

## ORIGINAL RESEARCH

# The relationship between types of depressive changes and suicidal thoughts in middle-aged Korean males

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(Bokyung Kim)**Abstract**

In this study, we explored the issue of depression and suicide ideation among middle-aged men in South Korea over a five-year period, focusing on an often overlooked yet pressing concern. Our main objective was to identify shifts in levels of depression and their potential influence on suicide ideation, focusing particularly on single-person households. By using data from a national health survey, we conducted extensive analyze which accounted for various sociodemographic factors. Analyses indicate that despite their depression levels being relatively low on average, middle-aged men exhibited increased suicide ideation due to low recognition of their own level of depression. Our analyses suggest that we need to develop depression prevention programs and labor support measures that are tailored to the specific circumstances and psychological characteristics of middle-aged men if we are to address this serious problem.

**Keywords**

Depression in middle-aged men; Suicidal ideation; Men's mental health; Single-person households; Public health policies

## 1. Introduction

Death, an inevitable encounter for us all, is often met with fear and denial rather than acceptance. Berger [1] reported that facing death is the most extreme limiting situation that an individual may confront. Death severs human relationships and threatens the fundamental assumptions that society relies on. In another study, Pradhan *et al.* [2] argued that death incites fear by compelling individuals to face the loss of something significant and meaningful. Thus, individuals normally strive to ignore or delay death by various means. Suicide, however, is a proactive act that deliberately seeks death, making this an unnatural and difficult phenomenon to comprehend. Consequently, individuals attempt to understand the motives underlying suicide and recognize its increasing prevalence as a serious social issue.

Suicide is no longer a rare occurrence in South Korea; in fact, suicide ranked in fourth place among all causes of death in 2010 and moved to the fifth place in 2021; it is highly evident that suicide is persistently included in the top ten causes of death excluding diseases in this country [3]. South Korea holds the record for the highest suicide rate per 100,000 individuals of all countries belonging to the OECD (Organisation for Economic Co-operation and Development) [3]. To address this, in 2004, the Korean government implemented a suicide prevention plan [4]; this is known as The Suicide Prevention Master Plan and has been consistently developed and implemented to the present day. Five policies were executed

between 2018 and 2022 as part of the 4th Suicide Prevention Strategy: (1) a strategic approach based on scientific evidence, (2) the establishment of a comprehensive social network to identify high-risk groups, (3) active intervention to eliminate suicide risk in high-risk groups, (4) the promotion of suicide spread prevention by enhanced post-management, and (5) the promotion of targeted suicide prevention [5].

Suicide affects all age groups and tends to be impulsive in children and adolescents, primarily due to family or peer relationship issues [6]. In those aged 20 to 30 years, employment status appears to be the major factor underlying suicide [7]. The rate of suicide in South Koreans aged over 70 years is among the highest of all OECD countries; furthermore, suicide rate increases with age in this specific population [3]. Depression is a common cause of suicide across all age groups. The principal causes of suicide in middle-aged men aged between 40 and 60 years, are psychological and financial instability [8]; these account for 55.6% of all South Korean suicides. However, the middle-aged group experiences the most substantial economic burden; this may suggest that the influence of a spouse's job or unemployment on income could increase the risk of depression and thus suicidal ideation [9]. Furthermore, there has been a recent increase in the number of single-person households occupied by middle-aged males; this represents a high-risk group that is emotionally vulnerable and susceptible to suicidal ideation, yet research targeting this group is scarce [10]. Moreover, the fact that research has been conducted on depression and suicidal ideation among middle-

aged individuals as a collective group [10, 11] highlights the urgent need for research to specifically target middle-aged men. The concept of suicidal thought discussed here might appear to represent a simple contemplation of suicide, but in reality, this has been the subject of extensive scholarly discussions. In particular, a range of methods have been developed to measure suicidal ideation more precisely; for example, it is necessary to use data that includes measurements from the recent 5 years or to secure a large sample size to clearly ascertain suicidal thoughts in modern middle-aged men [12].

Researchers previously identified a significant relationship between depression and suicidal ideation in that higher levels of depression correlate with higher suicidal ideation [13, 14]; however, this relationship differs markedly between males and females. Korean women are known to experience higher levels of depression than men [15, 16]; however, the suicide rate per 100,000 individuals is higher among men [16]. Thus, at a theoretical level, women with higher levels of depression should be associated with higher suicide rates; however, in reality, men are associated with higher suicide rates. The suicide rate among men is known to increase more rapidly with age when compared to women [7]. Multigroup analyses have interpreted this as indicating that the influence of depression on suicidal ideation is far greater in men than in women. In other words, men are more likely to commit suicide due to depression than women [17].

Previous longitudinal studies focusing on depression have investigated specific changes over time. Some of these studies demonstrated that depression increased over time in individuals aged 50 years and above [18], while others studies found that the level of depression fluctuated in individuals who were middle-aged and older [18]. When a broad age range was examined, no clear trends in depressive changes were identified. Critics have argued that the previous studies focusing on groups failed to account for psychological, demographic and social characteristics within these specific groups and therefore failed to reflect in-group heterogeneity, thus oversimplifying multiple trajectories into a single trajectory [19]. Recent longitudinal studies have been conducted on numerous mental health variables in the context of the COVID-19 pandemic, including depression. These studies revealed that the COVID-19 pandemic led to a significant increase in depression and anxiety [20]. To provide effective therapeutic options for depression, it is crucial that we identify the specific types of changes in depression. In other words, it is important to understand how groups of individuals can be divided based on changes in depressive patterns and what characteristics are associated with these specific groups.

Previously, researchers conducting longitudinal studies on depression have mainly focused on investigating an increase in depression or exploring depression as only one of the various factors known to affect mental health. Taking these considerations into account, this study aims not only to investigate specific trends in depressive changes but also to identify the specific manner of how these changes occur. In other words, we aim to delve deeper into whether such patterns of change can be categorized within groups, rather than solely observing the extent of the changes. Moreover, by incorporating

suicidal thought as a factor, this study aimed to understand the progression from depression to suicide. Our intention was to ultimately propose practical suggestions by understanding such processes, taking into account that that depression does not merely end as a mental disorder but can lead to the event of suicide. The significance of this approach lies in the fact that this is a longitudinal study focusing on middle-aged men, a group that has not been studied extensively.

In this study, we consider depression, a factor known to exert significant effects on suicidal thought, as an independent variable. We placed significant emphasis on middle-aged Korean men between 40 and 60 years-of-age, a demographic in which the effect of depression is more pronounced and contributes to a larger proportion of suicidal incidents. Instead of limiting depression to a specific period, we used data from the Korean Welfare Panel Survey (rounds 12–16) to estimate changes between 2017 and 2021. Our aim was to provide practical implications for future policies. By undertaking this research, we hoped to demonstrate the significance of depression and suicidal ideation among middle-aged men, especially those residing in single-person households. In particular, we aimed to determine whether middle-aged men belong to an at-risk group that is similar to the middle-aged population in general. By performing our analyses, we sought to propose suicide prevention measures that can be tailored to this specific demographic.

## 2. Methods

### 2.1 Statistical analysis

Statistical analysis was conducted using Stata 15.1 (Stata Corp LLC, College Station, TX, USA) and M-plus 8.0 (Mplus, Los Angeles, CA, USA) software, in accordance with a range of specific methods and procedures that are outlined herein. Firstly, we performed descriptive statistical analysis to gain insight into the sociodemographic traits and main characteristics of the participants. Secondly, we assessed fluctuations in depression among middle-aged men by applying a latent growth model in an assumed single group. Prior to analyzing different types of depressive changes in middle-aged men, we investigated the overall trajectory of depression across the entire study population by employing a latent growth model. To determine the fitness of the model, we used a range of metrics, including the TLI (Tucker-Lewis Index), CFI (Comparative Fit Index) and RMSEA (Root Mean Square Error of Approximation) due to their simplicity and insensitivity to sample size. If the TLI and CFI were  $>0.9$ , and the RMSEA was  $<0.1$ , the fitness of the model was considered to be high. In addition, a Chi-squared test and an independent samples *t*-test were utilized to identify differences in sociodemographic traits according to different patterns of depressive changes. Thirdly, to overcome the limitation of assuming the analysis target as a single group, and to identify different trajectories within the study population by assuming subpopulations, we applied Growth Mixture Modeling (GMM) to classify the patterns of depressive changes. In this model, the ideal number of change types was defined based on the *p*-values of certain criteria such as the AIC (Akiakie's Information Criteria),

BIC (Bayesian Information Criteria), SSABIC (Sample-Size Adjusted BIC), entropy and BLRT (Bootstrapped Likelihood Ratio Test). Lower AIC, BIC and SSABIC values indicated better model fitness; higher values of entropy (approaching 1) and BLRT  $p$ -values  $< 0.05$  were considered as indicators of better model fitness. Finally, to establish an association between patterns of depressive changes and suicidal thoughts, we performed logistic regression analysis by applying the Firth Method [21]. Since instances of suicidal thoughts are relatively rare and cases without suicidal thoughts are predominant, traditional logistic regression analysis may have underestimated probabilities and led to skewed parameter estimates [22]. In other words, traditional logistic regression analysis may have yielded coefficient estimates that were biased. In situations where the application of a general logistic model for the linear probability processing of discrete dependent variables could lead to potential bias in estimations, we used an alternative approach referred to as the relogit model. This approach allows for adjustment of the observed event of interest, in this case, “suicidal ideation”, based on the sample extraction of data to mitigate bias. However, the relogit model is limited by the fact that it alters the number of events in the dataset of interest. To address this issue, we performed thus analysis with the Firth method; this maintained the original number of events while reducing the impact of probabilities for non-events (0) during likelihood estimation. The analysis employed the penalized maximum likelihood estimation (the Firth Method) as proposed by Firth [21]; this method is suitable for rare event scenarios and can procure unbiased coefficient estimates [23].

## 2.2 Data

This study utilized data from the 12th to the 16th Korean Welfare Panel Study (KoWePS) which was carried out between 2017 and 2021. Our aim was to identify and classify alterations in depression among middle-aged men and to investigate the potential association with suicidal thoughts. The KoWePS is a representative panel study of Korean welfare that aims to understand living conditions and welfare desires among various population groups. The KoWePS has also contributed to the formation of new policies and systematic improvements by evaluating the effectiveness of policy implementation. In the present study, 1414 men aged between 40 and 60 years, corresponding to the middle age period, were selected as the final subjects to estimate changes in depression from the 12th round (2017) to the 16th round (2021). Cases with missing values for key variables were excluded from our analysis.

## 2.3 Variables

### 2.3.1 The independent variable: depression

Throughout this study, the independent variable was depression. In our analyses, we used an adaption of the Korean Welfare Panel Study, the shortened version of the CES-D (The Center for Epidemiologic Studies Depression Scale) generated by Kohout *et al.* [24] (1993). The CES-D, a self-administered instrument, gauges depressive symptoms in a non-diagnostic manner. In their study, Kohout *et al.* [24] tailored the original scale developed by Radloff (1977) [19]

into a shortened version featuring 11 items; we used this method in our research to minimize the level of strain on respondents. Depression was measured on a four-level scale where 1 indicated very infrequent occurrences, 2 referred to occasional experiences, 3 referred to frequent instances and 4 referred to most of the time. A higher score on this scale denoted a greater severity of depression. The consistency of this particular depression scale (as measured by Cronbach’s  $\alpha$ ) was 0.850 in 2017, 0.871 in 2018, 0.847 in 2019, 0.842 in 2020 and 0.852 in 2021.

### 2.3.2 The dependent variable: the presence of suicidal thoughts

The dependent variable in this study was the presence of suicidal thoughts, as evaluated by questioning whether a subject had experienced such thoughts over the previous year. A response of “0” indicated the absence of suicidal thoughts, whereas “1” indicated their presence.

### 2.3.3 Control variables: demographic characteristics

Demographic characteristics were used as control variables in this study. These included age (a continuous variable), equivalent income (a continuous variable), level of education (below high school = 0, university or higher = 1), residential location (metropolitan city = 0, small-medium city = 1), and living situation (not living alone = 0, living alone = 1). Equivalent income was derived by dividing the total household income by the square root of the number of household members; this was then log-transformed to achieve a normal distribution.

## 3. Results

### 3.1 Descriptive statistics

Table 1 illustrates the sociodemographic attributes of the individuals involved in this study.

**TABLE 1. Socio-demographic characteristics of the study participants (n = 1414).**

Variable	Categories	n	%
Age (M (SD))		49.79 (6.18)	
\$ Equivalent Income (M (SD))		28,650.37 (17,171.67)	
Education			
	High School or below	968	68.5
	University or above	446	31.5
Residential Area			
	Metropolitan Cities	580	41.0
	Small and Medium Cities	834	59.0
Living Alone			
	No	1299	91.9
	Yes	115	8.1
Thoughts of suicide			
	Never had thoughts	1392	98.4
	Had thoughts	22	1.6

Key: M: mean; SD: standard deviation.

Descriptive statistical analysis of the variable (depression) revealed that the mean score of depression increased slightly (Table 2), although this change was not statistically significant.

**TABLE 2. Descriptive statistics of depression (CES-D) (n = 1414).**

Year	Min	Max	M	SD
2017	1.00	3.27	1.21	0.33
2018	1.00	3.45	1.22	0.35
2019	1.00	3.39	1.22	0.32
2020	1.00	3.45	1.22	0.34
2021	1.00	3.73	1.23	0.34

Key: Min: minimum; Max: maximum; M: mean; SD: standard deviation.

### 3.2 Changes and types of depression

Prior to implementing the Growth Mixture Model, we used a Latent Growth Model to investigate the general progression of depression. For this, we used three distinct models to assess the fitness of the model: a no-change model, a linear-change model, and a quadratic-change model. We determined that all three models were suitable. However, the quadratic-change model met the fitness criteria better than the other models ( $\chi^2 = 21.100$  ( $p < 0.01$ ), CFI = 0.991, TLI = 0.985, RMSEA = 0.042). Hence, this was adopted as the final model (Table 3).

**TABLE 3. Assessment of model fitness for the latent growth modeling of depressive changes.**

Model	$\chi^2$	CFI	TLI	RMSEA
No growth model	84.181***	0.917	0.927	0.082
Linear model	44.317***	0.959	0.959	0.069
Quadratic model	21.100**	0.991	0.985	0.042

Key:  $\chi^2$ : Chi-squared; CFI: Comparative Fit Index; TLI: Tucker-Lewis Index; RMSEA: Root Mean Square Error of Approximation. \*\* $p < 0.01$ , \*\*\* $p < 0.001$ .

By utilizing the quadratic change model, we next used the growth mixture model to identify different patterns of depressive changes. The indices of model fitness indicated that the division of depressive changes into two types yielded lower AIC, BIC and SSABIC values when compared to divisions into one, three, and four types of change (Table 4). In addition, the division into four types resulted in an entropy value that was closer to 1 when compared to other divisions. However, the three and four types of divisions featured groups representing <5% of all cases. Therefore, the AIC, BIC and SSABIC values were the lowest, and two types of depressive changes were selected for analysis (with cases of all types being >5%).

Changes in depression were classified into two types, with each type given a name that represented the characteristics of the change involved. The first type, referred to as the “maintenance” type, did not show any changes in depression between 2017 and 2021; 1275 cases (90.2%) were classified into this type. The second type, referred to as the “increasing”

type, showed an overall increase in depression between 2017 and 2021; 139 cases (9.8%) were classified into this type.

Next, we conducted a Chi-squared test and independent sample *t*-test to evaluate differences in socio-demographic characteristics according to the types of depressive change. We found that the two types of depression change, referred to as the “Increasing Type” and “Maintenance Type”, showed significant differences with regards to household income ( $t = -8.683$ ,  $p < 0.001$ ), level of education ( $\chi^2 = 14.549$ ,  $p < 0.001$ ), and living alone or not ( $\chi^2 = 37.323$ ,  $p < 0.001$ ) (Fig. 1 & Table 5). In terms of household income, the “Increasing Type” was associated with approximately \$10,000 less income than the “Maintenance Type”. In terms of educational level, the “Increasing Type” featured a higher proportion of individuals with a high school education or lower when compared to the “Maintenance Type”. In terms of living alone or not, the “Increasing Type” featured a higher proportion of individuals living alone when compared to the “Maintenance Type”.

### 3.3 The relationship between types of depressive change and suicidal thoughts

Next, we investigated the specific relationship between the types of depressive change and suicidal thought in middle-aged men derived from the growth mixture model (Table 6). Since suicidal ideation is a rare event, we applied the Firth Method, which is known to be suitable for the analysis of rare events.

The research model was statistically significant ( $\chi^2 = 56.00$ ,  $p < 0.001$ ) and analysis indicated that the controlled variable, standardized income (Coefficient =  $-0.666$ ,  $p < 0.05$ ), was a significant determinant of suicidal ideation (Table 6). In other words, a lower standardized income was associated with a higher likelihood of having suicidal thoughts. On the other hand, the controlled variables, including age, education, residential area and living alone, were not significant determinants of suicidal ideation. The independent variable, a change in the pattern of depressive change (Coefficient =  $-2.594$ ,  $p < 0.001$ ), emerged as a significant determinant of suicidal ideation. Specifically, individuals with a pattern of increasing depression had a higher likelihood of having suicidal thoughts when compared to those with a stable pattern of depression. These data suggests that patients in which the levels of depression increase over time are more likely to experience suicidal ideation when compared to those whose levels remained unchanged over time.

## 4. Discussion

Traditionally, depression in males has been regarded as a less significant issue when compared to depression in women. However, considering the profound link between depression and suicide, as well as the high suicide rates among men, it is crucial not to overlook mental health issues; this is because previous research has reported lower levels of depression in men than women. Against the backdrop of South Korea’s high suicide rates, this study aimed to identify specific patterns of depressive change among middle-aged men and investigate the relationship between these patterns and suicidal ideation.

In accordance with the descriptive statistical analysis of

**TABLE 4. Evaluation of model fitness for growth mixture modeling (n = 1414).**

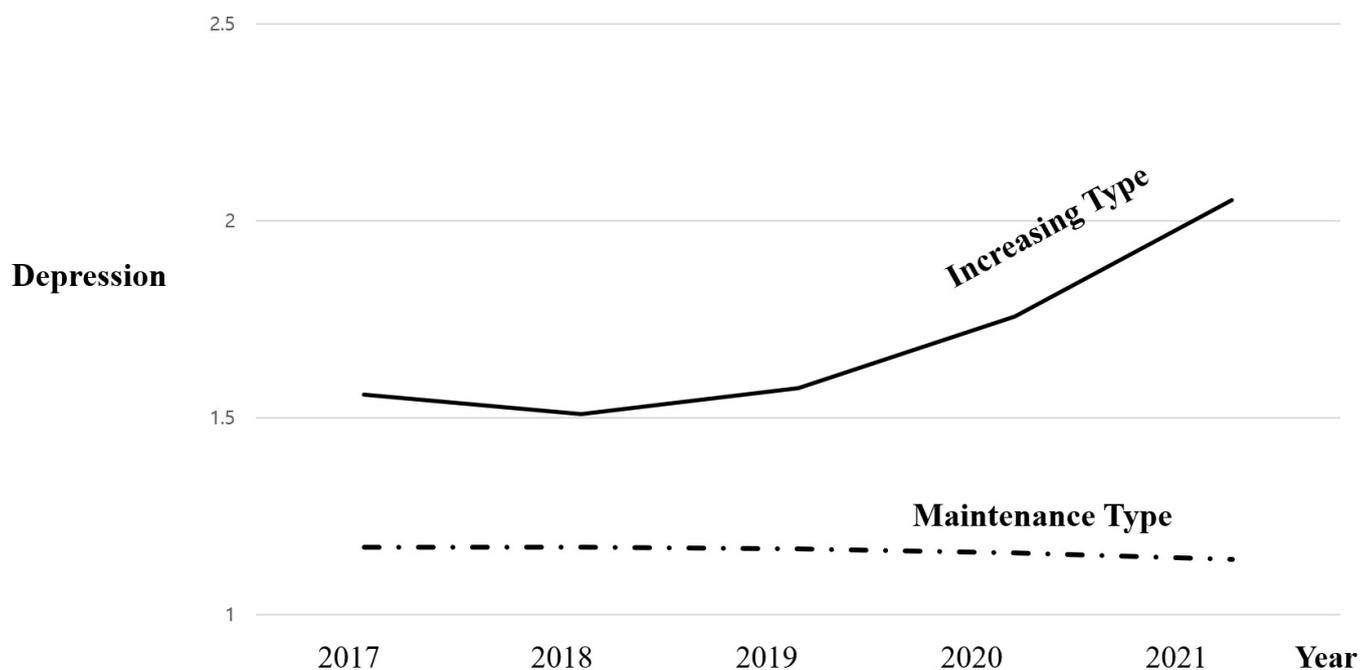
Type	Model fit					Groups
	AIC	BIC	SSABOC	Entropy	BLRT p-value	n (%)
1	3028.098	3101.657	3057.184	-	-	-
2	2324.414	2418.990	2361.810	0.956	<0.001	1275 (90.2), 139 (9.8)
3	2332.414	2448.006	2378.120	0.972	0.333	1275 (90.2), 104 (7.3), 35 (2.5)
4	234.414	2477.023	2394.430	0.978	0.847	1275 (90.2), 104 (7.3), 19 (1.3), 16 (1.1)

Key: AIC: Akiakie's Information Criteria; BIC: Bayesian Information Criteria; SABIC: Sample-Size Adjusted BIC; BLRT: Bootstrapped Likelihood Ratio Test.

**TABLE 5. Socio-demographic differences based on types of depressive change among middle-aged men.**

Variable	Categories	Depression change type				$\chi^2/t$
		Increasing type		Maintenance type		
		n	%	n	%	
Age (M (SD))		50.66 (6.27)		49.70 (6.17)		1.742
Household Income \$ (M (SD))		18,959.07 (13,442.86)		29,706.92 (17,207.52)		-8.683***
Education						
	High School or below	115	82.7	853	66.9	14.549***
	University or above	24	17.3	422	33.1	14.549***
Residential Area						
	Metropolitan Cities	65	46.8	515	40.4	2.102
	Small and Medium Cities	74	53.2	760	59.6	2.102
Living Alone						
	No	109	78.4	1190	93.3	37.323***
	Yes	30	21.6	85	6.7	37.323***

Key:  $\chi^2$ : chi-square; t: t-statistic; M: mean; SD: standard deviation. \*\*\* $p < 0.001$ .

**FIGURE 1. Estimated types of depression changes.**

**TABLE 6. Relationship between depressive change types and suicidal thoughts in middle-aged men (n = 1414).**

Variables	Coef.	S.E.	Exp (B)
Age	0.035	0.040	1.035
\$ Equivalent Income (log)	-0.666*	0.322	0.514
Education	-1.194	0.876	0.303
Residential Area.7 (ref. metropolitan cities)	-0.791	0.458	0.453
Living alone (ref. not living alone)	0.400	0.544	1.491
Depression Change Type (ref. Increasing Type)	-2.594***	0.512	0.075
Constant	5.532	3.673	252.535

Key: Coef.: Coefficient; S.E.: Standard Error; ref: reference.  $p < 0.05$ , \*\*\* $p < 0.001$ .

depression in middle-aged men, the mean depression score increased from 1.21 in 2017 to 1.23 in 2021; however, in reality, the mean score remained constant at 1.22 between 2018 and 2020. This score, close to 1 on a 4-point scale, can be considered as being low. However, it would be inappropriate to simply perceive the low level of depression in men as a non-issue. In particular, it is crucial to remember that men often view depression as a weakness and tend to hide this condition [25, 26]. Indeed, unlike women, men do not express the feelings of depression in an obvious manner, thus making it challenging to diagnose this condition [27]. The biased low level of depression in middle-aged men observed in this study may reflect this key characteristic of men.

Second, the types of depressive change in middle-aged men derived from the latent growth model and the growth mixture model were broadly categorized into two types: “maintenance” and “increasing”. The “maintenance” type, which featured 1275 cases (90.2%), was characterized by low levels of depression with no apparent changes between 2017 and 2021, thus indicating that the majority of middle-aged men can be considered part of this group. The “increasing” type, which included 139 cases (9.8%), had higher levels of depression than those with the “maintenance” type and showed an increasing trend over time. The existence of the “increasing” type resembles the significant increase in depression among parents in households with children, as described in a previous study [28]. In particular, the fact that the level of depression increased significantly over a period of five years in certain middle-aged men suggests the need for programs to address their depression.

Third, by applying *t*-tests and Chi-squared tests, we found that individuals with the “increasing” type of depression had a lower household income, lower levels of education, and higher rates of living alone when compared to those with the “maintenance” type. These data indicates that a lower household income, a lower educational level, and a higher proportion of living alone increases the likelihood of being in the “increasing” type of depression and experiencing a continuous increase in depression. Previous research also demonstrated the relationship between socioeconomic factors, living alone and an increase in depression. Studies by Kim *et al.* [29] suggested that middle-aged men living alone have higher levels of depression and that socioeconomic factors, such as income and job satisfaction, can exert effects on depression. Although the study by Baek *et al.* [30], which longitudinally examined

depression levels according to living arrangement, showed a different trend from our present study by revealing a reduction in depression levels among middle-aged men living alone over a seven years period, this previous study was consistent with the present study in that it detected higher levels of depression when compared to those living with a spouse or others. These findings suggest the need to consider a lower socioeconomic status and living alone when addressing depression.

Fourth, by examining the relationship between types of depressive change and suicidal ideation among middle-aged men, we found a higher likelihood of suicidal ideation in the “increasing” type when compared to the “maintenance” type. Of the control variables, lower income had a significant effect on suicidal ideation, thus suggesting that those in the “increasing” type or with lower incomes have a higher likelihood of suicidal ideation. These results are in line with those of a previous study [31]. Furthermore, we found that the economic status of middle-aged men exerts influence on suicidal ideation; this aligns with the findings reported by Lim & Kim [32], thus indicating that in comparison to other age groups, socioeconomic factors have a substantial impact on suicidal ideation among middle-aged individuals. The impact of financial status on suicidal ideation among middle-aged men can be attributed to the importance of acting as a breadwinner who is responsible for the family’s finances in shaping their self-identity [33]. These findings confirm that both psychological status and financial status are closely related to suicide in middle-aged men.

This study focused on middle-aged men in Korea and represents a significant enhancement in understanding because we investigated specific depression trajectories, categorized the men longitudinally, and investigated the relationship between different types of depression trajectory and suicidal ideation. In particular, the two depression types derived herein (maintaining and increasing) have significant implications as the “increasing” type is associated with income, education and living alone, and shows a strong connection with suicidal ideation, especially when accompanied by a low income. Based on these findings, we generated a range of suggestions for future consideration, as detailed below.

Firstly, we recommend that depression prevention programs for middle-aged men should be developed and implemented, particularly with a higher emphasis on single-person households. As single-person households are becoming increasingly prevalent on a global basis, and the proportion of single-

person households among middle-aged men is also increasing [34], identifying solutions to prevent these individuals from falling into depression or committing suicide will become an even more important task in the future. The nature of single-person households can exacerbate social isolation; this may become more severe with age. Therefore, while preserving individual autonomy, it is important to develop solutions that promote emotional exchanges between individuals, such as shared housing. In addition, it is necessary to prevent depression among middle-aged single men by implementing mental health programs.

Secondly, in order for depression prevention programs and treatments to be possible, it is important to reduce psychological and emotional barriers to the diagnosis and treatment of depression while considering the specific characteristics of men. The average level of depression in middle-aged men appears to be low, but if this result aligns with the stereotype that men are less depressed than women, it can lead to us overlooking the extent of depression in men. Instead, there is a need to focus on the very low awareness of depression in men. According to previous studies, men and women show different features of depression; women tend to express their emotions well and show sadness or crying while men often present with physical pain, difficulties in impulse control, or anger [27, 35]. This suggests that men may not recognize their own depression and that it is necessary to consider other behaviors and emotional patterns. Furthermore, when men experience depression, they struggle to express their inner feelings, avoid seeking help, and are very unlikely to seek help from healthcare professionals [36]. Considering these characteristics, it is necessary to increase the awareness of individuals with regards to depression and improve perceptions relating to mental health treatments to make the next step possible.

In this regard, for middle-aged men, even with lower average levels of depression, it is necessary to make special efforts to identify individuals at risk of suicide and establish targeted interventions for this population. According to our present findings, individuals with an increasing pattern of depression or a lower income are more likely to exhibit a higher risk of suicide. Considering that these men, who are more likely to fall into the increasing depression pattern, might have a lower socioeconomic status or be single, it may be possible to design targeted interventions for this group to address their potential suicide risk. In addition, ongoing research is required to identify multifaceted factors that predict depression and suicide among middle-aged men. Previous studies investigated gender differences related to depression and predicted that a range of indicators might better reflect depression in men, such as anger attacks, irritability and overreaction [37, 38]. The discovery and application of such indicators that may depict male depression could be a viable approach. Moreover, it is necessary to develop research projects to identify factors that predict suicidal thoughts and behaviors.

Finally, it is necessary to focus on suicide prevention, economic support and specifically labor support programs, for middle-aged men. As indicated herein, low income represents a significant predictor of suicide. Therefore, reinforcing economic support represents the foremost preventive strategy against suicide at both the community and national levels [39].

Currently, our society is navigating through the post-COVID-19 era. The pandemic exacerbated economic inequalities both on a national and individual level, and these economic repercussions are also exerting impact on personal levels of happiness in the future [40, 41]. Research on income distribution after COVID-19 revealed that employment income declined notably for single business owners, households with children under the age of 18 years, and single middle-aged households [28]. Taking these factors into account and considering the potential long-term impact of the economic downturn caused by the pandemic, there is a likelihood that a considerable portion of middle-aged individuals may transition from the “stable” depression pattern to the “increasing” depression pattern. To mitigate such a trend, it is crucial that we implement various labor support programs to prevent a decline in labor income. Furthermore, considering the high efficacy of suicide prevention programs aimed at middle-aged individuals [42], an expansion of suicide prevention initiatives targeting this demographic is warranted.

This research has the following significance and uniqueness. Firstly, this research was unique in that it investigated changes in depression among middle-aged men over the past five years and investigated whether such changes actually influence suicidal ideation. Furthermore, the present study is significant in that it suggests the direction of intervention for depression and suicidal thoughts among middle-aged men based on actual research data. In addition, the independent variable applied in this study, depression, was shown to influence suicidal ideation in the long term, thus demonstrating that depression should be considered in long-term policies to prevent suicide. In other words, it is expected that policies to improve depression will be proposed in future suicide prevention policies for middle-aged men.

## 5. Conclusions

In conclusion, this study highlights the urgent need to address depression and suicide ideation among middle-aged men, particularly those living in single-person households. Despite the perception of lower average levels of depression, it is evident that middle-aged men are at risk of suicide due to their low awareness and expression of depressive symptoms. Comprehensive solutions are required to tackle this issue effectively. This includes implementing tailored depression prevention programs, improving mental health treatments to reduce barriers for seeking help, and providing labor support initiatives. These findings emphasize the critical role of depression in suicide prevention strategies and underscore the urgency of policy efforts to enhance the mental well-being and economic conditions of middle-aged men.

## AVAILABILITY OF DATA AND MATERIALS

The data presented in this study are available on reasonable request from the corresponding author.

## AUTHOR CONTRIBUTIONS

KHJ, BKK, SEK, HJC and SHK—designed and conducted the research study; interpreted the data. KHJ and BKK—collected and analyzed the data. KHJ, SEK and HJC—drafted the manuscript. KHJ and HJC—revised the manuscript’s content. All authors read and approved the final manuscript.

## ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Institutional Review Board of Semyung University in Korea (SMU-EX-2023-07-002). Informed consent was obtained from all participants. Additionally, the survey of KoWePS was also approved by the Institutional Review Board of Korea Institute for Health and Social Affairs prior to commencement.

## ACKNOWLEDGMENT

Not applicable.

## FUNDING

This research received no external funding.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

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**How to cite this article:** Kyuhyoung Jeong, Bokyung Kim, Sungeun Kim, Heeran J. Cho, Sunghye Kim. The relationship between types of depressive changes and suicidal thoughts in middle-aged Korean males. *Journal of Men's Health*. 2023; 19(12): 66-74. doi: 10.22514/jomh.2023.131.