Original article

Economic insecurity and mental health; depression and suicidal ideation of the middle-aged and older adults in Korea

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Abstract

Objectives: In this research, the effect of economic insecurity on the mental health of Koreans aged between 45 and 79 was investigated. The multi-layered characteristics of economic insecurity were measured by 7 indicators: income volatility (A/B), economic difficulty, low-income period, subjective minimum living expenses, economic satisfaction, and economic anxiety/conflict.

Methods: A total of 4,167 men and women were analyzed from the third to the tenth wave of KoWEPS. The effect of economic insecurity indicators on mental health is investigated, controlling the effect of sociodemographic variables. A multi-level panel model was used in consideration for the factors at the time, individual, and household levels.

Results: Most indicators for economic insecurity had a statistically significant effect on depression and suicidal ideation. Specifically, drastic income fluctuations compared to the previous year (income volatility A), the experience of economic difficulties, and both emotional indicators (economic satisfaction, and economic anxiety/conflict) were associated with depression and suicidal ideation. On the other hand, income variance for certain years (income volatility B) had no statistically significant relationship with both mental states in multivariate analysis. Low-income period years and subjective minimum cost of living per month had a significant relationship with only depression.

Conclusion: The results suggest that not only low income itself but also negative economic conditions, perception, and emotional feelings about one's economic status have an impact on depression and suicidal ideation.

keywords: Economic insecurity, Mental health, Middle-aged and older, Multi-level panel, Korea

Introduction

Economic resources are essential for survival, and economic insecurity or uncertainty would ultimately contribute to health. This is especially true for mental health because it is vulnerable to stress, anxiety, or psychological pressure. Economic insecurity can influence mental health through both physical and psychological pathways [1].

Economic insecurity can reduce household expenditure [2], and it may cause vulnerability in nutrition [3] or residential areas. Material deficiency can contribute to poor mental health. Moreover, the perception of economic insecurity might damage social relations [4] buffering shocks in one's life. According to Elder [5], economic insecurity is a catastrophic event that can break the balance between one's expectations and available resources, making people feel like they have lost control of their own lives.

From this perspective, economic insecurity might be responsible for some mental health problems including suicide in Korea. Suicide is deeply related to mental health [6] and an increase in suicidal rate can be attributed to the tension from role conflict [7]. Over the past 10 years, Korea's suicide rate has been ranked top among OECD countries [8]. In 1998, Korea suffered a radical economic fluctuation from the Korean Financial Crisis of 1997, and the country's suicide rate skyrocketed (21.7 per 100,000); it has always been more than 20 per 100,000 after 2000 [6]. The biggest cause of suicidal ideation is economic problems for people aged 20 and older in 2016 [9].

The problem is specifically serious for the middle-

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aged. They have a considerable social responsibility and economic need while there is only a limited opportunity to work. They frequently experience long-term unemployment or early retirement and concomitant low-income levels [10]. In addition, only about 8.8% were well-prepared for old age [11]; which means the elderly are experiencing a relatively high level of economic stress [12].

Depression may be another important indicator affected by economic insecurity. It is significant itself because depression is frequently used to measure negative mental state, but it also exacerbates comorbidity such as chronic diseases [13-15] not to mention that it is closely linked to suicide [16,17]. In the 2000s, the rate of depression in Korea consistently increased [18-20]. Older people experiencing economic difficulty or health problems commonly felt a sense of guilt or depression; three out of ten people aged 65 and older had depression [21].

This paper identifies the impact of economic insecurity on the mental health of middle-aged and older adults in Korea. We incorporated the existing literature to design various measuring instruments. We aimed to test a variety of indicators of this group's mental health.

Theoretical Background

The scope of the concept of economic insecurity is quite wide and unclear, so the operational definitions vary greatly from study to study [22]. Therefore, when examining the literature dealing with economic insecurity, it is only possible to look at the approximate direction of how economic insecurity affects health at a conceptual level. In addition to Elder's life course dynamics perspective [5], the prospect theory as originally put forth by Kahneman and Tversky [23] flourished discussions about the impact of economic insecurity on mental health. In this tradition, Rohde et al. [24] suggest the existence of economic insecurity is what hampers mental health, not poverty itself.

However, if we look at the operational definition, it is limited to find studies that match or have similar operational definitions because plenty of studies were conducted with very different definitions in different settings. For example, Watson & Osberg [25] defined economic security (insecurity) as the probability of an income increase (decrease) of 25%.

Islam [26] considered economic insecurity as the vulnerability to negative income shocks that could lead to a fall below the poverty line. And Bossert & D'Ambrosio [27] defined economic instability as concerns arising from exposure to adverse events and the anticipation of difficulties in overcoming them. Deriving implications from studies applying different measurements to different population groups under different circumstances is very limited for empirical evidence.

Moreover, the mental health effect of a positive event on economic insecurity is not clear. It is a general expectation that positive changes such as income increase will have a positive effect on mental health, but research results on this are somewhat mixed. Watson & Osberg [25] found that the higher the probability of income increase, the more positive the effect on mental health. On the other hand, according to the life event concept of Dohrenwend and Dohrenwend [28], life events generating the need for individuals to adjust their behavior cause great stress by itself, and this stress is independent of whether the event is desirable or not. Thoits & Hannan [29] even found that the group participating in the income maintenance program had a higher distress level in several subgroups.

Therefore, it is necessary to simultaneously check the influence of multiple factors of economic insecurity in the same setting. This is because the existing scattered results that different indicators have a significant effect in different situations can only be discussed at a conceptual level, and it is difficult to have a comprehensive view of the effects of different measurement indicators at the empirical level. In particular, it is difficult to find such a study in Korea. This study seeks to find how multifaceted measures of economic insecurity will affect mental health in Korea's middle-aged and older age groups and contributes to setting empirical evidence on the relationship between economic insecurity and mental health in Korea.

Methods
Data and measures

We used the Korean Welfare Panel Study (KoWEPS), which has followed almost 7,000 households annually since 2006, investigating people's socioeconomic status and health conditions.

KoWEPS is a panel survey in which economically vulnerable households with income less than 60% of the standard median income are over-represented as 50% of the total surveyed population. Therefore, data from KoWEPS are appropriate to confirm the effects of economic insecurity indicators from the survey. We analyzed 8 waves from 2008 (3rd wave) to 2015 (10th wave). This study was exempted from approval of the ethics committee due to the use of secondary data, as a result of the deliberation by the Seoul National University IRB (IRB No. E1606/003-004).

Subjects were aged between 45 and 79 [30] in 2015. Our target population was composed of those who were expected to be economically active and whose economic need was high (ages 45–64) in addition to those who were old in a political perspective (ages 65–79). We excluded persons aged 80 and older, as they could be experiencing depression caused by various health problems other than those caused by economic insecurity. According to Lam, Fan, and Moen [31], the effect of economic insecurity can be different depending on one's socio-economic characteristics. We chose to analyze the middle-aged and older adults, for whom economic insecurity can be a great shock.

The definition of economic insecurity is not limited to low income or unemployment, but it is extended to a state in which income fluctuates more than a certain level or one feels economic instability. We categorized economic insecurity in three parts in Table 1; objective indicators, subjective – perceptive, and emotional – indicators based on Jang [32], Kim et al. [33], Bævre & Kravdal [34], Lee [35], Lee & Lee [36], and Christelis et al. [37]. The distinction between perceptional and emotional indicators enables a more sophisticated approach [38]. The effects of indicators are investigated individually because there is no consensus on how to combine indicators within the model. In addition, the possibility of multicollinearities such as the correlation between economic insecurity indicators and related variables (household annual income, household wealth, etc.) was explored, but the possibility of multicollinearity was judged to be low because the correlation coefficient did not exceed the

objective, subjective, and emotional indicators in the analysis.

Table 1. *Measures of economic insecurity*

Category[1]	Measurement	
	Variable	Operational definition
Objective Indicators	1),2) Income volatility	1) Income volatility A: Earnings difference between the current and previous year - Income increase≥30% (group 1) - Income increase<30% or Income decrease<15% (group 2) - Income decrease≥15% (group 3) *Group 2 is reference group
		2) Income volatility B: Temporal variance of income
	3) Economic difficulties	Experience of deficiency of food, housing, vital goods like electricity, and health (1)
	4) Low-income period	Period of household income lower than 60% of the standard median household income (year)
Subjective Indicators	Cognitive Indicators	5) Subjective minimum cost of living	Subjective minimum cost of living (KRW million per month)
	Emotional Indicators	6) Household income satisfaction	Satisfaction with family income (1)
		7) Economic anxiety/conflict	First or second reason for anxiety or conflict in the household is the economic difficulty, (un)employment of household members, and housing problems (1)

Since the analysis of the impact of economic insecurity indicators was done using individual models, there is little concern about multicollinearity due to the relationship between economic insecurity maximum of 0.3.

To measure mental health, we assessed depression symptoms and suicidal ideation. In KoWEPS, the Center for Epidemiological Studies-Depression Scale (CES-D) is employed for the assessment of depression. Depression can be an indicator of a negative aspect of mental health and CES-D has

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[1] The category classification for the measurement of economic insecurity was derived through a review of

previous studies, see Kim [22] for details.

many advantages as a non-diagnostic test [39-41]. Scores from 0 to 3 were imposed per question and a higher aggregated score indicated more severe depression. The original CES-D consists of 20 items, but there are only 11 items in KoWEPS. CES-D scores over a certain level would have a clinical implication (probable depression), so we constituted a dichotomous variable to identify "probable depression" referring to Yokoyama et al. [42].

CES-D would suggest a clinical disorder depending on the severity of symptoms; depression is somatized as headache [43], suicidal ideation, and even suicidal behavior [44]. Suicidal ideation was used as another indicator for mental health and also supplemented the validity of CES-D; CES-D can be lower in ethnic groups other than Caucasians [45].

In the KoWEPS, we got information about people's suicidal ideation from this question; "Have you ever seriously thought about suicide in the past 1 year from now?". Unlike CES-D, which was investigated from the first year of KoWEPS, suicidal ideation was surveyed from 2012.

We utilized plenty of variables to reflect socio-economic status (SES) and other characteristics. They are as follows: demographic variables (age, sex, marital status, education level, household size, family structure), economic variables (household assets, annual household income, house ownership, economic participation), relational variables (satisfaction with social/family relations), and health-related variables (chronic disease, hospital utilization).

The empirical analyses comprised a univariate analysis (model I) to determine the independent impact of each variable and multivariate analysis (model II) including the other control variables. Since each variable of economic insecurity was analyzed separately, it is impossible to compare the sizes between the coefficients.

Statistical analysis

This study used the panel data, which were repeatedly measured on the same person and consisted of layers of individuals and households. Therefore, the Mixed Model was used to reflect the individual and household levels simultaneously.

When analyzing data combined at the individual and group levels, the standard error in regression coefficient estimates would be small, resulting in a rejection of the null hypothesis [46].

We considered changes at the individual level to be more flexible for repeatedly measured data. Whereas typical regression models assume only one error term, the Mixed Model has a respective error term for each measurement level; that is, the first level is time, the second level is individual, and the third level is household. In this model, similarities in repeated measurements on the same individual or in the same group can be considered.

However, for the period of low income or the temporal variance of income, in which the time dimension is included in the variable, an analysis was carried out by reflecting only two layers: individual–household.[2]

Results
General Characteristics of the study populations[3]

A total of 4,167 men and women were analyzed. The characteristics of the study population for 8 years are shown in Table 2. 25.7% of subjects experienced probable depression and 4.0% of subjects had suicidal ideation. For 22.4% of subjects, annual income increased by over 30% compared to the previous year, and for 24.3%, annual income decreased by over 15% than last year. Income variance for the study period on average is 364.3. The percentage of subjects experiencing economic difficulties was 11.6%, and the average period of low income was 2.8 years. The subjective minimum cost of living per month was on average 1.8 million won, approximately 21% of people were satisfied with their household income, and more than 30% of people experienced the conflict or worry for economic reasons.

The mean age of the subject population is 59.5 years old, and about 57% of the subjects are women. Most of the subjects are married and received education above elementary school. The number of household members is 2.8 persons, and some of the subjects (13%) had structurally defective families

populations for each year.

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[2] See Appendix 1 for equations for econometric models.
[3] See Appendix 2 for general characteristics of the study

such as grandparents-grandson and single-parent families. Subjects' households have 140.8 million KRW in assets while earning 37.5 million KRW annually on average. About 63% of subjects participate in economic activities and 25.1% have their own house. 70-80% of the subjects are satisfied with their social and family relationship. Almost 64% have one or more chronic diseases, but slightly over 10% of the subjects utilize hospital healthcare.

Table 2. *Characteristics of study populations (average for 8 years)*

Category	Variables			percent(%)/Mean
Mental Health	Probable depression (CES-D11 ≥7)			25.7
	Suicidal ideation (experienced)*			4.0
Economic Insecurity	Objective indicators	Income volatility A (Earnings difference between current and previous year)	Income increase over 30%	22.4
			Income increase under 30% or income decrease under 15%	53.3
			Income decrease over 15%	24.3
		Income volatility B (Income variance)**		364.3
		Economic difficulties (experienced)		11.6
		Low-income period years **		2.8
	Cognitive indicators	Subjective minimum cost of living per month (KRW million)		1.8
	Emotional indicators	(Household) Income satisfaction (satisfied)		21.6
		Economic anxiety · conflict (experienced)		34.1
Demographic Characteristics	Age years			59.5
	Gender (Women)			57.1
	Marital status (With partner)			78.7
	(Divorced, Widowed)			19.4
	(Single)			1.9
	Education (No education)			7.8
	(Elementary/middle school)			49.0
	(Over high school)			43.2
	Household scale (person)			2.8
	Family structure (Structurally defective home)			13.0
	Household asset (KRW million)			140.8
Economic Characteristics	Annual household income (KRW million)			37.5
	Economic participation (Active)			63.6
	House ownership (Non-house-owner)			25.1
Relational Characteristics	Social relationship (Satisfied)			73.8
	Family relationship (Satisfied)			79.3
Health Characteristics	Chronic disease (Patient)			63.7
	Hospital healthcare (Utilized)			11.8

¶ Note: * Suicidal ideation was surveyed from 2012.
    ** Income volatility B (income variance) and low−income period were measured (calculated) as one value per individual unit over the entire analysis period.

Effect of economic insecurity on depression[4]

The effects of economic insecurity on depression were identified (Table 3). An income increase of over 30% increased the risk of depression (OR=1.335) in model I.

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[4] See Appendix A-1 of Kim [47], for full results of the regressions.

The effects of income reduction were not identified in model I, but a multivariate analysis found that it reduced the risk of depression (OR=0.881). For the income volatility B index, indicating the dispersion of income during the analyzed period, an increase in income volatility had no impact on depression in model II although the effect was statistically significant in model I. The results of the model I might be owing to correlation with other variables; e.g. temporal income variance can have a positive correlation with income level [48]. Large income variance implied a high level of income; therefore, in the univariate analysis, income volatility B may have implied a partial effect of income level.

The experience of economic difficulty, i.e., material deprivation, has increased the risk of depression (OR=1.355) in model II. It was found that a 1-year increase of low-income period increased the risk of depression (OR=1.220) in model II. It demonstrates that the negative experiences of the past can affect the current well-being regardless of the resources available at present, such as income. In terms of the subjective minimum living cost, a one-unit increase (one million KRW) is to reduce the risk of depression (OR=0.810) in model II. Under the same income level, an increase in the subjective minimum cost of living, means the future income stability improved, and decreased the risk of depression. Satisfaction with household income also reduced depression to a statistically significant level (OR=0.725) in model II. The worry or conflicts over economic problems, such as income, employment, and housing of household members increased the risk of depression (OR=1.353) in model II. This is the same as the analysis results of satisfaction with income; objective economic problems or unstable economic status could affect mental health, but the subjective consciousness of the individual also could be an important factor.

Table 3. *An analysis of the effects of economic insecurity on depression in the middle-aged or older adults*

Category			Model I: Univariate model		Model II: Multivariate model	
			Odds Ratio (OR)	Beta (Coeff.)	Odds Ratio (OR)	Beta (Coeff.)
Objective indicators	Income volatility A (Earnings difference between current and previous year)	Income increase (over 30%)	1.243***	0.218***	1.335***	0.289***
		Income decrease (over 15%)	1.043	0.042	0.881**	-0.127**
	Income volatility B (Income variance)*		1.000**	-0.000**	1.000	-0.000
	Economic difficulties (experienced)		1.717***	0.541***	1.355***	0.304***
	Low-income period years*		1.528**	0.424***	1.220***	0.199***
Cognitive indicators	Subjective minimum cost of living per month (KRW million)		0.634***	-0.456***	0.810***	-0.211***
Emotional indicators	(Household) Income satisfaction (satisfied)		0.584***	-0.537***	0.725***	-0.322***
	Economic anxiety·conflict (experienced)		1.555***	0.441***	1.353***	0.303***

¶ Note: 1. Income variability B and the low-income variable use the variance and frequency of observations, so they are derived from the cross-sectional data analysis (2014) without reflecting the time-layer in the analysis.

2. The effects of Age, Sex, Marital status, Education, Household scale, Household assets, Annual household income, Economic participation, House ownership, Social relationship, Family relationship, Chronic disease, and Hospital healthcare are controlled in multivariate models.

† $p<0.1$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$

Effect of economic insecurity on suicidal ideation[5]

We identified the effects of each variable of economic insecurity on suicidal thoughts (Table 4). An increase in income by over 30 % showed a statistically significant effect on suicidal ideation in model II (OR=1.264). When income decreased by more than 15 % from the previous year, the risk of suicidal ideation increased in model II (OR=1.408). Income variation during the analysis period (income volatility B) did not have a significant effect on suicidal ideation in model II, though it reduced the risk of suicidal ideation in model I. Experience of economic difficulties in areas other than income increased the risk of suicidal ideation for both in model I and II. Compared to no experience of

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[5] See Appendix A-2 of Kim [47], for full results of the regressions.

economic difficulties, for the person with one or more areas being physically deficient, the risk of suicidal ideation increased significantly (OR=1.790) in model II. The number of years of low income increased the risk of suicidal ideation by 1.404 times per year in model I. The increased risk of suicidal ideation increases with long-term exposure to low incomes, which implies a cumulative negative impact of low incomes. However, when controlling the effects of other variables in model II, there was

no statistical significance. The subjective minimum cost of living was found to reduce the risk of suicidal ideation by 0.627 times in model I, but there was no statistical significance in model II. Income satisfaction was shown to reduce the risk of suicidal thoughts at a statistically significant level (OR=0.576). Conversely, when there was a conflict or concern about income, employment status of household members, or the housing problem, the risk of suicidal ideation increased (OR=1.788).

Table 4. *An analysis of the effects of economic insecurity on suicide ideation in the middle-aged or older adults*

Category			Model I: Univariate model		Model II: Multivariate model	
			Odds Ratio (OR)	Beta (Coeff.)	Odds Ratio (OR)	Beta (Coeff.)
Objective indicators	Income volatility A (Earnings difference between current and previous year)	Income increase (over 30%)	1.171	0.158	1.264†	0.235†
		Income decrease (over 15%)	1.665***	0.510***	1.408**	0.342**
	Income volatility B (Income variance)*		1.000**	-0.002**	1.000	-0.000
	Economic difficulties (experienced)		4.088***	1.410***	1.790***	0.582***
	Low-income period years*		1.404*	0.339*	1.143	0.134
Cognitive indicators	Subjective minimum cost of living per month (KRW million)		0.627***	-0.467***	0.953	-0.048
Emotional indicators	(Household) Income satisfaction (satisfied)		0.306***	-1.185***	0.576***	-0.551***
	Economic anxiety · conflict (experienced)		2.934***	1.076***	1.788***	0.581***

¶Note: 1. Income variability B and the low-income variable use the variance and frequency of observations, so they are derived from the cross-sectional data analysis (2014) without reflecting the time-layer in the analysis.

2. The effects of Age, Sex, Marital status, Education, Household scale, Household assets, Annual household income, Economic participation, House ownership, Social relationship, Family relationship, Chronic disease, and Hospital healthcare are controlled in multivariate models.

† p<0.1, * p<0.05, ** p<0.01, *** p<0.001

Discussion

Meaning of economic insecurity on mental health

The study identified the various indicators of economic insecurity in the middle-aged and elderly population while examining the effect of variables on their mental health. Because different indicators were used, it is difficult to compare them to previous studies directly. However, the overall direction of the results of this study was found to be similar to those

of previous studies. Still, the results for income variability indicators need to be interpreted independently, as compared to previous ones.

First, the effects of the income volatility A index on depression can be explained in several ways. Looking at income growth and decline as a continuous event, it is likely that an increase in income (especially a radical increase over 30%) would mean a recovery of past income fall. In other words, it is likely that households with income

increase by over 30% had relatively lower incomes than others at the previous point of measure. It is possible that the effect of income increases over 30% is rather caused by the negative impact of the previous lower-income, e.g. concavity of income [33]. Therefore, an immediate wide income increase cannot have a positive influence on mental health.

Another explanation is in terms of the reasons for the increase in income. Sometimes, the increase in income is induced to cover unexpected expenses. Economic insecurity can be caused not only by a decrease in income but also by unexpected expenses [49]. Therefore, in this case, even if income increases, the economic burden felt by individuals would not be improved and an increase in income was not necessarily associated with an increase in additional resources or more disposable income [50]. It was also shown that the group with an income increase of 30% or more experienced more conflicts or concerns due to economic causes, and their income satisfaction was also relatively low in data. Even when income increases, the psychological state experienced by an individual may continue to be poor, and this subjective state may even affect depression.

In addition, the effects of the income increase/decrease could also be referenced by Bævre & Kravdal [33]. They argued that the increase in income could induce expectations for income decrease because income level might fluctuate, therefore, it could be a stressor for one's mental health. Given the effects of the past economic status on the present day, it is likely that the person who had a more glorious past would be more stressed when facing decline than those who did not.

Income volatility B measured by income variance for the whole period has no statistically significant relation in model II of both analyses. These results suggest that a more careful approach is necessary to see the impact of economic volatility. Of course, using income variance can make us see economic income multi-dimensionally rather than considering only the level or average of income. However, it still seems not enough according to the results of this study. It needs to be more detailed; why does income matter for mental health? Income as a material

risk level of the poor (public assistance recipients) was higher than that of the non-poor (public assistance non-recipients), but the difference

resource can be tested in the analysis of experiencing a material deficiency. In this study, the economic difficulties represent a lack of essential needs. If someone experiences a material deficiency in one or more areas, it increased the level of depression and suicidal ideation significantly. It shows us that a lack of essential needs is associated with worse mental health, and we can extrapolate that it can be caused by low income.

In another way, a stable and proper level of income makes people feel safe and rightly appreciated. Therefore, the satisfaction with income and economic anxiety/conflict could be interpreted as an individual's emotion about the level and persistence of available resources. The positive effect of income satisfaction in both analyses shows that income could affect mental health through the recognition of individuals in addition to the material mechanism. The negative effect of economic anxiety/conflict can be interpreted in the same way. Considering the larger odds ratios from emotional indicators than others, we can imply that the emotional aspects can be more important than the objective conditions.

For low-income period years and subjective minimum cost of living per month, we have to consider how people feel and react to financial difficulty. If the low-income state is maintained for a long time, people become more desperate, and they tighten their expenditures to survive for a longer time. By doing so, they feel more depressed. Thus, the longer the low-income period lasts and the lower the subjective minimum cost of living per month is, the more magnitude of depression people experiences.

An analysis of suicidal ideation is different from that of depression in several points: Income decrease, low-income period, and subjective minimum cost of living per month. A decline in income can reduce work-related stress, however, these inferences are difficult to generalize. On the other hand, it can degenerate the risk of suicidal ideation because more economic pressure from income decreases.

Statistical insignificance of the low-income period also intersects with previous studies. In Jeon's study [51] on the elderly in Korea, the initial suicide decreased as time goes by. Also, the subjective minimum cost of living per month was not confirmed to have a negative effect on suicidal

ideation.

Measuring mental health using KoWEPS

In this study, the relationship between objective and subjective economic insecurity indicators and depression and suicidal ideation was explored from a time series perspective using KoWEPS. KoWEPS is useful in that it investigates mental health and the socioeconomic variables for a long period of time, but there are some limitations nonetheless.

First, suicide does not necessarily occur as a result of suicidal ideation, so it is possible to overestimate the risk of suicide when using suicidal ideation as a measurement for suicide. However, in this study, suicidal ideation was used as an index for negative mental health status, not as a proxy for suicide. Therefore, it does not seem to pose a major threat to the validity of the study.

In addition, there may be limitations to analyzing subjective perception variables with a time-series perspective, which are less likely to continue to change over time. Methodologically, panel analysis can have several advantages, such as being easy to identify causal relationships, but a small number of changes over time can make it difficult to produce meaningful results. Alternatively, it can be supplemented through an in-depth separate investigation or qualitative research that fully reflects the characteristics related to mental health.

Conclusion

The findings of the study are general: not only the current economic status but also the potential economic risks of the future or past have implications on mental health [27,52]. The socio-economic status of individuals is a huge health constraint [53-55]. In this perspective, stabilizing the economic status of individuals would contribute to maintaining and improving mental health at the general population level.

Acknowledgments

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Annex 1. Equation model used in the analysis

$$\log\left(\frac{\pi_{hit}}{1-\pi_{hit}}\right) = \beta_0 + \beta_1 X_{1hit} + \cdots + \beta_K X_{Khit} + \beta_{K+1} X_{K+1ht} + \cdots + \beta_M X_{Mht} + z_{ht}u_h + z_{it}u_i$$
$$+ \epsilon_{hit}$$

$\log\left(\dfrac{\pi_{hit}}{1-\pi_{hit}}\right)$	Probability of probable depression/ suicidal ideation = 1.
β_0	The value of the result variable when X = 0 and u = 0 (Y intercept/constant)
$X_{1hit}, \dots, X_{Khit}$	Individual unit independent/control variables
$X_{K+1ht}, \dots, X_{Mht}$	Household unit independent/control variable
$\beta_1, \dots, \beta_K$	Coefficient of individual unit variable, consisting of the sum of personal and household effects
$\beta_{K+1}, \dots, \beta_M$	Coefficient of household variable, consisting only of furniture effects
z_{ht}	Covariates that indicate random effects in household units
z_{it}	Covariates that indicate random effects in individual units
u_h	The effect of the household unit. The effect of belonging to a particular household
u_i	The effect of individual units. The unique characteristics of a particular individual
ϵ_{hit}	Error term (variable). $\epsilon \sim (0, \sigma_t^2)$
K	Number of independent and independent variables among independent variables and control variables
M	Total number of independent variables and control variables
h (household level)	1,2,…,l (level 3)
i (individual level)	1,2,…,m (level 2)
t (time of observation)	1,2,…,n (level 1)

Annex 2. Characteristics of study populations from 2008-2015

Category	Variables			2008	2009	2010	2011	2012	2013	2014	2015
Mental Health	Probable depression (CES-D11 ≥7) (percent)			34.8	29.6	28.8	24.4	22.7	19.3	20.1	25.4
	Suicidal ideation (experienced)* (percent)			N/A	N/A	N/A	N/A	4.4	4.1	4.3	3.0
Economic Insecurity	Objective indicators	Income volatility A (Earnings difference between current and previous year)	Income increase over 30% (percent)	20.9	23.6	23.5	23.4	22.9	24.2	30.0	25.9
			Income increase under 30% or income decrease under 15% (percent)	49.8	50.5	51.9	54.8	58.2	54.9	51.9	54.1
			Income decrease over 15% (percent)	29.3	25.9	24.6	21.8	18.9	20.9	18.1	20.0
		Income volatility B (Income variance)**					364.3				
		Economic difficulties (experienced) (percent)		18.0	13.7	13.2	12.4	8.4	8.9	10.8	7.5
		Low-income period years **					2.8				
	Cognitive indicators	Subjective minimum cost of living per month (KRW million)		1.6	1.7	1.8	1.7	1.9	1.9	2.0	1.9
	Emotional indicators	(Household) Income satisfaction (satisfied) (percent)		17.6	17.4	21.5	21.3	20.5	22.7	23.1	28.5
		Economic anxiety · conflict (experienced) (percent)		41.7	38.1	29.4	29.2	33.8	36.6	32.8	31.2
Demographic Characteristics	Age years			56.0	57.0	58.0	59.0	60.0	61.0	62.0	63.0
	Gender (Women) (percent)			57.1	57.1	57.1	57.1	57.1	57.1	57.1	57.1
	Marital status (With partner) (percent)			80.6	80.4	79.8	79.1	78.6	77.9	77.0	75.9
	(Divorced, Widowed) (percent)			17.4	17.6	18.2	19.0	19.5	20.2	21.2	22.3
	(Single) (percent)			2.0	2.0	2.0	1.9	1.9	1.9	1.8	1.8
	Education (No education) (percent)			8.0	8.0	7.8	7.8	7.9	7.8	7.7	7.7
	(Elementary / middle school) (percent)			49.0	48.9	49.0	49.0	48.9	48.9	49.0	49.0
	(Over high school) (percent)			43.0	43.1	43.2	43.2	43.2	43.3	43.3	43.3
	Household scale (person)			3.0	2.9	2.9	2.8	2.8	2.7	2.7	2.6
	Family structure (Structurally defective home) (percent)			10.8	10.9	11.4	12.5	13.3	14.1	15.1	15.6
	Household asset (KRW million)			101.3	121.7	182.7	129.6	149.0	145.0	143.0	154.0
Economic Characteristics	Annual household income (KRW million)			32.9	34.5	36.6	37.5	38.6	40.3	39.8	40.2
	Economic participation (Active) (percent)			67.6	65.7	64.3	64.4	62.8	62.9	61.7	59.6
	House ownership (Non-house-owner) (percent)			26.5	25.7	25.6	25.4	24.9	24.8	24.3	23.7

Relational Characteristics	Social relationship (Satisfied) (percent)	72.7	67.3	78.0	73.3	73.6	76.2	73.8	75.4
	Family relationship (Satisfied) (percent)	77.2	75.9	79.8	79.3	80.9	79.3	79.8	82.3
Health Characteristics	Chronic disease (Patient) (percent)	55.9	60.1	58.0	62.4	64.6	68.5	70.8	69.3
	Hospital healthcare (Utilized) (percent)	9.3	11.4	11.8	10.8	12.8	13.6	11.5	13.2

¶ Note: ∗ Suicidal ideation was surveyed from 2012.

∗∗ Income volatility B (income variance) and low-income period were measured (calculated) as one value per individual unit over the entire analysis period.