented a similar empirical finding. Barzilay et al. examined young adults in the United States and found that those in the lowest SES tertile experienced a larger increase in the probability of suicidal ideation in response to assaultive trauma than those in the upper two SES tertiles. The authors suggested Stress Inoculation Theory as a potential explanation, arguing that "some environmental exposures in low SES neighborhoods might be associated with a degree of stress inoculation effect" (Barzilay et al. 2012, p.6).

These two studies (the one by Barzilay et al. and my own) directly challenge the prevalent understanding in suicidology and more generally in the study of mental health that views lower SES as a condition that decreases psychological resilience. However, more research is needed to clarify the link between SES and psychological resilience, especially considering the methodological limitations of these two papers. Both my preliminary study and that of Barzilay et al. were notably based on cross-sectional data, preventing the establishment of chronological order between the proximal stressor and the outcome variable. In addition, Barzilay et al. (2021) used cumulative lifetime assaultive trauma (rather than recent trauma), obscuring the nature of the statistical association between assaultive trauma and suicidal ideation.

In Chapter 2, I tackle these challenges, examining how the interaction between family economic status and victimhood of bullying predicts suicidal ideation using a longitudinal

dataset on South Korean adolescents. The goal of this chapter is to see if the unconventional results of Chapter 1 can be replicated using a separate dataset with time-varying measurements of the dependent variable.

Article 2. Family economic status and resilience to suicidal ideation among adolescents: A reexamination of recent findings

Background: Until recently, virtually all empirical research on the social determinants of resilience reported that adverse socioeconomic circumstances reduce resilience to mental disorders. However, two recent papers found that lower-SES adolescents may be more resilient to suicide in the face of negative life events, suggesting a process of stress inoculation.

Objective: I re-examine these recent findings using yearly longitudinal public survey data from South Korea. I adopt the basic theoretical insights of the stress-diathesis model but suggest a modified interpretation based on relevant developments in the study of psychological resilience.

Participants and Setting: This is a secondary data analysis that includes 2884 high school students from South Korea.

Methods: I follow the basic insight of the stress-diathesis model that explains the onset of mental disorders as an interaction between a proximal stressor and background vulnerability conditions or "diathesis." Multiple logistic regression is used to examine the association between suicidal ideation and a range of predictor variables, with a particular focus on the interaction between bullying victimhood and log family income.

Results: As expected, bullying victimhood increases the odds of suicidal ideation (OR =2.09, p=0.039). Bullying victimhood has a positive interaction with log family income (OR=2.91, p=0.009), indicating that students from wealthier backgrounds exhibit a larger increase in the predicted probability of suicidal ideation in the face of bullying. The results were robust to changes in the range of control variables. However, using a different – and less conventional –

cutoff for suicidal ideation produced nonsignificant results, suggesting that further research is needed.

Keywords: Stress-diathesis model; stress inoculation; resilience; suicidal ideation; bullying

2.1. Introduction

In social studies of mental health, it is common to posit that living in stressful, deprived, poor, and generally adverse socioeconomic conditions exerts a negative effect on mental health. This view is buttressed by a large empirical literature that finds a negative association between socioeconomic status (SES) and the risk of various mental health disorders (Eaton et al. 1999; Hudson 2005; McLaughlin et al. 2012). While considerably smaller than the study of risk, the literature on resilience has also viewed low SES as a factor that reduces individuals' resilience to psychopathological outcomes in the face of proximal stressors. This view has been buttressed by a rather small but consistent body of empirical research, which found that socioeconomic deprivation amplifies the effect of episodic stress on mental health issues such as suicidal behavior and depression (Cutrona et al. 2005; Dupéré et al. 2009; Verbeek et al. 2019; Zimmerman 2013).

Yet, the psychological literature on resilience has long paid serious attention to the possibility that repeated exposure to stressful experiences may exert a positive effect on mental health by building resilience (Başoğlu et al. 1997; Diestbier 1989; Fletcher and Sarkar, 2013; Katz et al. 2009; Rutter 1993; Liu 2015; Lyons and Parker 2007). Research efforts have often focused on the mental health of young adults and adolescents, for whom cumulative childhood adversity is reported to foster mental resilience in the face of episodic stress through a process of "inoculation" (Hagan et al. 2014; Luecken and Gress 2010; Mortimer and Staff 2004; Schweizer et al. 2016; Seery et al. 2013). Evidence for stress inoculation has been reported for a wide range

of substantive mental health issues including life satisfaction, PTS symptoms, functional impairment (Seery et al. 2010), self-esteem (Mortimer and Staff, 2004), self-efficacy (Mortimer and Staff 2004), and depressive symptoms (Mortimer and Staff 2004; Shapero et al. 2016).

It well established that socioeconomic status correlates with exposure to various ecological stressors, which, according to stress inoculation theory, may strengthen psychological resilience upon repeated exposure (Boyce and Ellis 2005; Seery et al. 2010). It is therefore possible that lower SES may, at least in some cases, have a protective effect on the onset of mental health issues. However, as opposed to socioeconomic risk factors which are extensively studied, the socioeconomic determinants of resilience are less well understood and buttressed by a much smaller body of literature. And even this small body of literature has consistently confirmed the traditional understanding that associates lower SES with reduced psychopathological resilience.

However, two very recent papers—one using data on American young adults and the other on South Korean teens— independently presented preliminary evidence for a lower resilience to suicidal ideation in the face of psychosocial trauma among individuals with higher SES compared to those with lower SES (Barzilay et al. 2021; Jeong 2021). One of these papers additionally reported a highly similar pattern for perceived stress, such that those who report the lowest levels of chronic stress were found to exhibit relatively large additive and multiplicative increases in the risk of suicidal ideation in the presence of a recent negative life event (Jeong 2021). These two papers challenge the predominant understanding of the social correlates of suicidal resilience but suffer from several technical limitations such as the use of cross-sectional data. The dearth of similar empirical findings and the existence of prior research that reports opposite patterns also preclude confident conclusions and call for additional research.

The current paper is structured as follows. First, I review the relevant theoretical frameworks used for the study, namely, the stress-diathesis model, stress-inoculation theory, and the "bi-dimensional" framework of resilience. The study design is fundamentally based on the stress-diathesis model, but the model is interpreted in a way that incorporates insights from the two other theories. Second, using longitudinal survey data on South Korean adolescents, I examine if the revisionary findings presented by the two recent papers can be replicated. I conclude with a brief discussion of the theoretical and policy implications of the results.

2.2. Theory

2.2.1. Stress-diathesis models of psychopathology

The stress-diathesis model is a popular framework for understanding a wide range of psychiatric outcomes such as schizophrenia (Corcoran et al. 2003; Zubin and Spring 1977), insomnia (Drake et al. 2014), depression (Hammen 2005; Monroe and Simmons 1991), and suicide (Rubinstein 1986; van Heerignen 2012; Mann 2002). Stress-diathesis models commonly interpret the onset of a certain type of psychopathology as a combined result of a proximal stressor that precipitates the outcome and background vulnerability factors that predispose a person to such an outcome. Diathesis is just an alternative term for "predisposition" (Zuckerman 1999), and the stress-diathesis model is sometimes referred to as the stress-vulnerability model.

The proximal stressor, which is indicated by the "stress" part of the model, is typically conceived as a psychosocial crisis or the onset of a psychiatric disorder that disrupts a person's mental, emotional, and physiological stability (van Heeringen 2012; Ingram and Luxton 2005). Such events are most often conceived as externally ordained events that happen *to* a person (Ingram and Luxton 2005). The background factors, which correspond to the "diathesis" part of the model, are trait-like characteristics of a person that facilitate or protect against the onset of a

disordered state in the face of episodic stress. The earliest applications of the stress-diathesis model focused almost exclusively on genetic and biological traits as vulnerability factors (van Heeringen 2012), but subsequent research extended the concept to psychometric constructs like personality characteristics and social circumstances such as (the lack of) family support and poverty. While it was once common to model diathesis as a dichotomous condition, subsequent research has tended to conceive diathesis as a graded condition (van Heeringen 2012).

Stress-diathesis models come with a certain degree of interpretative flexibility in the literature, and some authors have proposed discrete typologies of stress-diathesis models (Ingram and Luxton 2005; Monroe and Simmons 1991; Quaedflieg and Smeets 2013). A widely noted principle that underlies various versions of the stress-diathesis model is additivity (Ingram and Luxton 2005; Monroe and Simmons 1991; Quaedflieg and Smeets 2013). Additivity envisages the onset of mental disorders or symptoms as a result of a combined effort of vulnerability factors and the proximal stressor, such that this principle is sometimes illustrated as pouring a load into a cup (or bucket) that already contains a certain amount of liquid (Brabban and Turkington 2002; Wikipedia 2023). The common element in the two components that are stacked to bring about the disordered state (i.e., the "liquid") is stress.

The principle of additivity thus reflects the stress-centric nature of the stress-diathesis model. The combined influence of the stress coming from background vulnerability factors and episodic stress is compared to a certain "threshold" that triggers the disorder. If the disorder is conceived as a graded state that does not exhibit any discrete threshold, the severity of the disorder would then be the additive result of these dual sources of stress. The principle of additivity provides a simple answer to the observation that while stress does trigger mental disorders, not everyone exposed to a stressful event will develop mental disorders, or at least not

to the same level of severity. Having a low vulnerability—also called "resilient" by some accounts of the stress-diathesis framework (Ingram et al. 1998)—can therefore be conceived as a condition in which there remains only a short distance to the threshold, and even minor traumatic events or psychological disruptions are sufficient to trigger the disordered state (Zuckerman 1999, p.4).

The principle of additivity is directly embedded in multivariable analyses in which the outcome is regressed on a sum of multiple "risk factors" that typically contain both trait-like variables and event- or state-like variables. While such analyses account for the observation that not everyone develops a certain disorder in response to a proximal stressor, they also blur the distinction between resilience-vulnerability and risk. In a purely additive model of psychopathology, any variable that adds to the severity or probability of the outcome could be considered a risk factor as well as a vulnerability factor. However, as described in the next section, the two have different meanings, and it the two terms should not be used interchangeably.

2.2.2. Psychological resilience

At least two notable ideas in psychological studies of resilience can contribute to a more refined understanding of the stress-diathesis model of psychopathology. The first is stress inoculation, which holds that repeated exposure to stress or adversity, if successfully coped with, increases psychological resilience to shocks. Adequately "inoculated" individuals are reported to have better coping skills, exhibit smaller increases in physiological reactivity (Shakiba et al. 2020), and experience a less serious deterioration in various indicators of mental health including, among others, depressive symptoms (Mortimer and Staff 2004; Shapero et al. 2016). Second, multiple studies have reported that continued exposure to adversity during the early stages of

life, notably childhood, is particularly conducive to stress inoculation for adolescents and young adults (Hagan et al. 2014; Hartmann and Schmidt 2019; Luecken and Gress 2010; Mortimer and Staff 2004; Schweizer et al. 2016; Seery et al. 2013).

Stress inoculation theory challenges or at least complicates existing conceptions of additivity that commonly appear in interpretations of the stress-diathesis model. In particular, it challenges the understanding that higher levels of adversity associated with one's background circumstances shorten the "distance" to the threshold and thereby increase vulnerability to mental disorders. Still, one should not overstate the incompatibility between these two theories. Zubin and Spring's (1979) original theorization of the stress-diathesis model for schizophrenia did not equate stressful living conditions with vulnerability and merely described vulnerability as "the influence" of various life events and circumstances (p.109). The original insight of the stress-diathesis model, namely, explaining the onset of psychopathology as an interaction between a proximal stressor and a unique vulnerability profile specific to each individual, remains uncompromised by stress inoculation theory. Stress inoculation theory also shares with the typical interpretation of the stress-diathesis model its stress-centric nature as an explanatory framework. I therefore ground this study not on a complete rejection of the stress-diathesis model but a modified interpretation thereof, which acknowledges that more stressful background conditions may, at least in some cases, associate with reduced psychological vulnerability.

Another notable idea in the literature on psychological resilience relevant to the stress-diathesis model comes from the so-called "bi-dimensional" framework of resilience (Johnson et al. 2010; Johnson 2016). The main idea of this framework is that resilience must be understood as a separate dimension from risk and is aptly modeled as an *interaction* between two variables in quantitative studies. Traditional research on psychological resilience as well as the stress-

diathesis model was often unclear about the distinction between risk and resilience, with the term "resilience" sometimes being used to denote the opposite pole of risk (Johnson et al. 2016, p.77). However, resilience is an "interactive concept" (Rutter 2006, p.1) that has to do with the varying degrees to which a person is adversely affected by stressful experiences that are generally conducive to certain mental disorders (Johnson 2016; Lee et al. 2013). Seen from this perspective, the stress-diathesis model can be understood as a theory of resilience (or vulnerability).

Johnson's (2016) presentation of the bi-dimensional framework of resilience specifically proposes resilience as a psychological construct (see, however, Lee et al. (2013) and Rutter et al., (2008) that acknowledge social or 'external' resilience factors). Yet, social studies of mental health are primarily interested in the social environment that produces either resilience or vulnerability. In such studies, it is pragmatic to refer to various social factors as resilience or vulnerability factors.

2.2.3. Social determinants of resilience to suicide and suicide-related symptoms

The empirical literature on resilience can be differentiated depending on the type of psychopathology studied. In this paper, I focus on suicide, or more specifically, suicidal ideation. The existing literature on suicidal resilience mostly studies *psychological* resilience factors. A wide range of constructs have been reported to interact with a certain proximal stressor (most commonly a recent negative life event or depression) and buffer its effect on suicidality, typically measured by survey or clinical data on suicide attempts or ideation. These include grit (Blalock et al. 2015), perceived problem-solving alternatives (Adams and Adams 1993; 1996), emotional intelligence (Cha and Nock 2004; Extremera et al. 2018), loneliness (Chang et al.

2010), optimistic explanatory style (Hirsch et al. 2009; Hirsh and Rabon 2015), enhancing attributional style (Kleiman et al. 2012), and self-esteem (Brausch and Decker 2014).

While less common, some studies have examined *social* resilience factors. Family support (Au et al. 2009; Brausch and Decker 2014) and support from friends and classmates (Miller et al. 2015) have been found to buffer the effect of negative life events or other stressors on suicidal ideation among young adults or adolescents. Similarly, Lee et al. (2021) found that school connectedness reduces the effect of cyberbullying victimization on adolescent suicidal ideation. Maimon and Kuhl (2008) reported a positive interaction between past-year depression and neighborhood religiosity for predicting adolescent suicidal ideation in a representative sample of American adolescents and argued that local religious organizations buffer the deleterious effects of depression on suicidal ideation (see however, Jeong (2022) for a critique of the research design and a failed replication).

Socioeconomic status (SES) and other closely related constructs such as income, poverty, and neighborhood disadvantage are among the most widely researched variables in social studies of health, and several notable studies have examined how these factors associate with psychological resilience. Until very recently, all research of this kind found socioeconomic adversity to be a vulnerability factor. Using a representative sample of Canadian adolescents, Dupéré et al. (2009) reported that the association between recent negative life events and suicide attempts is amplified in neighborhoods with a higher proportion of poor households. Cutrona et al. (2005) reported that the effect of negative life events on depression is amplified in neighborhoods with a higher neighborhood disadvantage score. Verbeek et al. (2019) reported a similar finding among pregnant Dutch women, such that the effect of negative life events on prenatal depression is amplified among lower-SES individuals. Zimmerman (2013) reported that

the effect of depression on suicidal attempt among American adolescents is amplified in more violence-ridden neighborhoods, which are likely to be lower-SES neighborhoods. These studies commonly attribute the increased vulnerability among the socioeconomically underprivileged to high levels of background stress that depletes one's coping resources and makes one more readily overwhelmed at a time of crisis.

More recently, however, two studies have put into question whether lower SES is necessarily associated with greater vulnerability. First, Barzilay et al. (2021) found a *negative* interaction between the experience of assaultive trauma and neighborhood SES for predicting suicidal ideation among young adults in the United States. Respondents who belonged to the top two SES tertiles, compared to those in the bottom tertile, experienced a larger increase in the probability of suicidal ideation in the presence of assaultive trauma and also had a higher absolute probability of suicidal ideation in the presence of assaultive trauma. The authors interpreted this as a finding that goes contrary to the stress-diathesis model of suicide and proposed that "some environmental exposures in low SES neighborhoods might be associated with a degree of stress inoculation effect" (p.6).

Second, Jeong (2021) analyzed a very large representative sample of South Korean middle and high school students, focusing on the effect of past-year severe grief or exposure to severe violence on suicidal ideation. For both proximal stressors, the paper reported a U- or J-shaped additive and multiplicative interaction effect with the student's self-reported family economic status, such that students with medium or medium-low levels of family economic status had the smallest increase in the probability of suicidal ideation. The paper also reported a highly similar pattern of interactions using the student's self-reported stress instead of family

economic status. The study proposed stress inoculation as a potential explanation for these findings.

Given recent advances in the literature on stress inoculation, it is theoretically plausible that lower socioeconomic status may, at least in some cases, increase psychological resilience in the face of episodic trauma. In the current study, I examine this possibility more rigorously than in previous research, which had some methodological limitations. Barzilay et al. (2021) examined *lifetime* suicidal ideation and assaultive trauma, making it difficult to establish the chronological order of the proximal stressor and the pathological outcome. Jeong (2021) used past-year measurements for these variables, but the cross-sectional nature of the data still obfuscates the chronological order between trauma and suicidal ideation.

2.3. Methods

The data used for the analysis comes from the Korea Youth Panel Study (KYPS), a six-wave yearly panel survey of South Korean adolescents conducted by the Korea National Youth Policy Institute from 2003 to 2008. Data from waves 4 and 5 were used for the analysis. Wave 4 covers second-year high school students (11th grade, 17-18 years), and wave 5 third-year high school students (12th grade, 18-19 years). This choice of panels was motivated by two reasons: First, the data up to wave 3 does not contain some questions that can be used to construct control variables like collective efficacy. Second, wave 6 is post-secondary school, and therefore the survey was conducted following a considerable change in the social circumstances of most of the respondents. Only those students that participated in both waves 4 and 5 were selected for analysis. This gives a total sample size of 2884 students.

The outcome variable is suicidal ideation, which is based on a single five-point Likert-scale item “I sometimes feel I just want to die.” Responses 4 and 5, labeled “tend to agree” and

"strongly agree," respectively, are coded as suicidal ideation following previous influential studies on suicidal ideation that use KYPS data (Kim & Chang, 2018; Kim & Kim, 2009; Wang, 2016). Around 9.4 percent of adolescents fall into these categories, which is roughly similar to the 13 percent presented in Jeong (2021) based on a binary survey item on suicidal ideation. To ensure chronological posteriority, the outcome variable was taken from the later wave, namely, wave 5.

The wording of the survey item makes the outcome variable appear as if it is an indicator of specifically "passive" suicidal ideation or "death ideation," defined as the "desire for death and the belief that life is not worth living" (Van Orden et al. 2015, p.973). A relevant question is how comparable this is with measurements conducted with survey items worded with the phrase "kill oneself" used in many previous studies on resilience to suicidal ideation including Jeong (2021) and Barzilay et al. (2021). Beck et al.'s (1979) factor analysis of the 19-item Scale for Suicide Ideation found that the item "Wish to die" strongly loads on Factor 1, which included most of the survey items except those related to planning, concealing, and courage. Szanto et al. (1996) challenged the clinical utility of the active/passive distinction for suicidal ideation based on the overall psychiatric similarity between the two groups and their chronologically porous boundaries over the duration of an episode. For these reasons, I will refer to the outcome variable as suicidal ideation rather than passive ideation but still note that the survey question is worded as "want to die" instead of "want to kill oneself."

All predictor variables are taken from wave 4. The proximal stressor of interest is past-year experience of bullying, operationalized by a survey item that asked whether the respondent was "severely made fun of or insulted" in the past year. This can be understood as an indicator of primarily social and verbal abuse, which has been shown by previous studies to predict suicidal

ideation just as strongly as physical bullying (Ford et al., 2017). Bullying victimhood is believed to be a cause rather than a consequence of various psychopathological outcomes (Kim et al., 2006) and is frequently targeted in intervention programs for suicide prevention, making it suitable as a proximal stressor within the stress-diathesis framework.

The focal "diathesis" variable is the natural log of family monthly income, which was collected in wave 4 parents' questionnaire that accompanied the students' questionnaire. The distribution of this variable is heavily right-skewed, with the median at 3 million South Korean Won (KRW) and the mean at 6.46 million KRW. The log-transformed variable is approximately bell-shaped, and the monthly income that corresponds to the average of the logged values is 3.14 million KRW.

In addition to these key variables, a range of control variables are used. Perhaps the most important control is *prior wave (wave 4) suicidal ideation*, which can be expected to be a strong predictor of later wave (i.e., wave 5) suicidal ideation. Female gender, a factor that is generally reported to increase the risk of suicidal ideation (Beautrais 2002; Zhang et al. 2019), is also controlled for in all models. *Smoking*, also a binary indicator, is another variable that is widely known to associate positively with adolescent suicidal outcomes among Korean adolescents (Huh and Cho 2021). A self-reported measure of *delinquency* is added in light of previous research that finds a strong association between adolescent delinquent behavior and suicidal symptoms (Thompson et al., 2007). *Low self-esteem* is a global predictor of suicidal behaviors and ideation among adolescents (as well as adults) (Jang et al., 2014; Nguyen et al., 2022; Overholser et al., 1995). *Residential environment quality*, computed by combining questionnaire items such as "Our neighborhood is littered with trash" and "There are many dark and shady places in our neighborhood," is expected associate negatively with adolescent suicidal behavior

and included in the models to account for so-called "neighborhood effects". Finally, considering the importance of social support and peer relationships for adolescent suicide, five variables, namely, *family relations*, the *number of friendships*, the presence of *delinquent friends*, neighborhood *collective efficacy*, and participation in *school club activities* are accounted for in the statistical models. Social activity and social support are generally known to decrease the risk of suicidal ideation among adolescents (Au et al. 2009; Handley et al. 2012; Miller et al. 2014; but delinquent peer relationships likely increase risk by exposing adolescents to various risk factors such as alcohol and substance abuse (Logan et al. 2011; Kim and Chang 2018). All continuous variables are standardized to have a standard deviation of 1 and a mean of zero. Generally, log transformations were applied for highly skewed distributions. Online Appendix 1 contains a detailed description of questionnaire items used to construct all variables.

Below, I regress suicidal ideation on a combination of predictors using a logit link function. Four variables had missing values, which I addressed by using multiple imputation. As the data were obtained from a complex nationwide survey, I analyzed them using the 'svy' prefix command in Stata 17 (StataCorp, 2021), with the sampling strata and cross-sectional survey weights sourced from wave 5 (Chen & Harris, 2020). The first set of models merely identifies the risk factors without interaction terms. The second set of models examines interactions between bullying victimization and log family income. As a robustness check, I conducted a separate analysis with listwise deletion. As expected given the low proportion of missing data (see Table 2.1), the results are very similar and do not challenge any of the substantive interpretations presented in this paper.

2.4. Results

Table 2.1 shows the descriptive statistics of all variables used in the study. Two variables, residential environment quality and collective efficacy, were measured at the individual level in the original survey but aggregated to the neighborhood level for the analysis (n=150). Using disaggregated data for these two variables does not change any of the results in a meaningful way.

Table 2.1. Descriptive statistics by the value of the outcome variable

	W5 ideators (n=271)	W5 non-ideators (n=2607)	Difference	Missing Values
	Mean	Mean	p	n
W4 suicidal ideation[#]	0.417	0.084	0.000	0
Bullying victimhood[#]	0.055	0.019	0.000	0
Log family income	0.000	-0.001	0.993	128
Female[#]	0.539	0.488	0.111	0
Smoking[#]	0.244	0.120	0.000	0
Self-esteem	-0.553	0.057	0.000	0
Log family relations	0.305	-0.032	0.000	1
Log friendship size	-0.127	0.013	0.033	0
Club activity[#]	0.399	0.431	0.302	0
Delinquent peers[#]	0.637	0.488	0.000	2
Self-rated delinquency	0.422	-0.044	0.000	0
Collective efficacy	-0.086	0.008	0.177	0

Residential quality	0.300	-0.031	0.000	0

Note: # indicates dummy variable. All continuous variables are z-scores computed for the entire sample. The outcome variable—W5 ideation—has one missing value. P-values are two-tailed.

Table 2.2 shows the results of the regression models. Model 1 is purely additive without interaction terms. The results mostly confirm risk factors of suicidal ideation that are already widely known in the literature. Not surprisingly, wave 4 suicidal ideation has a very strong association with wave 5 suicidal ideation. The focal proximal stressor—the experience of bullying as measured by severe insult or mockery—also strongly predicts suicidal ideation even after accounting for same-wave suicidal ideation and concurs with numerous reports that found bullying victimization to be a major risk factor of adolescent suicidal ideation or attempt (Geel et al. 2014; Kim and Chun 2020; Kim and Ko 2021; Kim et al. 2005). Adolescent smoking, delinquent peer relationships, and self-esteem also showed substantial associations with suicidal ideation. The analysis revealed no significant association between family economic status (here measured by log monthly income) and suicidal ideation, which contradicts some (Park 2008) but is consistent with other research (Chung et al. 2010) on Korean adolescents that use a different data source. This is also consistent with previous research that used KYPS data (Kim and Chang 2018).

Model 2 has the same controls as Model 1 but adds a linear interaction term between bullying victimhood and log family income. The interaction is strongly positive, indicating that the association between bullying victimhood and suicidal ideation becomes stronger among adolescents from higher-income households. Model 3 checks for a possible quadratic pattern of interactions by interacting bullying victimhood with log family income as well as the square of

log family income. While the interaction between bullying and log income is positive and significant, the interaction between bullying and the square of log income does not produce a significant result in either direction.

Table 2.2. Logistic regression of wave 5 suicidal ideation

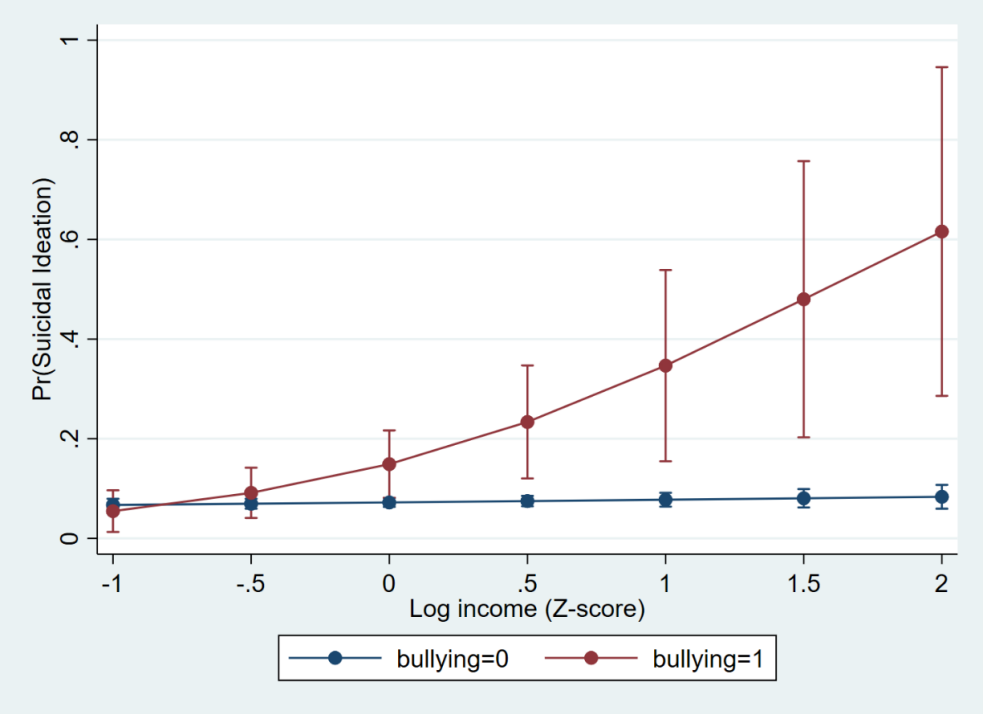
	(1) b/se	(2) b/se	(3) b/se
Wave 4 suicidal ideation	1.629**	1.639**	1.641**
	(0.154)	(0.154)	(0.155)
Bullying victimhood	0.735*	0.816*	0.870*
	(0.356)	(0.327)	(0.400)
Log family income	0.101	0.074	0.139
	(0.086)	(0.083)	(0.087)
Female	0.197	0.200	0.203
	(0.143)	(0.143)	(0.144)
Smoking	0.490*	0.507**	0.515**
	(0.196)	(0.196)	(0.197)
Self-esteem	-0.306**	-0.310**	-0.312**
	(0.078)	(0.078)	(0.078)
Log family relations	0.126+	0.129+	0.127+
	(0.073)	(0.073)	(0.073)
Log friendship size	-0.119	-0.121+	-0.124+
	(0.072)	(0.073)	(0.073)
Club activity	-0.096	-0.107	-0.113
	(0.144)	(0.144)	(0.144)
Delinquent peers	0.352*	0.348*	0.358*
	(0.157)	(0.157)	(0.157)
Self-rated delinquency	0.128+	0.135+	0.138+
	(0.076)	(0.075)	(0.075)
Collective efficacy	0.085	0.100	0.126
	(0.277)	(0.278)	(0.281)

Residential environment quality	-0.389	-0.408	-0.398
	(0.252)	(0.253)	(0.256)
Bullying x Log family income		1.067**	0.984*
		(0.390)	(0.482)
Log family income^2			0.024+
			(0.013)
Bullying x Log family income^2			-0.070
			(0.347)
Constant	-3.018**	-3.024**	-3.058**
	(0.156)	(0.155)	(0.159)
N	2886	2886	2886

+ p<0.1; * p<0.05; ** p<0.01; *** p<0.001

Figure 2.1 plots the predicted probability of suicidal ideation using Model 3. In the absence of the proximal stressor, there is no noticeable association between the risk of suicidal ideation and log family income as indicated by the horizontally flat curve. However, given the recent occurrence of the proximal stressor, the probability increases together with the student's log household monthly income such that those from wealthy backgrounds experience substantial increases in the probability of suicidal ideation but those from modest backgrounds do not experience any.

Fig 2.1. Predicted probability of suicidal ideation by log income and bullying victim



Note: All non-interacted covariates are set at the mean value.

2.5. Robustness checks

I conducted two types of robustness checks. The first checks whether the results remain valid through variations in the range of control variables used. The second checks whether the results are consistent throughout different cutoff points for the outcome variable.

For the first robustness check, I reran all three models removing one or two variables at a time from the full model until only the focal independent variables and statistically significant ($p<0.05$) controls were left. The variables with the highest p-values were the first to be dropped. The results are displayed in Tables 2.3, 2.4, and 2.5. Bullying victimization and its interaction with log income remained significant for Models 1 and 2 (see Tables 2.3 and 2.4). For Model 3, the p-value of the linear interaction term between bullying and log income slightly exceeded 0.05

with the stepwise removal of controls but remained significant at the 0.1 level (Table 2.5). As in the full model presented in Table 2.2, the quadratic interaction term remained completely nonsignificant with a point estimate close to zero in Table 2.5. The results largely support the results presented in the preceding section.

Table 2.3. Stepwise removal of controls for Model 1 of Table 2.2.

	(1) b/se	(2) b/se	(3) b/se	(4) b/se
Wave 4 suicidal ideation	1.622**	1.630**	1.642**	1.671**
	(0.154)	(0.153)	(0.152)	(0.150)
Bullying victimhood	0.730*	0.706*	0.727*	0.773*
	(0.354)	(0.348)	(0.340)	(0.339)
Log family income	0.099	0.095	0.099	0.088
	(0.084)	(0.083)	(0.080)	(0.081)
Smoking	0.493*	0.456*	0.536**	0.539**
	(0.197)	(0.197)	(0.188)	(0.188)
Self-esteem	-0.304**	-0.309**	-0.353**	-0.371**
	(0.077)	(0.077)	(0.074)	(0.073)
Delinquent peers	0.342*	0.328*	0.297+	0.315*
	(0.156)	(0.154)	(0.152)	(0.151)
Log family relations	0.127+	0.125+	0.157*	
	(0.073)	(0.073)	(0.070)	
Self-rated delinquency	0.178+	0.176+		
	(0.100)	(0.100)		
Log friendship size	-0.120+	-0.128+		
	(0.073)	(0.072)		
Female	0.205			
	(0.140)			
Residential environment quality	-0.394			
	(0.252)			
Constant	-3.867**	-3.714**	-3.465**	-3.470**

	(0.277)	(0.255)	(0.220)	(0.220)
N	2886	2886	2886	2886

+ p<0.1; * p<0.05; ** p<0.01; *** p<0.001

Table 2.4. Stepwise removal of controls for Model 2 of Table 2.2.

	(1) b/se	(2) b/se	(3) b/se	(4) b/se
Wave 4 suicidal ideation	1.632**	1.639**	1.651**	1.681**
	(0.154)	(0.153)	(0.152)	(0.150)
Bullying victimhood	0.804*	0.776*	0.796*	0.831**
	(0.326)	(0.323)	(0.317)	(0.317)
Log family income	0.072	0.069	0.074	0.064
	(0.081)	(0.080)	(0.077)	(0.078)
Bullying x Log family income	1.057**	1.011**	0.949*	0.913*
	(0.388)	(0.385)	(0.384)	(0.379)
Smoking	0.511**	0.473*	0.558**	0.560**
	(0.196)	(0.197)	(0.187)	(0.187)
Self-esteem	-0.308**	-0.313**	-0.359**	-0.376**
	(0.078)	(0.078)	(0.074)	(0.074)
Delinquent peers	0.336*	0.323*	0.291+	0.310*
	(0.156)	(0.155)	(0.153)	(0.152)
Log family relations	0.130+	0.127+	0.162*	
	(0.073)	(0.073)	(0.070)	
Self-rated delinquency	0.188+	0.186+		
	(0.099)	(0.099)		
Log friendship size	-0.122+	-0.130+		
	(0.073)	(0.072)		
Female	0.210			

	(0.140)			
Residential environment quality	-0.414			
	(0.253)			
Constant	-3.914**	-3.755**	-3.494**	-3.499**
	(0.273)	(0.251)	(0.219)	(0.220)
N	2886	2886	2886	2886

+ p<0.1; * p<0.05; ** p<0.01; *** p<0.001

Table 2.5. Stepwise removal of controls for Model 3 of Table 2.2.

	(1) b/se	(2) b/se	(3) b/se	(4) b/se
Wave 4 suicidal ideation	1.633**	1.641**	1.653**	1.683**
	(0.155)	(0.153)	(0.152)	(0.150)
Bullying victimhood	0.850*	0.840*	0.821*	0.879*
	(0.398)	(0.394)	(0.389)	(0.391)
Log family income	0.134	0.131	0.133	0.124
	(0.086)	(0.085)	(0.086)	(0.085)
Bullying x Log family income	0.979*	0.916+	0.891+	0.832+
	(0.479)	(0.476)	(0.463)	(0.467)
Log family income^2	0.023+	0.023+	0.021+	0.022+
	(0.012)	(0.012)	(0.012)	(0.012)
Bullying x Log family income^2	-0.059	-0.089	-0.026	-0.064
	(0.345)	(0.348)	(0.332)	(0.339)
Smoking	0.518**	0.479*	0.565**	0.568**
	(0.197)	(0.197)	(0.187)	(0.187)
Self-esteem	-0.309**	-0.314**	-0.361**	-0.379**
	(0.078)	(0.078)	(0.074)	(0.074)
Delinquent peers	0.345*	0.331*	0.299+	0.317*

	(0.156)	(0.155)	(0.153)	(0.152)
Log family relations	0.128^{+}	0.125^{+}	0.160*	
	(0.073)	(0.073)	(0.070)	
Self-rated delinquency	0.193^{+}	0.190^{+}		
	(0.099)	(0.099)		
Log friendship size	-0.125^{+}	-0.133^{+}		
	(0.073)	(0.072)		
Female	0.216			
	(0.140)			
Residential environment quality	-0.407			
	(0.255)			
Constant	-3.965**	-3.802**	-3.530**	-3.537**
	(0.278)	(0.254)	(0.222)	(0.222)
N	2886	2886	2886	2886

+ p<0.1; * p<0.05; ** p<0.01; *** p<0.001

For the second robustness check, I used a different cutoff for the dependent variable (suicidal ideation). Coding the responses "strongly agree" and "tend to agree" as suicidal ideation seems reasonable and has been conventionally used in prior studies of KYPS (Kim and Chang 2018; Kim and Kim 2009; Wang 2016). However, the argument would be further strengthened if the findings of the preceding section could be replicated for a more restrictive or liberal coding of suicidal ideation. Tables 2.6 and 2.7 repeat Table 2.2 a coding of suicidal ideation that includes only the very top category (i.e., "strongly agree"; Table 2.6) and the top three categories (i.e., "strongly agree," "tend to agree," and "neutral"; in Table 2.7), respectively. In terms of proportion, the former coding only includes 2.05 percent of the sample, while the latter constitutes 30.5 percent of all respondents in the sample. In comparison, the coding used in

section 2.4. (i.e., responses of "tend to agree" and "strongly agree") account for around 9.4. percent of the sample.

Table 2.6. Replication of Table 2.2. for responses "strongly agree" only

	(1) SI5bin b/se	(2) SI5bin b/se	(3) SI5bin b/se
Wave 4 suicidal ideation	1.563**	1.626**	1.639**
	(0.462)	(0.441)	(0.438)
Bullying victimhood	0.571	0.747	1.002
	(0.628)	(0.547)	(0.612)
Log family income	-0.191*	-0.212*	-0.192
	(0.094)	(0.088)	(0.159)
Female	-0.069	-0.056	-0.054
	(0.285)	(0.285)	(0.284)
Smoking	0.364	0.401	0.406
	(0.339)	(0.337)	(0.334)
Self-esteem	-0.393*	-0.394*	-0.391*
	(0.178)	(0.178)	(0.179)
Log family relations	0.159	0.161	0.156
	(0.137)	(0.135)	(0.135)
Log friendship size	-0.075	-0.079	-0.084
	(0.136)	(0.137)	(0.138)
Club activity	0.084	0.071	0.074
	(0.263)	(0.263)	(0.264)
Delinquent peers	0.282	0.271	0.274
	(0.314)	(0.312)	(0.313)
Self-rated delinquency	-0.006	0.016	0.022
	(0.132)	(0.132)	(0.132)
Collective efficacy	-0.594+	-0.556	-0.553
	(0.344)	(0.346)	(0.357)

Residential quality	0.533	0.538	0.552
	(0.352)	(0.357)	(0.360)
Bullying x Log family income		1.082^{+}	0.928
		(0.606)	(0.909)
Log family income^2			0.003
			(0.021)
Bullying x Log family income^2			-0.504
			(0.653)
Constant	-4.279**	-4.301**	-4.309**
	(0.300)	(0.304)	(0.304)
N	2886	2886	2886

Table 2.7. Replication of Table 2.2. for responses "strongly agree," "agree," and "neutral"

	(1) SI5bin b/se	(2) SI5bin b/se	(3) SI5bin b/se
Wave 4 suicidal ideation	1.037**	1.040**	1.041**
	(0.094)	(0.094)	(0.094)
Bullying victimhood	0.588*	0.551^{+}	-0.053
	(0.274)	(0.290)	(0.422)
Log family income	-0.014	-0.007	-0.026
	(0.042)	(0.043)	(0.055)
Female	0.163^{+}	0.165^{+}	0.167^{+}
	(0.093)	(0.093)	(0.093)
Smoking	0.444**	0.444**	0.449**
	(0.137)	(0.137)	(0.138)
Self-esteem	-0.265**	-0.264**	-0.264**
	(0.051)	(0.051)	(0.051)
Log family relations	0.152**	0.150**	0.152**

	(0.046)	(0.046)	(0.046)
Log friendship size	-0.045	-0.045	-0.044
	(0.046)	(0.046)	(0.047)
Club activity	-0.105	-0.103	-0.100
	(0.091)	(0.091)	(0.091)
Delinquent peers	0.039	0.039	0.035
	(0.097)	(0.097)	(0.097)
Self-rated delinquency	0.146**	0.145**	0.143**
	(0.050)	(0.050)	(0.050)
Collective efficacy	0.133	0.127	0.118
	(0.166)	(0.166)	(0.167)
Residential quality	-0.115	-0.105	-0.113
	(0.155)	(0.155)	(0.156)
Bullying x Log family income		-0.514	-0.538
		(0.391)	(0.552)
Log family income^2			-0.008
			(0.010)
Bullying x Log family income^2			1.510
			(0.911)
Constant	-1.393**	-1.395**	-1.389**
	(0.099)	(0.099)	(0.100)
N	2886	2886	2886

Unlike the robustness checks shown in Tables 2.3 to 2.5, the results of Tables 2.6 and 2.7 fail to replicate the significant results for bullying victimhood. The more restrictive coding of suicidal ideation used for Table 2.6 produces coefficients of focal independent variables that are generally in the same direction as Table 2.2 but fall short of statistical significance due to the small number of positive cases (only 59) and large standard errors. On the other hand, the more inclusive coding of suicidal ideation used for Table 2.7 produces coefficients that are remarkably

different. While bullying victimhood still positively associates with suicidal ideation, the linear interaction between bullying victimhood and log family economic status is now completely nonsignificant with a negative point estimate. The interaction between bullying victimhood and the square of log family income has a sizable positive coefficient but comes with large standard errors that keep it out of statistically significant ranges.

In sum, the results of Table 2.2, most notably the positive interaction between bullying victimhood and family economic status, are robust throughout variations in control variables but not when the outcome variable is coded to include a "neutral" response to the survey question on suicidal ideation.

2.6. Discussion

Apart from the diverging results of the last robustness check that includes responses of "neutral" as instances of suicidal ideation, the results of this study show that the association between episodic trauma and suicidal ideation is relatively heightened among adolescents from higher-income or higher-SES backgrounds. This finding is in line with Jeong (2021), which also finds that higher SES can be a vulnerability factor for suicidal ideation. However, unlike Jeong (2021), this study did not identify a U- or J-shaped association between resilience and family economic status, suggesting more research is needed to establish the nature of this relationship. Considering the sizable standard errors for the quadratic interaction term in Model 3 of Table 2.2, the possibility of a type 2 error for the quadratic interaction term cannot be ruled out.

The diversity of results in the existing literature, combined with the sensitivity of the results to different operationalizations of the outcome variable, does not support the contention that adolescents from poorer family backgrounds are more psychologically resilient than those from affluent backgrounds. Instead, socioeconomic adversity may *in some cases* be associated

with increased resilience. Such a qualified conclusion with limited generalizability has indeed been a common feature in research on stress inoculation (Seery et al. 2011). Still, the analysis presented here joins recent studies in suggesting that the link between SES and vulnerability to suicidal behavior is likely more complex than previously thought and possibly heavily context-dependent.

Speaking of context, it is notable that many, albeit not all, of the existing studies other than the current study that show that adolescents living in socioeconomically deprived or psychologically stressful environments are less resilient to suicidal ideation come from Korea (Jeong 2021; Kim and Chang 2018; Kim and Chun 2020; Lee and Choi 2016). While similar results from the United States (Barzilay et al. 2021; Gaylord-Harden et al. 2016) and broader theoretical literature on stress inoculation discourage the interpreting this as a phenomenon unique to Korea, there may be certain sociocultural factors specific to Korea that make adolescents facing adversity particularly resilient to suicidal ideation. More research, including qualitative research, is need to examine whether such cultural specificities exist, and if so, what they are.

The findings have important policy implications. In the absence of a clear case-specific justification, the distribution of resilience-building resources across different social strata should not neglect affluent social sectors based on the insufficiently confirmed yet popular theory that high SES is generally a psychological resilience factor. The findings of this study do not necessarily refute repeated calls in the existing literature to focus resilience-building resources on socioeconomically deprived sectors (Dupéré et al. 2009; Näher et al. 2020; Samaritans 2017; Verbeek et al. 2019). Rather, policy decisions should take full consideration of the recent series of empirical and theoretical research that deviates from the traditionally received wisdom about

the link between social stratification and resilience and pay serious attention to the mental health of those coming from more affluent backgrounds as well.

2.7. Conclusion

Previous literature on the social determinants of psychological resilience commonly identified low SES as a vulnerability factor for mental health issues including suicidal ideation. However, more recent research reported that high SES might be a vulnerability factor for adolescent suicidal ideation. Using time-varying data from a public longitudinal survey from South Korea, this paper presented another such case in which higher economic status is associated with increased vulnerability to suicidal ideation in the face of bullying victimhood. The results show that, after controlling for various covariates, adolescents from affluent backgrounds exhibit substantial increases in the predicted risk of suicidal ideation, while those from economically modest backgrounds do not experience such increases. These findings suggest that resilience-building interventions should not neglect high-SES demographic sectors.

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Foreword to Chapter 3

In the two previous chapters, I empirically examined how adolescents' family economic status moderates the association between recent trauma and suicidal ideation. Both chapters mainly employed family economic status measured at the individual level. However, in social studies of health, it is possible, and perhaps customary, to examine if there are any "neighborhood effects" SES that go beyond the effect of the individual-level variable. Put differently, one may wonder whether neighborhood SES moderates the association between recent trauma and suicidal ideation over and above what is already moderated by individual SES.

Specifically in section 1.3.2, I examined the distinct moderating effect of school average SES or school average stress by interacting the L1 proximal stressor not only with individual measures of SES or perceived stress but also with the school average of each variable. The results were significant for the L1-L1 interactions but nonsignificant for L1-L2 interactions, which provided support for the thesis that individual SES or perceived stress moderates the effect of recent trauma on suicidal ideation but not for the thesis that school average SES or perceived stress serve as moderators. Had the L1-L2 interactions been significant, that would have provided preliminary evidence of a "contextual effect" of these diathesis variables on psychopathological resilience. I did not estimate contextual effects in Chapter 2, but I could have attempted to estimate the contextual effect of family SES on suicidal ideation to check whether neighborhood SES moderates the relationship between bullying and suicidal ideation over and above what is already moderated by individual-level SES.

Nevertheless, the estimation of contextual effects for the two empirical studies just presented come with conceptual and methodological problems. The main problem is that virtually all existing theoretical discussions of contextual effects take place in a non-interaction

setting, that is, in cases with a monadic outcome variable. There has not been any formal discussion of contextual effects for dyadic outcome variables, or cases in which the estimand of interest is itself the effect of one variable on another. So the analysis in section 1.3.2, as well as many other observational studies that purport to demonstrate a "contextual" or "neighborhood" effect of a certain variable on psychological resilience, are working with a concept that lacks a proper definition. In Chapter 3, I address this gap in the literature by proposing an updated theoretical review of the concept of contextual effects and extending it to an interaction setting. In doing so, I will also show that most existing research that claims to identify a "contextual" or "neighborhood" effect of a certain variable on psychological resilience fails to provide adequate empirical support due to a common type of model misspecification.

Article 3. Contextual fallacy in MLMs with cross-level interaction: A critical review of neighborhood effects on psychiatric resilience

Abstract: In the multilevel modeling literature, *contextual effect* is defined as or identified by the effect of the target group-level variable while controlling for the corresponding individual-level variable. This paper extends the notion of "contextual effects" (or "neighborhood" or "school" effects) to an interaction setting, such that the effect of one explanatory variable X_{ij} on the outcome Y_{ij} is modeled as a function of a group-level 'moderating' or predisposing variable Z_j^* as well as its counterpart at the individual level Z_{ij}. Researchers frequently use regression models that only contain a cross-level interaction between X_{ij} and Z_j^* to test contextual hypotheses in an interaction setting, but this modeling strategy is unable to discriminate the immediate rival hypothesis that attributes a causal role to the corresponding individual-level variable. This paper points out the prevalence of this type of fallacy through a review of past research on contextual determinants of psychiatric resilience. It is argued that the simple step of adding an appropriate individual-level interaction $X_{ij}Z_{ij}$ could help more robustly test substantive hypotheses about how neighborhood context alters the effect of proximal stressors on health outcomes.

Keywords: Contextual effect; Neighborhood effect; Multilevel modeling; Cross-level Interaction; Resilience

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3.1. Introduction

Many social phenomena occur in an environment in which individuals are nested in groups. Quantitative modeling of such nested social structures commonly involves variables from both levels, i.e., individual- and group-level variables, or level-1 (L1) and level-2 (L2) variables. Group-level variables, in particular, quantify properties that are instantiated by groups. As such,

they can be used to study how a certain group characteristic covaries with or explain the behavior of individuals nested in the group.

In principle, one may use the term "contextual effect" to refer to the effect of nearly any group-level variable on an individual-level outcome as expressed in Barton's (1970) statement that "the point of contextual analysis … [is] to find out what general characteristics of contexts are related to the dependent variable" (p.515). However, particularly in the multilevel modeling (MLM) literature, this term is typically used for group-level properties that also have a theoretical "counterpart" at the individual level, and the term "contextual analysis model" refers to statistical regression models that include both the target L2 variable *and* a corresponding L1 variable as covariates (Diez-Roux 2002; Lüdtke et al. 2008). "Contextual effect" in such models refers to the distinct effect of the L2 variable after accounting for the corresponding L1 variable (Asparouhov and Muthen 2018; Diez-Roux 2002; Lüdtke et al. 2008; Raudenbush and Bryk 2002).

There is perhaps no clear-cut rule on what qualifies as a legitimate bundle of L2 and L1 variables to be used for contextual analysis. However, a guiding principle is that the L1 variable expresses the same or a highly analogous theoretical property as the target L2 variable. Examples of such L2-L1 pairs include individual and school academic performance (Marsh 1987) and individual and neighborhood SES (Pikett and Pearl 2001). The conceptual similarity between the L2 and L1 properties commonly allows the former to be measured or operationalized by aggregating the latter. In some cases, the researcher may even conceive the L2 construct as *formed* through an aggregation of a certain L1 property not only at a measurement level but at an ontological level, such that the L2 construct of theoretical interest simply *is* the group average of the L1 variable.

The conceptual similarity between the L2 and L1 properties usually makes it theoretically plausible that, if one of them has an effect on the outcome, the other would also have an effect on

the same outcome. As such, a failure to partial out the effect of the corresponding L1 variable may lead to theoretical inferences that overinterpret the role of social context. There seems to be a lack of a standard term for this type of fallacy related to the level of analysis (for example, compare the fourfold classification presented in Diez-Roux 1998), and this paper will call it "contextual fallacy."

Virtually all existing theoretical discussions of "contextual effects" in multilevel modeling involve models without interaction terms. However, the core idea behind contextual effects can be extended to an interaction setting. Interaction effects in regression analysis operationalize how the strength of the association between two variables X and Y (i.e., the "slope") varies as a function of a third variable Z. In cases where that third (i.e., moderator) variable is an L2 variable, we have a model that examines the "effect" of a group-level variable not on a monadic Y variable but the *slope* between two variables X and Y. Yet, for the same reason that conventional analyses of contextual effects may not be adequate without the inclusion of the L1 theoretical counterpart of the L2 variable of interest, it may sometimes be theoretically desirable to model the "slope" between X and Y not just as a function of the L2 variable of interest (say, $\bar{Z}_j$) but also the corresponding L1 variable (say, Z_{ij}). This paper proposes to call such models *contextual moderation models*. Contrary to the ubiquity of conventional contextual analysis models, contextual moderation models are rare in applied research.

The main argument of this paper is that cross-level interaction alone is rarely sufficient for contextual analysis despite often being used for this purpose. It also proposes that adding an appropriate L1-L1 interaction to the cross-level interaction could, in principle, grant the model some ability to test contextual hypotheses. These two points will be illustrated by using examples from research on contextual determinants of psychiatric resilience.

The main body of the paper is organized as follows: First, it presents a theoretical exposition of contextual effects in the traditional statistical, acausal sense and extends it to an interaction context. Second, it extends the associative concept of contextual effects to an explicitly causal concept in line with the heavy causal connotation that this term frequently implies. Third, it illustrates the practical relevance of contextual moderation models by looking at the subject of contextual determinants of psychiatric resilience. Four research articles published in highly visible sociology and psychology journals will be critically reviewed with special attention to how they use multilevel models with a cross-level interaction to argue for a "neighborhood effect" on psychiatric vulnerability/resilience. It will be argued that these studies do little to support the contextual hypotheses that they advance and contextual moderation models may have offered a better test of the proposed hypotheses.

Before further discussion, a clarification of terminology is in order. The term "compositional effect" is sometimes used interchangeably with "contextual effect" to refer to the effect of group-level properties after accounting for corresponding individual-level traits (Raudenbush and Bryk 2002, p.139; Suzuki et al. 2012). Both terms are frequently used in the literature, but this paper will opt to use the term "contextual effect." This is because, somewhat confusingly, there are also precedents in epidemiology that use the term "compositional effect" as a *contrast* to "contextual effect" to refer to the "effects of individual-level factors… on individual-level outcomes after accounting for the effects of relevant group- or area-level factors" (Porta 2014, p.53; see also Diez-Roux 2002; Duncan et al. 1998). It may be an interesting endeavor to explore the historical development of this term in the social-scientific and epidemiological literature, but such is beyond the scope of this paper.

3.2. The concept of contextual effects

3.2.1. The associative concept of contextual effects

Formal definitions of contextual effect in the MLM literature are often expressed without an explicit causal language. According to Raudenbush and Bryk (2002, p.139), "such effects are said to occur when the aggregate of a person-level characteristic, $\overline{X}_{.j}$, is related to the outcome, Y_{ij}, even after controlling for the individual characteristic, X_{ij} (see also Lüdtke et al. 2008, p.204; Asparouhov and Muthen 2018, p.8). Shin and Raudenbush (2010, p.27), citing Willms (1986), stated that "[t]he contextual effect is formally defined as the difference between the between-group and the within-group regression coefficients." It may be argued that the causal concept, discussed in sections 2.3 and 2.4, more genuinely captures the meaning of contextual effects (Oakes 2004) and that the associative concept is either inadequate or at best seen as a rough guideline for identifying the causal concept. Nevertheless, the widespread usage of the traditional associative notion in the MLM methodological literature makes it a suitable starting point for discussion.

Let subscript 'i' denote individuals and subscript 'j' groups. Let X_j^* be the group-level construct of interest and X_{ij} the corresponding individual-level variable. The same symbol (i.e., X) is included in the notations for the L2 construct and the L1 counterpart to indicate the conceptual affinity between them, although the L2 construct is marked with an asterisk to distinguish it *qua* an unobserved L2 construct. Here, $\overline{X}_j$—the group average of X_{ij}—will be used as a measurement or proxy of X_j^* as is common in contextual analysis (Blalock 1984, p.359; Lüdtke et al. 2008; Suzuki 2012, p.2). Consider a regression model that regresses the outcome Y_{ij} on X_{ij} and $\overline{X}_j$. If Y is clustered, it is apt to add a group-level random intercept u_j. The individual-level residual is denoted by ϵ_{ij}. u_j and ϵ_{ij} are assumed to be normally distributed and i.i.d. with a mean of zero.

This distributional assumption about u_j and ϵ_{ij} holds for all other equations in this paper unless otherwise stated.

$$Y_{ij} = r_0 + r_1X_{ij} + r_2\overline{X}_j + u_j + \epsilon_{ij} \quad \text{(Eq 1)}$$

In Equation 1, the contextual effect is given by the coefficient of the group mean, i.e., r_2. It is the association between the outcome and the group-mean "controlling for" the individual-level variable. Note that the very concept of contextual effect crucially depends on the postulation of an L1 variable that must be controlled for before the association between the outcome and the target L2 variable can be examined.

Another way to compute the contextual effect is to include the group mean together with the within-group deviation score (Asparouhov and Muthen 2018).

$$X_i \triangleq X_{ij} - \overline{X}_j \quad \text{(Eq 2)}$$

$$Y_{ij} = r_0 + r_1X_i + r_2\overline{X}_j + u_j + \epsilon_{ij} \quad \text{(Eq 3)}$$

The contextual effect is obtained by subtracting the coefficient of X_i ("within-effect") from the coefficient of $\overline{X}_j$ ("between-effect"). In Equation 1, the contextual effect was obtained by the difference in the expected outcome between observations that differ in the group mean $\overline{X}_j$ by one unit but have the same absolute value of X_{ij}. How does the difference between the between-effect and the within-effect also capture this quantity? Intuitively, a one-unit increase in the group mean $\overline{X}_j$ coupled with a one-unit decrease in the within-group deviation score X_i amounts to a one-unit increase in the group mean and no change in the absolute value of the individual-level trait. In hierarchical linear models without random slopes, the two methods are mathematically equivalent and produce the same estimates of the contextual effect (Kreft, de Leeuw, and Aiken 1995).

3.2.2. Associative contextual effects in interaction models

Consider a slightly modified version of Equation 1: An individual-level outcome Y_{ij} is regressed on two individual-level variables X_{ij} and Z_{ij} as well as $\bar{Z}_j$. One could also include $\bar{X}_j$, but for simplicity, the following discussion will assume that X is considered only at the individual level.

$$Y_{ij} = r_0 + r_1X_{ij} + r_2Z_{ij} + r_3\bar{Z}_j + u_j + \epsilon_{ij} \quad \text{(Eq 4)}$$

Equation 4 has a fixed slope of X_{ij} on Y_{ij} (i.e., r_1). It would be possible to allow the slope of X_{ij} to vary by different values of $\bar{Z}_j$ by adding an interaction term (i.e., a "cross-level" interaction term) as shown in Equation 5. It is often suitable to add an L2 random effect u_{1j} for the "slope" of L1 variables, especially ones that are involved in a cross-level interaction (Heisig and Schaeffer 2019), although it is sometimes omitted due to a lack of between-group slope variability or to reduce issues with convergence or computation time (Preacher et al. 2016). A further possible extension is to allow an L1 random effect ϵ_{1ij} for the slope of an L1 independent variable (say, X_{ij}) by adding the term $\epsilon_{1ij}X_{ij}$ to the equation (Steele 2009a). This option is more rarely used but may be suitable when there is heteroskedasticity of L1 residuals (Ibid). Consistent with common practice, only u_{1j} is included, but the choice of slope random effects may vary depending on the data and computational resources.

$$\begin{aligned} Y_{ij} &= r_0 + r_1X_{ij} + r_2Z_{ij} + r_3\bar{Z}_j + r_4X_{ij}\bar{Z}_j + u_{0j} + u_{1j}X_{ij} + \epsilon_{ij} \\ &= r_0 + (r_1 + r_4\bar{Z}_j + u_{1j})X_{ij} + r_2Z_{ij} + r_3\bar{Z}_{j\,+}\, u_{0j} + \epsilon_{ij} \end{aligned} \quad \text{(Eq 5)}$$

The researcher may also be interested in whether the association between X_{ij} and Y_{ij} varies not only by different strata of $\bar{Z}_j$, but also Z_{ij} as shown in Equation 6.

$$Y_{ij} = r_0 + r_1X_{ij} + r_2Z_{ij} + r_3\bar{Z}_j + r_4X_{ij}\bar{Z}_j + r_5X_{ij}Z_{ij} + u_{0j} + u_{1j}X_{ij} + \epsilon_{ij}$$

$$= r_0 + (r_1 + r_4\bar{Z}_j + r_5 Z_{ij} + u_{1j})X_{ij} + r_2 Z_{ij} + r_3\bar{Z}_j + u_{0j} + \epsilon_{ij} \quad \text{(Eq 6)}$$

One may call the coefficient r_4 in Equation 6 the *contextual moderation effect* of Z on the slope between X_{ij} and Y_{ij}. This way, one could examine if two people who have the same score of Z but differ in the average scores of neighbors, classmates, or colleagues can be expected to differ systematically in the association between X_{ij} and Y_{ij}, which is a straightforward application of the idea of the (associative) concept of contextual effects defined in regression models without interaction terms.

3.2.3. The causal concept of contextual effects

Despite influential definitions of "contextual effect" that do not use an explicit causal language, this term has been frequently understood as referring to a type of causal effect since its early uses in the 1970s (Erbring and Young 1979; Farkas 1974; Firebaught 1979). Traditional sociological discussions of contextual effects sometimes expressed it as the "independent" (Firebaugh 1979) or "unique" (Farkas 1974, p.346) effect of the L2 variable on the outcome. The basic intuition behind the causal concept of contextual effect can be understood as the induced change in the potential outcome following an intervention in the target L2 variable while the corresponding L1 variable remains unaltered. Note that the nature of intervention in the concept of contextual effect is different from the group-level intervention theorized in Suzuki et al. (2012, p.3), which imagines a change in the group mean that is also reciprocated by the disaggregated variable by the same amount.

Altering the value of the L2 variable while the L1 counterpart remains unchanged brings about at least two kinds of change: It produces changes in the group-level variable, and it also affects one's relative position within the group. As such, contextual effects can be decomposed into two

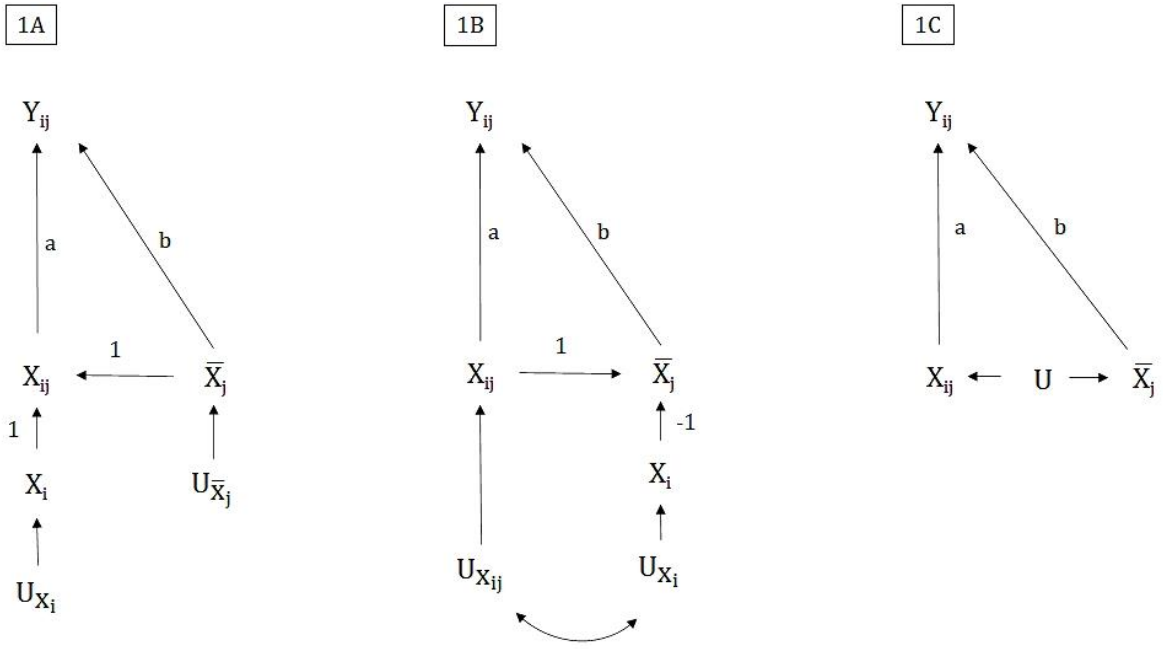
types according to the mechanism through which group membership may affect individual outcomes (Blalock 1984). The "group-mean effect" refers to processes that respond to the overall level of intensity of a certain group environment or climate, or to use the words of Blalock (1984, p.359), "normative controls or some notions as climate of opinion" (Blalock 1984, p.359). The "frog-pond effect," on the other hand, occurs when "individuals compare themselves to a group mean" and adjust their behavior according to their perceived location within the group (Blalock 1984, p.360). If one builds a causal model with $\overline{X}_j$ (or more generally X_j^*), X_i, and X_{ij}, their distinct effects on the outcome would reflect a contextual effect of the "group-mean" type, a contextual effect of the "frog-pond-type", and what can be called a "noncontextual effect" that operates regardless of group membership, respectively.

Unless one has direct access to the variables that mediate at least one of these two types of contextual effect (c.f. Marsh et al. 2000), it is not possible to decompose the estimated contextual effect into the group-mean and frog-pond components (Firebaugh 1980), although doing so is ideally desirable in theory-driven research. Nevertheless, the inability of effect decomposition often does not pose a critical problem for testing contextual hypotheses. Sometimes, as in the case of student achievement and academic self-concept (Marsh et al. 2008), the group-mean effect, if any, operates *ex hypothesi* in a direction that offsets the frog-pond effect such that a negative contextual effect attests to the existence of a frog-pond effect. Alternatively, there may be a plausible theory or hypothesis for one type of contextual effect but not the other, which would allow the researcher to assume one of the two types of contextual effects to be nonexistent and treat the estimated contextual effect as an unbiased indicator of the posited causal mechanism. Because there is an empirical identification problem between the group-mean and frog-pond components of contextual effects, and also because this problem can often be dealt

with only at a theoretical level, it is in most cases harmless to work with a causal model that features just one of $\overline{X}_j$ and X_i. For consistency with the examples discussed later in this paper whose theoretical focus is of the group-mean or 'climate' type, and also in light of research precedents (Farkas 1974; Marsh et al. 2000; Wodtke and Parbst 2017), this paper works with causal models that feature X_{ij} and $\overline{X}_j$ but not X_i.

A recurring issue in causal modeling with the target group-level construct (or the group-mean) together with the absolute level of the individual-level variable concerns the direction of causality between them (Farkas 1974; Blalock 1984). The group-level construct can be modeled as causing the individual-level variable, or the individual-level variable can be seen as affecting the group construct. It has been proposed that the more permeable the group, the more the individual-level variable will tend to cause the group mean (Blalock 1984, p.369). Alternatively, one could also model X_{ij} and X_j^* (or $\overline{X}_j$) as connected through some set of common causes U. Specifically, including past X_{ij} and past X_j^* in U would indicate mutual causality. The three different varieties of possible causal relationships just described are shown in Figures 3.1A-3.1C assuming constant path coefficients.

Fig 3.1. Causal relationships between $\bar{X}_j$ and X_{ij}



Note: The exogenous error terms U_{X_i} and $U_{\bar{X}_j}$ (the within-group deviation score and the group mean) in 1A are orthogonal.

A formal definition of contextual effect in the causal sense would vary depending on the relationship between the L2 and L1 variables. Given a causal model with an outcome variable Y_{ij}, the target L2 construct X_j^*, an appropriately specified L1 theoretical counterpart X_{ij} that is not a descendant of the target L2 variable (corresponding to 1B and 1C), and exogenous assignments U=*u*, one could define,

Contextual effect of X for individual *u* = $Y_{Xj^*=k+1}(u) - Y_{Xj^*=k}(u)$ (Eq 7)

Averaging over population U,

Average contextual effect of *X* for population U

$= E[Y_{Xj^*=k+1}(u)] - E[Y_{Xj^*=k}(u)]$ (Eq 8)

Equation 8 is just a formal paraphrase of the expressions "the ACE [average causal effect] of neighborhoods on health outcomes" and "ACE of neighborhood context on health endpoint *y*" that Oakes (2004, p.1937, p.1932) uses to describe "causal neighborhood effects." Assuming the causal model visualized in model 1B or 1C of Fig. 3.1, the path coefficient *b* represents the contextual effect.

In case X_{ij} is modeled as a descendant of X_j^* as exemplified in model 1A of Fig. 3.1 (c.f. VanderWeele 2010), an intervention in the latter would entail changes in the former, and its effect on Y_{ij} would consist of both the "group-mean" or "climate" effect and a "noncontextual" effect that operates solely based on the individual-level characteristic (provided that the frog-pond effect is zero). It should be possible to define contextual effect as such, but I propose that, in this case, the contextual effect is aptly conceptualized as the *direct effect* of the L2 construct. This is partly in light of consistency with the traditional practice in MLM in which controlling for X_{ij} is generally considered a proper procedure for estimating the contextual effect. Perhaps more importantly, there is in most cases a substantive theory (usually involving some sort of climate effect) that is attributed to the contextual effect, and this may differ from the mechanism emanating from the individual-level variable. The proposed intuition is that, if the structural coefficient *b* was zero and structural coefficient *a* nonzero in model 1A of Fig 3.1, one would in many cases not say that there is a contextual or neighborhood effect of X. Terminology aside, the main quantity of interest in this paper will be the direct effect of the target group-level construct for cases where it can be assumed to determine its individual-level counterpart.

The direct effect of the group-level construct on the outcome can be conceived as either controlled or natural: they would generally come with different concepts, identifiability conditions, and practical uses (VanderWeele 2010). Yet, in the absence of treatment-mediator

interactions, the distinction between controlled and natural direct effect collapses (Richiardi et al. 2013). For the case in which X_{ij} is a descendant of the target L2 construct,

Average contextual effect of *X* for population U

$$= E[Y_{Xj^*=k+1,\ Xij=x}(u)] - E[Y_{Xj^*=k,\ Xij=x}(u)] \qquad \text{(Eq 9)}$$

Given model 1A of Fig 3.1, the quantity expressed by Equation 9 equals the path coefficient *b*.

Regardless of whether X_{ij} is seen as a mediator, assuming a linear system, regressing Y_{ij} on X_j^* while controlling for X_{ij} (Equation 1) and reading the regression coefficient of X_j^* identifies the contextual effect of X. Note that, in the presence of confounding, the identifiability condition of the contextual effect is more demanding for the case where X_{ij} is seen as a descendent of X_j^*since one would need to deconfound not only the relationship between X_j^* and Y_{ij} but also between X_{ij} and Y_{ij} (Pearl et al. 2016, p.77).

3.2.4. Contextual effects in causal interactions

One may sometimes hypothesize that the causal effect of a certain explanatory variable X on the outcome Y is determined by the value of another explanatory variable Z (assume single-level data for now with no subscripts). For a tuple of exogenous variables U=*u*, the average causal interaction effect between X and Z can be written as:

Average Treatment (or Causal) interaction effect

$$= E[Y_{X=x+1,\ Z=z+1}(u)] - E[Y_{X=x,\ Z=z+1}(u)] - \{E[Y_{X=x+1,\ Z=z}(u)] - E[Y_{X=x,\ Z=z}(u)]\} \qquad \text{(Eq 10)}$$

Equation 10 expresses the average causal effect of X on Y under the intervention Z=*z*+1 minus the average causal effect of X on Y under the intervention Z=*z*. Following the "conditional

effects interpretation" of causal interaction (Egami and Imai 2019, p.532), one can understand Equation 10 as expressing how Z affects or "causes" the causal effect of X on Y.

How does this relate to contextual analysis? Sometimes, the variable that is hypothesized to bring about changes to the effect of (i.e., causally interact with) an L1 focal independent variable X_{ij} is an L2 variable Z_j^*. And the group-level variable may be deemed to have an analogous L1 counterpart Z_{ij}, such that the former could even be reasonably measured by aggregating the latter. Consistent with the discussion in section 2.2, assume Y_{ij} and X_{ij} are both considered only at the individual level. In such cases, one may speak of a contextual effect in an interaction setting, or a *contextual interaction effect* of Z. Intuitively, this concept expresses the "unique" effect of the target group-level variable Z_j^* on the causal effect of X_{ij} on Y_{ij}.

If the L1 counterpart Z_{ij} is not modeled as a descendent of the target L2 property Z_j^*, regarding the effect of an L1 variable X_{ij} on an L1 outcome Y_{ij},

Average Contextual Interaction Effect of Z

$$=E[Y_{Xij=x+1},\, z_{j*=k+1}] - E[Y_{Xij=x},\, z_{j*=k+1}] - \{E[Y_{Xij=x+1},\, z_{j*=k}] - E[Y_{Xij=x},\, z_{j*=k}]\} \qquad \text{(Eq 11)}$$

Equation 11 is just a repetition of Equation 10 except that Z is considered at the aggregated level and X and Y at the individual level.

Alternatively, in case Z_{ij} is modeled as a descendent of the target L2 property Z_j^*, following the same reasoning presented in section 2.3, Z_{ij} would need to be intervened in and held constant amidst interventions in Z_j^*. As such,

Average Contextual Interaction Effect of Z

$$=E[Y_{Xij*=x+1},\, z_{j*=k+1},\, z_{ij=z}] - E[Y_{Xij*=x},\, z_{j*=k+1},\, z_{ij=z}]$$

$$-\{E[Y_{Xij^*=x+1},\ z_{j^*=k},\ z_{ij=z}] - E[Y_{Xij^*=x},\ z_{j^*=k},\ z_{ij=z}]\} \quad \text{(Eq 12)}$$

Some types of substantive hypotheses in social-epidemiological research—such as those that stress the role of a certain type of group climate for amplifying or attenuating the effect of a proximal stressor on a health outcome—are essentially theories of contextual interaction effects. One caveat for this type of causal interaction is that, due to the conceptual affinity between Z_{ij} and Z_j^*, when there is a plausible theory for causal interaction between X_{ij} and Z_j^*, it would in most cases be *prima facie* plausible that there is a causal interaction between X_{ij} and Z_{ij} as well. Identification strategies for contextual interaction effect should fully account for this caveat to avoid model misspecification.

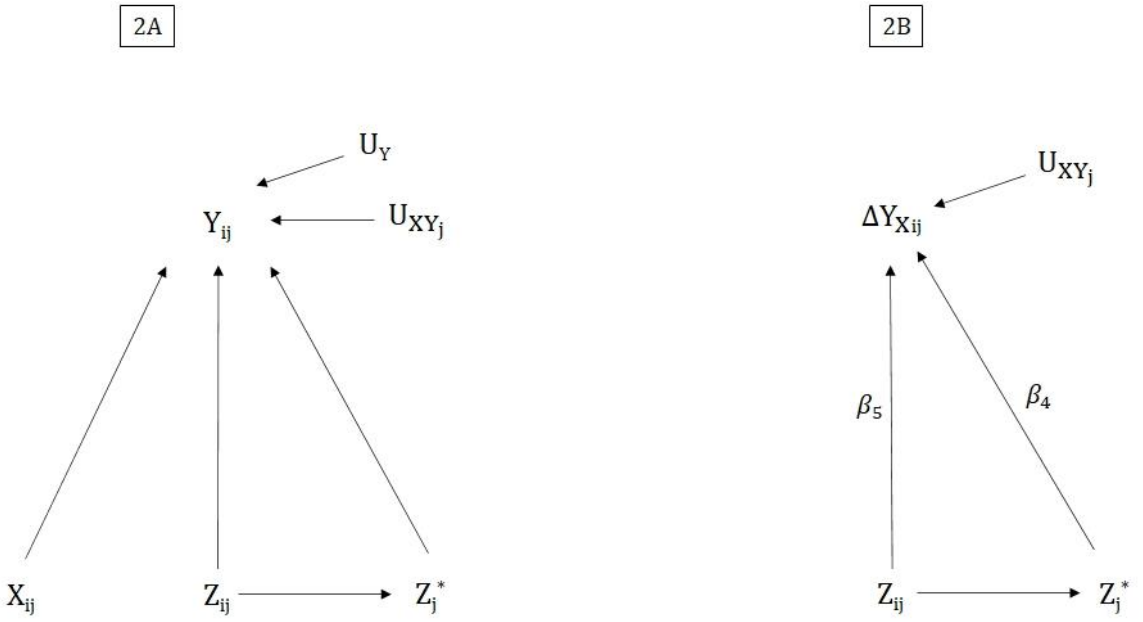
To illustrate this point in more detail, consider a sample structural causal model represented by Equation 13 and DAG 2A and 2B in Fig 3.2. As shown in Equation 13, there is a linear causal interaction between X_{ij} and Z_j^* and X_{ij} and Z_{ij} and linear structural coefficients for all other paths. U_{Yj} and U_{Yij} are the L2 and L1 noise terms for Y_{ij}, respectively, both i.i.d. and normally distributed with a mean of zero. U_{XYj} is a zero-mean normally distributed L2 noise term that causally interacts with X_{ij}. The arrow symbol in Equation 13 was used to distinguish it as a structural rather than regression equation following the suggestion of Pearl et al. (2016, p.81). As shown in DAGs 2A and 2B in Fig 3.2, it is assumed that Z_{ij} causes Z_j^* so that interventions in Z_j^* have no bearing on Z_{ij}. Figure 2B is what Nilsson et al. (2021) calls an "IDAG," which is a proposed notational convention for graphically representing interaction effects (Ibid., p.617-618). "In brief, the IDAG works like any DAG but…depicts how different variables influence the size of a chosen effect measure" (Nilsson et al. 2021, p.614). The symbol ΔY_{Xij} denotes the causal effect of X_{ij} on Y_{ij}, which, as shown between the parentheses in Equation 13, is determined as a linear function of both Z_j^* and Z_{ij} (plus a zero-mean noise term). Given such a

causal model, the structural coefficient β_4 equals the contextual interaction effect of Z as defined by Equation 11.

$$Y_{ij} \leftarrow \beta_1 X_{ij} + \beta_2 Z_{ij} + \beta_3 Z_j^* + \beta_4 X_{ij} Z_j^* + \beta_5 X_{ij} Z_{ij} + U_{Yj} + U_{XYj} X_{ij} + U_{Yij}$$

$$= (\beta_1 + \beta_4 Z_j^* + \beta_5 Z_{ij} + U_{XYj}) X_{ij} + \beta_2 Z_{ij} + \beta_3 Z_j^* + U_{Yj} + U_{Yij} \quad \text{(Eq 13)}$$

Fig 3.2. Sample structural model with X_{ij}-Z_j^* and X_{ij}-Z_{ij} causal interaction.



In case Z_{ij} is modeled as a descendent of Z_j^*, Fig 3.2 would need to be modified such that the arrow between Z_{ij} and Z_j^* is reversed. Given this modified Fig 3.2 and the structural equation for Y_{ij} expressed in Equation 13, the structural coefficient β_4 still represents the contextual interaction effect as defined by Equation 12. This can be easily checked by computing each of the four expected potential values of Y_{ij} in Equation 12 under the specified interventions using Equation 13.

Assuming that Equation 13 is indeed the true structural equation for Y_{ij}, a regression model like Equation 6 that contains both an L1-L2 ($X_{ij}Z_{ij}$) and an L1-L1 ($X_{ij}Z_j^*$) interaction term can be

used to identify the contextual interaction effect β_4. This holds regardless of the direction of causation between Z_{ij} and Z_j^*, although, with one more variable that is intervened in, Equation 12 generally comes with more demanding identifiability conditions than Equation 11 in the presence of confounding: While Equation 11 requires conditioning on variables that confound the relationships between X_{ij} and Y_{ij} and between Z_j^* and Y_{ij}, Equation 12 additionally requires conditioning on confounders for the relationship between Z_{ij} and Y_{ij}. Note that, if the substantive theory being tested implies causal interaction and not just effect modification, merely deconfounding the relationship X_{ij}-Y_{ij} is insufficient (VanderWeele 2009). This point should be taken into account when, for example, choosing covariates to be included in regression analysis.

The problem is that, in practice, regression models like Equation 6 are almost never used even when the research goal is to test a substantive theory about a contextual interaction effect. Instead, researchers often use models like Equation 5 that merely contain a cross-level interaction. This makes it almost impossible to know if the estimated quantity indeed reflects the intended X_{ij}-Z_j^* interaction rather than an X_{ij}-Z_{ij} interaction. Generally, when the substantive goal of the research is to argue for the distinct importance of a group-level property, simply estimating the "between-effect" is almost entirely unable to discriminate between the theory that grants causal power to a property of the social environment and the immediate rival theory that focuses on the role of an analogous individual-level trait. Yet, when contextual hypotheses are conceived in an interaction setting, many researchers appear to overlook this common insight.

To demonstrate the inadequacy of cross-level interactions more fully for identifying contextual interaction effects, I present a simple simulation study. Artificial data with 40000 observations in 200 groups of equal size is generated according to the following structural equations and exogenous assignments.

$$Y_{ij} \leftarrow 1.5X_{ij} + 3Z_{ij} + 0.5\bar{Z}_j + 2X_{ij}Z_{ij} + U_{Yj} + U_{XYj}X_{ij} + U_{Yij}$$

$$X_{ij} \leftarrow U_{Xij}\,;\, \bar{Z}_j \leftarrow U_{\bar{Z}j}\,;\, Z_i \leftarrow U_{Zi}$$

$$U_{Xij} \sim \text{Normal}(2, 1);\ U_{\bar{Z}j} \sim \text{Normal}(1, 0.5);\ U_{Zi} \sim \text{Normal}(0, 1)$$

$$U_{Yj} \sim \text{Normal}(0, 0.5);\ U_{Yij} \sim \text{Normal}(0, 1);\ U_{XYj} \sim \text{Normal}(0, 0.2)$$

The following two regression models are used for the analysis. Model II has an L1-L1 interaction term in addition to a cross-level interaction term while Model I only contains a cross-level interaction term.

$$Y_{ij} = r_0 + r_1X_{ij} + r_2Z_{ij} + r_3\bar{Z}_j + r_4X_{ij}\bar{Z}_j + u_{0j} + u_{1ij}X_{ij} + \epsilon_{ij} \quad \text{[Model I]}$$

$$Y_{ij} = r_0 + r_1X_{ij} + r_2Z_{ij} + r_3\bar{Z}_j + r_4X_{ij}\bar{Z}_j + r_5X_{ij}Z_{ij} + u_{0j} + u_{1ij}X_{ij} + \epsilon_{ij} \quad \text{[Model II]}$$

Table 3.1. Comparison of regression results for simulated data

	Structural Coefficient	Model I	Model II
X	1.5	2.017 (0.056)	1.555 (0.082)
Z_{ij}	3	7.012 (0.011)	3.011 (0.051)
$\bar{Z}_j$	0.5	-3.497 (0.076)	0.500 (0.067)
$X_{ij}Z_{ij}$	2		**1.997 (0.005)**
$X_{ij}\bar{Z}_j$	0	**1.967 (0.045)**	-0.037 (0.041)
Intercept	0	0.094 (0.095)	0.001 (0.082)
var(u_{0j})	0.5	0.531	0.470
var(u_{1j})	0.2	0.203	0.188
var(ϵ_{ij})	1	4.879	0.996

Note: Standard errors in parentheses; The R package 'lme4' (ver. 1.1-27.1) was used for estimation (Bates et al. 2015).

In the actual causal structure, there is a direct linear causal interaction between X_{ij} and Z_{ij} but not between X_{ij} and $\bar{Z}_j$. Any study that specifically proposes how $\bar{Z}_j$ causally interacts with X_{ij} would need to consider and test this alternative possibility. However, as shown in Table 3.1, estimating a regression model merely with a cross-level interaction between X_{ij} and $\bar{Z}_j$ (i.e., Model I) returns a regression coefficient that does not correctly identify the true structural coefficient, which is zero. Instead, the structural coefficient of the L1-L1 interaction is misleadingly carried over to the regression coefficient of the cross-level interaction term, which would have led the researcher to erroneously claim empirical support for a contextual hypothesis. Only when the L1-L1 interaction term $X_{ij}Z_{ij}$ is added to the regression equation (Model II), does the regression coefficient of each interaction term identify the true underlying causal interaction.

3.3. Case study: Contextual determinants of psychiatric vulnerability/resilience

The study of diathesis (sometimes called vulnerability) or resilience to psychiatric outcomes is a field in which the main explanandum is readily operationalized as a causal relationship between two individual-level variables. Generally, for a certain psychiatric outcome, there is a scale that can be used to operationalize its severity. The concept of diathesis/resilience builds on but is not identical to, such scales (Johnson et al. 2010). According to the stress-diathesis model widely used in the medical sciences, psychiatric or behavioral problems occur as a result of interactions between a proximal or precipitating stressor (the "stress" part) and background factors that predispose individuals to adverse health outcomes in the face of precipitating events (the "diathesis" part) (Ingram and Luxton 2005). A high level of vulnerability (or a low level of resilience) is seen when a certain proximal stressor greatly amplifies an individual's psychiatric scale, and a low level of vulnerability (or a high level of resilience) is seen when the proximal stressor exerts only a meager effect on it.

The concept of diathesis originally focused on genetic or biological traits but has expanded to psychological and social states (van Heeringen 2012). Observational research in this field frequently regresses a measure of a psychiatric outcome, say, suicide or depression, on a proximal stressor and examines its interaction with a certain psychometric construct such as problem-solving skills and emotional intelligence (Adams and Adams 1996; Cha and Nock 2009) or a social resource such as support from family or schoolmates (Au et al. 2009; Miller et al. 2015). These conditions are sometimes called "internal" and "external" protective factors, respectively (Rutter et al. 2008).

Occasionally, research of the 'external' kind takes interest in the "contextual" or "neighborhood" effects of a certain socioeconomic variable. In the remaining parts of this section, I will critically review several research articles published in influential sociology or psychology journals that use hierarchical linear regression to argue for a neighborhood effect of a certain external variable on one's vulnerability to suicidal or depressive symptoms. With perhaps only one exception that includes both an L1-L2 and an L1-L1 interaction (Zimmerman 2013), all visible research of this kind merely includes a cross-level interaction between an L1 proximal stressor and an L2 group-level variable of interest even when the latter has a valid counterpart at L1.

The main contention of the following discussion is that such models are generally insufficient to reveal the distinct importance of the group-level variable for amplifying or attenuating the effect of the proximal stressor. It will be additionally proposed that adding an appropriate L1-L1 interaction term could offer a better test of the hypothesized neighborhood effects, assuming the absence of residual confounding and familiar technical issues regarding collinearity, stability of results, and model convergence. These assumptions may be formidable in practice, and this is not to suggest that adding an appropriate L1-L1 interaction will always be feasible or allow an

unbiased identification of the contextual interaction effect. Yet, it does represent one simple tool that could, in principle, considerably improve the correspondence between theory and empirical analysis than what has been frequently done in this type of study.

3.3.1. Neighborhood religiosity and adolescent resilience to suicide in the face of depression

Maimon and Kuhl (2008) published in the *American Sociological Review* starts from the theoretical postulation that "[s]ocial determinants of suicide are likely to contribute as much as, if not more than, individual risk factors" (p.922, originally cited from Knox et al. 2004, p.38). The main finding of the paper is that the relationship between past-year adolescent suicidality collected in the second wave of the National Longitudinal Study of Adolescent to Adult Health (Add Health) (Harris 2018) in 1996 and depression scale collected in the first wave in 1994-1995 is weaker for adolescents living in religious compared to non-religious neighborhoods. This finding comes from fitting a hierarchical linear regression with wave 2 past-year suicide attempt as the dependent variable and including an interaction term between (grand-mean centered) wave 1 individual-level depression scale and wave 1 neighborhood religiosity measured by aggregating the respondents' parent's religiosity scale. The cross-level interaction is negative and significant. According to the authors,

> [t]hese findings emphasize the importance of neighborhood integrative functions, particularly through religious institutions as Durkheim emphasized, in reducing adolescents' suicidality. Community religiosity may provide adolescents with some measure of strategic adaptation to stress…(p.940)

While theoretically sound, nothing prevents one from interpreting the statistical result as indicative of the importance of individual-level religiosity rather than neighborhood religiosity. Individuals living in religious neighborhoods tend to be religious, and a critic may contest that

individual religiosity is what matters for adolescents' resilience to suicidal outcomes in the face of depression.

Below, Maimon and Kuhl's (2008) article is replicated using the restricted-access Add Health dataset used in the original study. Most general-purpose public health surveys including Add Health contain only rough measurements of suicidality in a categorical format even though suicidality can be conceptualized as a latent variable with a continuous scale (Durkheim 2002[1897], xliii; see also Posner et al. 2011; Mundt et al. 2013). The replications presented below work with a binary variable for past suicide attempt. A multilevel logistic model is used, which can be written as:

$$Y_{ij}^{*} = r_0 + r_1 X_{ij} + r_2 Z_{ij} + r_3 Z_j^{*} + r_4 X_{ij} Z_j^{*} + \text{other covariates} + u_{0j} + u_{1j} X_{ij} + \epsilon_{ij} \qquad \text{(Eq 14)}$$

Y_{ij}^{*} is a continuous latent variable for suicidality, X_{ij} depression scale, Z_{ij} individual religiosity, Z_{ij} neighborhood (average) religiosity. Equation 14 is just like Equation 5 except that Y_{ij} is latent and ϵ_{ij} follows a standard logistic distribution rather than a normal distribution (c.f. Steele 2009b).

The pre-processing of the raw data and model estimation followed the authors' description in the paper as closely as possible but could not end up with the same number of adolescents and neighborhoods. Direct communication with the first author failed to resolve the discrepancy due to the unavailability of the original code. Note that the original article used a Poisson link function (p.932), but this is problematic due to zero inflation, and more importantly, the raw survey data on past suicide attempt is, in fact, not in count format contrary to what the authors state (p.929; see variable H2SU2 on Add Health Codebook). The authors mention in footnote 8 that they "ran all models using multi-level logistic regression" and "found no significant

differences" (p.929), so this replication goes with the logistic option. Despite the use of interaction terms, multicollinearity was not a major issue when diagnosed with variance inflation factors (<5).

Table 3.2. Replication of cross-level interaction model in Maimon and Kuhl (2008)

	Dependent variable: logit(P(Suicide Attempt=1))					
	(1)		(2)		(3)	
	Coef (se)	p two-tailed	Coef (se)	p two-tailed	Coef (se)	p two-tailed
Depression	0.488 (0.078)	0.000	0.488 (0.078)	0.000	0.492 (0.080)	0.000
Neighborhood Religiosity	0.050 (0.099)	0.616	0.057 (0.100)	0.570	0.057 (0.100)	0.567
Individual Religiosity	-0.003 (0.079)	0.966	-0.027 (0.094)	0.775	-0.027 (0.094)	0.777
Public Assistance	-0.094 (0.264)	0.722	-0.093 (0.264)	0.725	-0.045 (0.344)	0.897
Depression x Neighborhood Religiosity	-0.089 (0.054)	0.101	-0.097 (0.058)	0.091	-0.097 (0.058)	0.091
Depression x Individual Religiosity			0.026 (0.057)	0.651	-0.025 (0.057)	0.658
Depression x Public Assistance					-0.045 (0.198)	0.828
Intercept	-4.578 (0.212)	0.000	-4.580 (0.212)	0.000	-4.585 (0.213)	0.897

Residual intercept sd	0.481	0.483	0.483
	(0.143)	(0.143)	(0.143)
Residual slope sd	0.204	0.207	0.208
	(0.143)	(0.142)	(0.142)
Observations L1	7213	7213	7213
Observations L2	365	365	365

Note: Control variables not shown. The full regression table is included as online supplementary material.

Model 1 includes only a cross-level interaction term between depression and neighborhood religiosity. However, unlike in the original article, the coefficient of the interaction term is only mildly negative with a relatively elevated p-value of 0.1. One may at this point simply declare the result as inconclusive and halt the analysis, but for the sake of discussion, let's assume that the coefficient was more substantial. A suitable next step for testing the authors' contextual hypothesis is to see if the negative cross-level interaction remains after adding an interaction term between depression and individual religiosity. The result shows no indication that adolescent vulnerability to suicidal attempt varies by individual-level religiosity when neighborhood religiosity is considered.

One could, in addition to Model 2, also try to think of additional confounders. One theoretically plausible candidate would be poverty, which has been reported by a handful of observational studies to increase vulnerability to suicide or depression (Dupéré et al. 2009; Jeong 2021; Verbeek et al. 2019) and correlate with group and individual religiosity. Model 3 adds to Model 2 an interaction term between depression and receipt of public assistance, the latter of which is used as a measure of household poverty. At least in this sample, there is hardly any indication that receipt of public assistance alters the effect of depression, and the negative coefficient of the cross-level interaction remains largely unchanged. Had the cross-level interaction between

neighborhood religiosity and depression been more substantial throughout these models, it could have provided much more tangible support for the authors' "Durkheimian" hypothesis that neighborhood religiosity protects adolescents from suicide in the face of depression by promoting social integration.

3.3.2. Neighborhood poverty and adolescent vulnerability to suicide in the face of negative life events in Canada

Dupéré et al. (2009) published in *Psychological Medicine* is a paper with a similar design as the one above. As Maimon and Kuhl (2008) emphasized the protective effect of religion and specifically religion at the neighborhood level, Dupéré et al. (2009) stress the predisposing effects of poverty with particular attention to poverty at the neighborhood level. Using data from the Canadian National Longitudinal Survey of Children and Youth, the authors regressed the presence or absence of suicidal attempt in the past twelve months among 18 to 19-year-olds on a range of (grand-mean centered) covariates and added a cross-level interaction term between negative life event and neighborhood poverty, the latter of which was operationalized by the proportion of residents living under the poverty line. The authors reported that the interaction coefficient is positive and "marginally significant" ($p=0.06$).

The result indicates that adolescents living in a poor neighborhood tend to be less resilient to the suicide-inducing effects of negative life events and suggests that poverty is a predisposing factor when it comes to suicidal outcomes. But how much insight does this offer into what we could reasonably call a "neighborhood" or "contextual" effect of poverty? Does neighborhood poverty amplify suicidal vulnerability in addition to what (if any) is already amplified by individual-level poverty, such that a poor person living in a non-poor neighborhood can be expected to have been

more vulnerable to suicide in the face of negative life events than if that person's neighborhood had been poor?

Among the ways in which poverty might affect suicidal vulnerability, one could identify ones that operate by virtue of residing in the vicinity of other poor people or in a socioeconomically deprived residential environment, and those that operate with little connection to the level of deprivation of the surrounding residential environment. The analysis presented by Dupéré et al. (2009), despite the emphasis on neighborhood effects, only attests to the general implication of poverty on suicidality and does not say much about the distinct importance of living in a poor neighborhood climate. As such, it hardly offers additional theoretical insight than research that examines the interaction between negative life event and individual-level SES (Verbeek et al. 2019). Modeling the effect of negative life events on suicidality not just as a function of neighborhood poverty but also individual-level poverty could have offered at least some initial insight into the neighborhood effect of poverty on suicidal vulnerability in the face of negative life events, barring the possibility of residual confounding and technical problems related to model estimation.

3.3.3. Neighborhood disadvantage and African Americans' vulnerability to suicide in the face of negative life events.

Cutrona et al. (2005) published in *Journal of Abnormal Psychology* opened the discussion with the theoretical perspective that "[t]he neighborhood contexts in which people live affect many aspects of their lives," and positioned the paper within a body of research about neighborhood contextual effects on mental health (p.3). Specifically, the paper identified negative life events and the personality trait of negative affectivity as two risk factors of depression and hypothesized that an "[a]dverse neighborhood environment would amplify the effects of these known risk

factors for depression" (p.3). Using data from the Family and Community Health Study (FACHS), neighborhood-level disadvantage was measured by aggregating various individual or household-level economic variables and individual questionnaires about residential quality. Logistic hierarchical linear regressions with a cross-level interaction between neighborhood disadvantage and each of two individual-level proximal stressors were run, one at a time. A positive and significant result was reported for the interaction involving negative life events, which was interpreted as providing empirical support for the proposed hypothesis. The models did not contain any other interaction terms, which the authors justified by citing Kreft and Leeuw's (1998) recommendation to examine each interaction term "in isolation in multilevel models to minimize the negative effects of multicollinearity" (Cutrona et al. 2005, p.10).

It is unclear if the models were actually checked for multicollinearity problems, and I was not able to retrieve the raw data for replication after contacting the first author and all three principal investigators of FACHS (all of whom did not reply to the request). As observed in the replication of Maimon and Kuhl (2008), including more than one interaction term in a multiple regression does not always result in problematic levels of multicollinearity (see also Jeong 2021). Regardless of whether multicollinearity prevented the addition of other interaction terms in the original study, the significant cross-level interaction alone provides extremely limited support for the authors' hypothesis that living in a disadvantaged *neighborhood climate* amplifies the effect of negative life events on depression. The authors' hypothesis could have received more tangible support if the cross-level interaction remained substantial even after including an appropriate L1-L1 interaction term involving an individual-level measure of socioeconomic deprivation.

3.3.4. Neighborhood income and adolescent suicidal vulnerability in South Korea

A more recent example is Kim and Chang (2018) published in *Social Forces*. The authors used a cross-level interaction between one of several measures of neighborhood quality (average income, residential quality, and suicide rate) and the number of delinquent peers for predicting adolescent suicidal ideation to test a theory about how disadvantaged neighborhood context amplifies the effect of delinquent peer relations on adolescent suicidal ideation. To avoid repetition, I will not pursue a detailed criticism of this article here but merely note that complete vulnerability to contextual fallacy is not hard to come by in the existing literature that involves hypotheses about contextual interaction effects.

3.4. Conclusion

The discussion presented above can be summarized in two parts. First, it revisited the old issue of contextual effects, which, the long history of methodological debates and practical application notwithstanding, has seen scant recent in-depth theoretical review. I argued that contextual analysis models are fundamentally based on a theoretical postulation of conceptually analogous variables at L1 in addition to the target L2 construct. The term has two types of usage in the literature, one expressed in a purely associative language of traditional statistics, and one explicitly causal. In the purely associative sense, it represents the expected difference in the outcome variable between two individuals with the same individual-level property (say, individual poverty/deprivation) but who differ in the analogous group-level property (say, neighborhood poverty/disadvantage). In the causal sense, contextual effect captures what would have happened to the outcome in response to hypothetical interventions in the target L2 property while assuming that the corresponding L1 variable would have remained unaffected. In linear

systems, and in the absence of confounding, the associative definition of contextual effect identifies the contextual effect in the causal sense.

Second, it argued that the concept of contextual effects can be extended to an interaction setting, specifically one in which the effect of an individual focal explanatory variable X_{ij} varies as a function of both the L2 construct of interest and the corresponding L1 variable (say, Z_j^* and Z_{ij}). As an example, I presented the field of diathesis/resilience to suicide or depression, of which explanandum can be conceived as the causal effect of a proximal stressor on suicidality or depression. Sometimes, researchers would make theoretical claims about how a certain characteristic that pertains specifically to one's neighborhood context amplifies or diminishes the effect of a proximal stressor on a psychiatric outcome. Most studies of this type use multilevel regression models that merely include a cross-level interaction between the proximal stressor X_{ij} and the target neighborhood-level construct Z_j^*, but this modeling strategy is generally incapable of differentiating the distinct effect of the neighborhood-level variable as opposed to the corresponding individual-level variable. I argued that adding an appropriate L1-L1 interaction term (i.e., X_{ij}-Z_{ij} interaction) may, in principle, grant such regression models at least some ability to test contextual hypotheses and alleviate the risk of committing a contextual fallacy. Albeit imperfect and subject to further assumptions, this solution is just a direct extension of the basic insight of the traditional definition of "contextual analysis model," which models the outcome as a function of not just the target L2 construct but also its L1 counterpart.

Data availability

This is not an empirical paper, but there is one replication study. I do not have the right to distribute the data, but I present the software script and a brief description of how to obtain the data.

Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2022.115279.

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Discussion

The three articles in this dissertation offer several original contributions to the study of the socioeconomic determinants of suicidal ideation among adolescents. I found that coming from an affluent family background can, at least in some cases, be a vulnerability rather than a resilience factor for adolescents. While this finding defies received wisdom, it is consistent with the accumulated research on stress inoculation, which holds that continued exposure to adversity can sometimes have the positive consequence of "steeling" or "inoculating" the individual against detrimental stressors. In the field of suicidology, a handful of papers published in the past several years reported cases in which youths who are exposed to more ecological hardships or adversity exhibit a smaller increase in the risk of suicidal ideation following traumatic events such as school bullying (Barzilay et al. 2021; see also Gayford-Harden et al. 2016; Kim and Chun 2020). We should therefore revisit the common assumption that less favorable social and ecological conditions necessarily associate with decreased psychological resilience due to an accumulation of stress (Cutrona et al. 2005; Dupéré et al. 2009; Verbeek et al. 2019; Zimmerman 2013).

Throughout the dissertation, I used the stress-diathesis model as a basic framework for understanding psychopathology, including suicidal behavior. Following the stress-diathesis model, I assumed that psychiatric outcomes are triggered by precipitating events against the backdrop of preexisting vulnerability factors. This basic theoretical intuition of the stress-diathesis model helped reduce theoretical arbitrariness in the selection of focal independent variables. However, I also argued that the prevalent interpretation of the stress-diathesis model contained methodological and theoretical deficiencies, most notably related to the concept of additivity (Ingram and Luxton 2005; Monroe and Simmons 1991; Quaedflieg and Smeets 2013). While it remains plausible that stress from chronic conditions and episodic stress both contribute

to the onset of mental disorders, the possibility of adaptation to stress challenges the idea that stress simply adds up to trigger mental disorders.

My dissertation research also offers some methodological contributions. I argue that estimating "contextual" or "neighborhood" effects on resilience necessitates the inclusion of an appropriate L1-L1 interaction term (or terms) if the L2 variable can be considered to have a theoretically valid L1 counterpart. Virtually all existing research on the socioeconomic determinants of resilience to mental disorders merely includes a cross-level (L1-L2) interaction between an individual-level proximal stressor and the group-level background factor of interest. However, this modelling makes certain assumptions that are almost always unrealistic, and there is no way to know if a significant L1-L2 interaction reflects a genuine "contextual" effect or is a statistical artifact that comes from an underlying noncontextual effect. For example, a positive interaction between depression (L1 variable) and neighborhood poverty (L2 variable) for predicting suicidal ideation says nothing about the "neighborhood effect" of poverty on resilience, as it could simply mean that individual poverty determines the effect of the proximal stressor on the outcome, and poorer neighborhoods, almost by definition, have a higher percentage of poor individuals. I therefore suggest that future research in this field should, at a minimum, include a proper individual-level interaction to estimate contextual effects (assuming the lack of technical issues related to estimating such complex interaction effects) or omit the goal of identifying a distinctively "neighborhood" effects of a certain background factor of interest on psychological resilience.

In the rest of this section, I will elaborate on four issues that were not sufficiently discussed in the standalone article chapters. First, I will elaborate on the issues in the theoretical interpretation of reduced responsivity to stress. Second, I will introduce failed replication studies

and their implications on our understanding of the relationship between SES and adolescent psychological resilience. Third, I will describe the methodological limitations of the current study with special focus on the possibility of reverse causality. Fourth, I suggest some caveats for the theoretical use of contextual effects in socials studies of health.

Resilience or emotional deactivation?

In all three substantive chapters, I interpreted decreases in the "effect" of the proximal stressor on suicidal ideation as reflecting psychological resilience to stress. However, reduced pathological responsivity to stressors may occur not only through resilience but also through emotional deactivation. This possibility has been suggested by the "Adoptive Calibration Model" (ACM) of stress reactivity, proposed by Del Giudice et al. (2011). The authors hypothesized four distinct profiles of stress responsivity labeled "I. Sensitive," "II. buffered," "III. vigilant," and "IV. unemotional" (the numberings help highlight the order in the developmental adversity scale). These four profiles are thought to correspond to a monotonically varying scale of ontogenetic stress, with the first associated with a "low stress, safe environment" and the last with "severe, traumatic stress." (Del Giudice et al. 2011, p.1577). Notably, an empirical test of the ACM among Dutch adolescents found the four profiles to be monotonically associated with family socioeconomic status, with profile "I. Sensitive" having the highest average SES and "IV. Unemotional" the lowest (Ellis et al. 2017). ACM extends the U-curve theory of resilience (Seery et al. 2011; 2013; Russo et al. 2012; see also Boyce and Ellis (2005) for a direct theoretical precursor to the ACM) into an *И*-shape by adding the fourth "unemotional" profile.

The "buffered" and "unemotional" ideal-typical profiles are both instances of muted responsivity to stress. Yet, the underlying mechanisms and their implications on mental health

are very different. While the former occurs and is developed through experiences of successful coping, typically under moderate adversity, the latter is an emotional malfunction characterized by "a lack of empathy or guilt, manipulativeness, and emotional constrictedness" (Del Giudice et al. 2011, p.1583) that is hypothesized to occur as a result of extreme stress. The "window of tolerance" heuristic, popular in clinical psychiatry, may be useful for illustrating this contrast (Siegel 1999). According to this framework, individuals have a certain "window" of psychological arousal in which they can function properly. Exposure to stress may induce the level of arousal to exceed or fall below the window, resulting in pathological levels of arousal or withdrawnness. The "II. buffered" profile describes a person with a "thick" window, whereas the "IV. unemotional" type corresponds to a person whose window is, figuratively speaking, broken. Suitable intervention policies diverge for each type of unresponsivity, and it would be greatly problematic if resilience research failed to partial out the component of unresponsivity that originates from emotionally deactivated individuals.

Yet, there are factors that dispel or at least mitigate this issue for the studies conducted in this dissertation. For the analysis in Chapter 1, the modeling of the stress-diathesis interactions did not assume any parametric form but simply treated each survey response (Five-point Likert scale) as a separate category. The models in Chapter 1 were therefore highly receptive to the true underlying pattern of interactions. This modeling strategy is unconventional and would have been undesirable for most datasets due to small numbers of observations in extreme categories and the risk of statistical "overfitting." However, the very large sample used in Chapter 1, which covered a substantial portion of the entire population, allowed me to model the stress-diathesis interaction without assuming a particular form in advance. The resulting pattern was a clear U or J, with no indications of the *И*-shape (i.e., a cubic shape) suggested by the ACM. This may not

be an anomaly since the empirical evidence for the cubic association between stress and responsivity is still scant (Ellis et al. 2017; Del Giudice et al. 2012) and has only been partially demonstrated for few measures of physiological arousal in an experimental setting.

The applicability of the general hypothesis of the ACM may vary depending on the type of psychopathology, and it is currently unknown if individuals who experienced the most severe ontogenetic stress tend to have exceptionally muted responsivity to suicidal behaviors. The literature on suicidal behavior and depressive symptoms has yet to report such a pattern and more research is needed to examine its feasibility. Still, considering the clear U- or J-shaped pattern of stress-diathesis interactions reported in Chapter 1, it is natural to interpret the low level of stress-responsivity as indicative of resilience and buffering rather than emotional desensitization that might occur under conditions of extreme stress and trauma.

The linear interaction identified in Chapter 2 raises greater theoretical concern. Even if the statistically significant linear interaction in Model 2 of Table 2.2 reflects a true underlying mechanism, there is a possibility that the muted responsivity to bullying among lower-SES individuals partly comes from emotionally desensitized individuals. However, the small number of empirical studies that at least partially confirmed the ACM all report a far larger proportion of the "buffered" profile compared to the "unemotional" one (Ellis et al. 2017; Del Giudice et al. 2012), suggesting that the negative linear interaction between bullying victimhood and family SES primarily reflects the resilience of students with moderate levels of developmental adversity rather than the emotional callousness of students with traumatic ontogenetic experiences. The lack of evidence of the "unemotional" profile for suicidal outcomes only strengthens this interpretation.

Insights from failed replications

I gained several important insights in the replication study presented in Chapter 3. Here, I briefly describe a point about failed and impossible replications that I was not able to elaborate on in depth in the article. In addition to the failed replication of Maimon and Kuhl (2008) presented in section 3.3.1, the next paper by Dupéré et al. (2009) I reviewed (but not replicated) in section 3.3.2 also could not be replicated. As with Maimon and Kuhl (2008), the descriptions in the published article were insufficient for replication, and the first author responded in a private email communication that she no longer has the original software code. Even after multiple attempts, I was unable to obtain results that are anywhere close to the main result of that article, which reported a "marginally significant" positive interaction between recent negative events and neighborhood poverty for predicting youth suicidal ideation. Even when using individual-level rather than neighborhood-level poverty for the main diathesis variable I was not able to reach results similar to those of the original study. Considering that this article was one of the most highly cited papers buttressing the hypothesis that socioeconomically disadvantaged youth have lower psychological resilience, the failure of replication provides yet another reason to be skeptical of this hypothesis. In addition, the article by Cutrona et al. (2005) reviewed in section 3.3.3—an even more influential paper that argues that individuals from socioeconomically deprived neighborhoods are more vulnerable to depression in the face of negative life events—was not available for replication. In this case, neither the first author nor any of the three principal investigators of the Family and Community Health Study (FACHS) were willing to share any replication material or even allow outsider access to raw data. Altogether, the inability to replicate two highly visible empirical pillars of the thesis that individuals from poorer

backgrounds are more vulnerable to psychopathological outcomes casts serious doubt about the validity of this thesis.

The threat of reverse causality

The two empirical articles of this dissertation (Chapters 1 and 2), as well as all the studies replicated or reviewed in Chapter 3, assume that the statistical association between the stressor and the mental disorder wholly reflects the former's causal effect on the latter. While the statistical models include control variables, our confidence in the sufficiency of the controls is limited due to fact that the exact causal structure of adolescent suicidal ideation is unclear. Still, the various robustness checks with a diverse range of controls for the analyses of Chapters 1 and 2, increase our confidence in the conventional interpretation of the results and suggest that residual confounding is unlikely to be a major problem. Yet, even if confounding is not a major issue, the direction of causality remains a key issue. While bullying victimization can certainly mental disorders, some scholars have also argued that emotional problems may "invite" bullies (Hodges and Perry 1999; Slee and Rigby 1993). For example, one longitudinal study found that internalizing problems such as an open display of anxiety or sadness predict changes in bullying victimization and suggested that adolescents who exhibit these emotional problems are prone to being perceived as "weak" by potential bullies (Hodges and Perry 1999). The possibility of reverse causality is especially pertinent to Chapter 1, which relies on a cross-sectional design.

While the possibility of reverse causality is a substantial limitation of Chapter 1, there are factors that mitigate the problem. First, the available evidence for the causal effect of bullying victimization on mental problems is much more consistent that the effect from mental problems to bullying victimization, with multiple studies finding only the former but no study finding only

the latter (Bond et al. 2001; Kim et al. 2006). In particular, the only focused study on the causal direction between bullying victimization and psychopathological behavior among Korean adolescents failed to identify such reverse causality (Kim et al. 2006). Moreover, the view that bullying causes mental problems is conventional in studies of suicidal ideation, and most proposed path models involving bullying victimization and suicidal ideation feature a path from the former to the latter but rarely vice versa (Kim et al. 2014; Reed et al. 2015; Sampasa-Kanyinga et al. 2014).

Methodological implications for the use of contextual effects

A final point that has not been sufficiently discussed in the main text of this dissertation has to do with the practical interpretability of contextual effects. In social studies of health, it is common, perhaps even trendy, to mention contextual or neighborhood effects even when the argument can be almost equivalently presented without such terms. My main criticism in Chapter 3 was mainly focused on a common type of model misspecification for identifying contextual effects, but an equally important criticism concerns the practical applicability and theoretical interpretability of contextual effects. One major motivation for speaking about contextual or neighborhood effects in social studies of health may be to stress the distinctively sociological focus of the research. Such a language signals that the researcher is paying due attention to the fact that human behavior is greatly influenced by social surroundings and interactions, in contrast to the supposed social blindness of purely psychological studies (see, for example, Maimon and Kuhl (2008) for an explicit expression of this idea). However, a lack of attention to contextual or neighborhood effects does not indicate that "social" influences are ignored. A purely individual-level analysis that examines the effect of poverty, for example, already captures the effects that arise from

various “social” circumstances such as a violent residential environment, deprived social capital, and reduced access to various public services that typically accompany poverty.

I therefore suggest one important criterion for speaking about contextual effects. The estimation of contextual effects is justified when the group-level construct is associated with a distinct causal mechanism, which needs to be separately identified for the purpose of the research. For example, Marsh et al (2008)’s study of the relationship between test scores and academic self-concept used school-average exam scores as a proxy for the overall academic prestige of a school, which was thought to produce the “reflected glory effect” that arises as students develop academic self-concept based on the prestige of their school. However, had the researchers used individual measures of academic scores only, they would not have been able know how much of the estimated effect is attributable to the “reflected glory effect” and how much to another type of effect, namely, the “frog-pond effect” that arises as students compare their scores to one another within each school.

In contrast, many discussions of contextual effects in health research lack a clear mechanism that can be uniquely attributed to the contextual effect. For example, how much theoretical difference is there between the effect of neighborhood deprivation on longevity and the effect of individual-level socioeconomic deprivation on longevity? Or, to take the example from section 3.3.2 (Dupéré et al. 2009), how much difference is there between the effect of neighborhood poverty on adolescent suicide attempt and the effect of individual-level poverty on the same outcome? The answers to these questions are not obvious, and without a clear and context-specific theoretical justification, such a distinction easily becomes more a matter of disciplinary posture than a substantial theoretical interpretation. Moreover, the estimation of contextual effects and the resulting multilevel model considerably complicates the statistical

modeling and has often resulted in a mismatch between model and theory, as demonstrated in Chapter 3. For this reason, except for the brief estimation of contextual effects in section 1.3.2, I refrained from theorizing or estimating the "neighborhood" or "contextual" effect of SES on psychological resilience in the two empirical chapters of this dissertation. I suggest that future research should be more attentive to the theoretical interpretability of contextual or neighborhood effects and use them sparingly when a distinct causal mechanism can be attributed to the contextual effect.

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Concluding remarks

This dissertation had two main goals: The first was to propose a counter-hypothesis to the prevalent thesis that lower SES associates with reduced resilience to mental disorders and test it empirically. All empirical studies worked with suicidal ideation as the main type of mental disorder. I showed evidence that SES *in some cases* positively associates with resilience to suicidal ideation in the face of a traumatic event. While this finding cannot be generalized to all cases, it seriously weakens the preexisting tendency to assume that socioeconomic adversity generally reduces resilience due to a lack of coping resources and accumulation of stress.

The second goal was to formally lay out the concept of contextual effects in an interaction setting and propose empirical identification methods. A highly relevant topic for social studies of psychological resilience, this task has never been done in the existing literature, and the last chapter of this dissertation attempted to fill this gap. I argued that most existing research on "contextual" determinants of psychopathological resilience suffers from a severe model misspecification that makes the statistical models nearly completely unable to detect their stated goal of identifying contextual effects. Apart from the theoretical and methodological contribution, I also demonstrated that most published findings of contextual effects on psychological resilience are invalid.

Appendix

A description of variable coding for the Chapter 2, “Family economic status and resilience to suicidal ideation among adolescents: A re-examination of recent findings.”

The dataset used is the Korea Youth Panel Study, which can be downloaded from https://www.nypi.re.kr/archive/board?menuId=MENU00219

The codebook for each wave can also be downloaded on the same website together with the raw data.

Wave 4 students’ questionnaire

- W4 suicidal ideation

Question 49-3-14

“I sometimes feel I want to die.”

Likert scale 1-5, responses 4 and 5 were coded as suicidal ideation.

- Past-year experience of severe bullying

Question 40-1

“I was severely made fun of or insulted”

Yes/No question followed by the number of times if yes. Distribution was heavily zero-inflated. Coded as 0 if No, as 1 otherwise.

- Self-esteem

Questions 49-1-1 to 49-1-6

The average of 6 Likert-scale items, each on a scale of 1-5. Questions 4-6 were reverse-coded. (alpha = 0.75)

“I think I am a person with a good character”; “I think I am a capable person”; “I think I am a valuable person”; “I sometimes think I am a useless person”; “I sometimes think I am a bad person”; “I sometimes think I am a failed person.”

- Self-reported delinquency

Questions 38-7 to 38-10

The average of 4 Likert-scale items, each on a scale of 1-5. (alpha = 0.92)

“I think I am a problem child”; “I think I am a delinquent”; “People around me think I am a problem child”; “People around me think I am a delinquent.”

- Delinquent peers

Questions 36-6-1 to 36-1-6

"Among close friends (answered in Question 37-3 used to populate the 'number of friendships' variable), how many of them engaged in the following activities in the past year?" 1) Drinking, 2) Smoking, 3) Unauthorized absence from school; 4) Beating up another person; 5) mug/forcefully take money from someone, 6) steal someone's money

Responses were integers, with heavy zero-inflation. Coded as 1 if yes to any of the six questions, 0 otherwise.

- Smoking

Question 38-1

"Have you ever done any of the following activities? …Smoking"

- Female

Gender was coded as binary in the survey.

- Club activity

Question 32

"Are you currently participating in any of the following club activities?"

1) Official School clubs
2) Clubs outside of school
3) Non-official small clubs

4) Cyber clubs

Coded as 1 if yes to any of the four, 0 if otherwise

- Family relations

Questions 33-1 to 33-4

The average of 4 Likert-scale items, each on a scale of 1-5. (alpha = 0.85)

“My parents and I try to spent a lot of time together”; “My parents always show love and affection to me”; “My parents and I understand each other well”; “My parents and I speak our minds to each other openly”

- Friendship size

Question 37-1

“How many close friends do you have?”

Respondents are asked to input a number.

- Residential environment quality

Questions 54-4-1 to 54-1-4

The average of 4 Likert-scale items, each on a scale of 1-5. (alpha = 0.78)

"Our neighborhood is littered with trash"; "There are many dark and shady places in our neighborhood"; "There are many drunk people wandering around at night in our neighborhood"; "One can often see teens hanging around in large groups in our neighborhood"

- Collective efficacy

Questions 36-1 to 36-4

The average of 4 Likert-scale items, each on a scale of 1-5. (alpha = 0.68)

"The people in our neighborhood meet often"; "The people in our neighborhood trust each other"; "If I drink alcohol or smoke cigarettes in our neighborhood, the elderly people in our neighborhood would scold me"; "If I am getting beat up by other kids in our neighborhood, the people in our neighborhood would either intervene to stop or call the police"

Wave 4 parents' questionnaire

- Log family income

Question 8

"How much is the average monthly income of your household? Average monthly income should be calculated by dividing by 12 the sum of the all the yearly income including labor, interest, rent, and pension."

Wave 5 students' questionnaire

- W5 suicidal ideation

Question 49-3-14

“I sometimes feel I want to die.”

Likert scale 1-5, responses 4 and 5 were coded as suicidal ideation.