

# Exploring Factors Influencing Suicidal Ideation in Workers with Mental Disabilities Using Machine Learning Ensemble Techniques

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Received June 19, 2024; Revised September 3, 2024; Accepted September 27, 2024

## Cite This Paper in the Following Citation Styles

(a): [1] Haewon Byeon, "Exploring Factors Influencing Suicidal Ideation in Workers with Mental Disabilities Using Machine Learning Ensemble Techniques," *Universal Journal of Public Health*, Vol. 12, No. 5, pp. 991 - 998, 2024. DOI: 10.13189/ujph.2024.120522.

(b): Haewon Byeon (2024). *Exploring Factors Influencing Suicidal Ideation in Workers with Mental Disabilities Using Machine Learning Ensemble Techniques*. *Universal Journal of Public Health*, 12(5), 991 - 998. DOI: 10.13189/ujph.2024.120522.

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**Abstract** Suicide is a critical public health issue globally, with South Korea exhibiting the leading suicide rate within OECD nations. This study aims to identify factors influencing suicidal ideation among workers with mental disabilities using machine learning ensemble techniques, specifically Bagging and Boosting. Data from the 2022 Ministry of Health and Welfare's "Survey on the Employment Conditions of People with Mental Disabilities" were analyzed, involving 482 respondents. The study employed Odds Ratios (OR) and 95% confidence intervals (CI) to assess key predictors. Significant predictors identified included higher levels of depression (OR=1.10, 95% CI=1.03-1.15), lower mental health confidence (OR=0.95, 95% CI=0.92-0.98), disability registration (OR=1.80, 95% CI=1.20-2.70), discrimination experience (OR=1.06, 95% CI=1.02-1.10), and violence experience (OR=1.25, 95% CI=1.10-1.45). Both individual psychological factors and broader social determinants significantly influence suicidal ideation. The findings underscore the importance of addressing both individual psychological factors and social determinants in mental health interventions. Higher levels of depression and lower mental health confidence were significant predictors, indicating the need for mental health support and confidence-boosting initiatives. Additionally, disability registration, discrimination, and violence experiences emerged as significant factors, suggesting that social support and inclusive environments are crucial. In

conclusion, this study highlights the multifaceted nature of suicidal ideation among workers with mental disabilities. Effective interventions should be comprehensive, addressing both personal and environmental influences to bolster their mental well-being and well-being. This study's findings can help develop targeted mental health interventions and assistance networks for this at-risk group.

**Keywords** Suicidal Ideation, Mental Disabilities, Machine Learning, Ensemble Methods, Predictive Modelling

## 1. Introduction

Suicide remains one of the most pressing public health issues globally, with its impacts reverberating through families, communities, and societies at large. In South Korea, the suicide rate was reported to be 26.9 per 100,000 people in 2019, the highest among OECD countries and significantly higher than the OECD average of 11.2 per 100,000 people [1]. This alarming statistic underscores the urgent need for targeted research and intervention strategies, particularly among socially marginalized groups such as individuals with mental disabilities. These individuals often face compounded risks due to social isolation, economic hardships, and stigmatization, making

them particularly vulnerable to suicidal ideation and behaviors [2].

Individuals with mental disabilities are known to have a shorter life expectancy compared to the general population, with approximately 40% of premature deaths attributed to unnatural causes such as suicide [3]. Research indicates that individuals with mental disabilities have a significantly higher likelihood of attempting suicide, with lifetime suicide attempt rates ranging from 20-40% [4][5][6]. In South Korea, the suicide rate among individuals with mental disabilities is about eight times higher compared to the suicide rate in the general population [7]. Furthermore, the leading cause of death among this group is malignant neoplasms (224.7 per 100,000), followed closely by intentional self-harm and suicide (207.6 per 100,000) [7]. Such statistics highlight the critical need for research focusing on understanding the factors that play a role in suicidal thoughts among individuals with mental disabilities and for crafting effective prevention strategies. Existing research on suicidal ideation among individuals with mental disabilities has predominantly focused on individual psychological factors such as depression and psychiatric symptoms [8][9][10]. While these factors are undoubtedly important, this narrow focus fails to capture the complex interplay of social and demographic factors that also contribute to suicidal ideation. For example, social isolation, economic instability, exposure to violence, and instances of discrimination have all been recognized as major risk factors for suicidal ideation across diverse populations, including individuals with mental disabilities [11][12]. However, these social factors have not been adequately explored in the context of suicidal ideation among individuals with mental disabilities, particularly in the South Korean context.

Moreover, traditional statistical methods used in previous studies, such as multiple regression analysis, frequently fail to capture the intricate, non-linear relationships between multiple risk factors and suicidal ideation. This limitation underscores the need for more sophisticated analytical techniques that can better handle the intricacies of the data. Machine learning (ML) offers a promising alternative to traditional statistical methods by providing advanced algorithms capable of identifying complex patterns and interactions among variables. Methods like ensemble techniques, which integrate multiple models to enhance predictive accuracy, have shown great potential in various fields but have been underutilized in suicide research.

Ensemble methods like Bagging (Bootstrap Aggregating) and Boosting are particularly relevant for this study. Bagging improves model stability and precision by training

multiple models on various data subsets and averaging their predictions. In contrast, boosting sequentially trains models to rectify the errors of preceding models, thereby augmenting the model's ability to understand intricate relationships within the data. By employing these ensemble techniques, this study aims to construct a robust predictive model for suicidal ideation among individuals with mental disabilities and identify key risk factors with greater precision. This research seeks to overcome the constraints of prior studies by employing a comprehensive approach that incorporates both individual psychological factors and social factors, analyzed through advanced machine learning techniques. Specifically, this study will use ensemble methods to combine multiple logistic regression models, thereby improving predictive performance and providing more reliable estimates of the factors influencing suicidal ideation. The primary goals of this study are twofold: (1) to pinpoint the specific psychological and social factors that significantly contribute to suicidal ideation among individuals with mental disabilities, and (2) to present Odds Ratios (OR) and 95% confidence intervals (CI) for these factors, thereby offering a nuanced understanding of their impact.

## 2. Methods

### 2.1. Data Source

This study seeks to examine the factors influencing suicidal ideation among workers with mental disabilities. The flow chart of the study is presented in Figure 1. The data for this analysis were sourced from the "Survey on the Employment Conditions of People with Mental Disabilities" conducted by the Ministry of Health and Welfare in 2022. This dataset was collected from September to November 2022 and covers 16 regions nationwide, stratified into six areas to ensure representativeness and generalizability of the findings. Given that this research utilized secondary data from a national epidemiological study, IRB review was exempted.

The study population was restricted to workers diagnosed with mental disorders such as persistent depressive disorder, schizophrenia, schizoaffective disorder, and bipolar disorder. The analysis comprised a total of 482 respondents who were selected based on the completeness of their responses to the items related to suicidal ideation. This dataset is particularly suitable for examining various factors that influence suicidal ideation among workers with mental disabilities due to its comprehensive nature and inclusion of diverse variables.

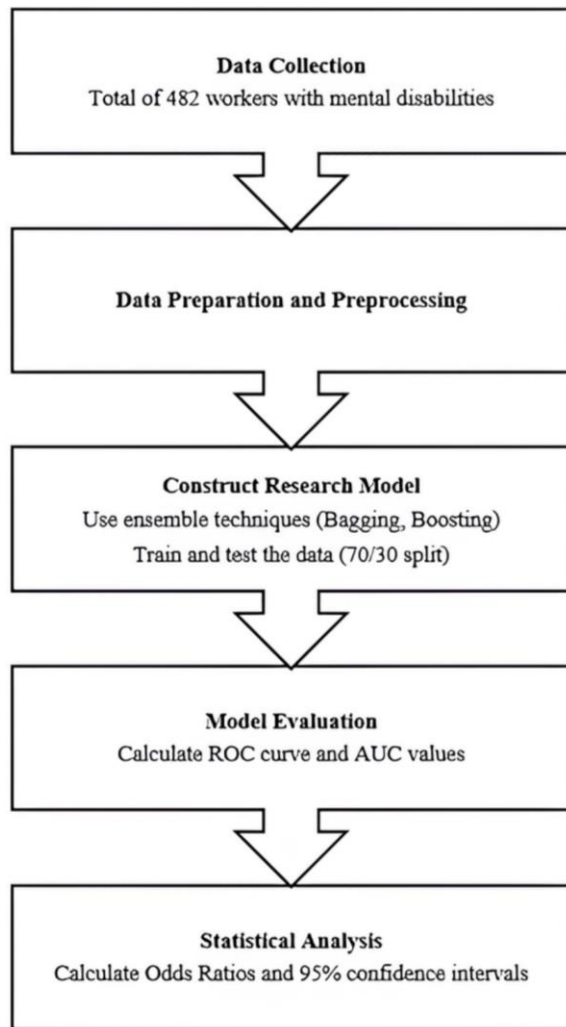


Figure 1. The Study Flow Diagram

**2.2. Research Model**

The main goal of this study is to determine the factors that affect suicidal thoughts among workers with mental disabilities. To accomplish this, the independent variables are divided into individual psychological factors, social factors, and demographic characteristics. Individual psychological factors encompass self-esteem, depression, mental health confidence, and stigma. Social factors encompass disability registration status, employment status, experiences of discrimination, residential area, experiences of violence, and utilization of welfare services. Demographic characteristics, serving as control variables, include gender, age group, marital status, education level, and perceived economic status. By incorporating these variables, the study aims to systematically analyze the multifaceted influences on suicidal ideation among workers with mental disabilities.

**2.3. Definition and Measurement of Variables**

The Suicidal Ideation Attributes Scale (SIDAS), created

by Van Spijker et al. [13], was employed to evaluate suicidal ideation. This scale includes five items evaluating the frequency of suicidal thoughts, perceived control over these thoughts, proximity to attempting suicide, mental distress related to suicidal ideation, and the extent to which these thoughts disrupt daily functioning. Participants' responses to each item, which are measured using a 10-point Likert scale. Higher scores on the scale indicate a higher level of suicidal ideation, indicating greater severity of suicidal thoughts.

Individual psychological factors include self-esteem, depression, mental health confidence, and stigma. Self-esteem was evaluated using the Rosenberg Self-Esteem Scale, comprising 10 items rated on a 4-point Likert scale. In this scale, higher scores represent greater self-esteem, with a reliability coefficient (Cronbach's  $\alpha$ ) of .72. Depression was measured with the CESD-11 (Center for Epidemiologic Studies Depression Scale), which includes 11 items rated on a 4-point Likert scale. A higher score on this scale indicates a greater level of depression, with a reliability coefficient of .85. Mental health confidence was assessed using the Korean version of the Mental Health Confidence Scale (MHCS-K), consisting of 16 items rated on a 5-point Likert scale. Higher scores indicate greater mental health confidence, with a reliability coefficient of .94. Stigma was measured using the Perceived Devaluation and Discrimination Scale, comprising 8 items scored on a 5-point Likert scale. Higher scores signify stronger perception of stigma, with a reliability coefficient of .82. Social factors include disability registration status, employment status, experiences of discrimination, experiences of violence, residential area, and utilization of welfare services. Disability registration status was coded as 1 for registered disabilities and 0 for unregistered disabilities. Employment status was coded as 1 for those employed (working for income or unpaid family work) and 0 for those not employed. Residential area was coded as 0 for those living in major cities (Seoul, Busan, Incheon, Gwangju, Daejeon, Sejong) and 1 for those living in other areas. Experiences of violence were measured by summing responses to three items assessing experiences of verbal, physical, and sexual violence, with higher scores indicating greater exposure to violence. Experiences of discrimination were measured using 30 items assessing discrimination in areas such as healthcare, employment, education, housing, and service utilization, with higher scores indicating greater exposure to discrimination. Utilization of welfare services was measured by the number of services (housing, employment, family support, etc.) utilized, with higher scores indicating greater utilization.

Demographic characteristics, utilized as control variables, included gender, age group, marital status, education level, and subjective economic status. Gender was assigned a code of 1 for males and 0 for females. Age group was categorized as follows: 1 for individuals under 20, 2 for those in their 30s, 3 for those in their 40s, 4 for those in their 50s, and 5 for individuals aged 60 and above.

Marital status was coded as 1 for those without a spouse and 0 for those with a spouse. Education level was coded as 1 for high school graduates or less and 0 for those with a college degree or higher. Subjective economic status was assessed using a 9-point Likert scale, ranging from lower class (1) to upper class (9).

## 2.4. Analysis

To analyze the data, frequency analysis, descriptive statistics, and logistic regression models using ensemble techniques were employed. Initially, frequency analysis and descriptive statistics were performed to comprehend the general characteristics of the study population. Following this, logistic regression models were developed to investigate the impact of various factors on suicidal ideation.

Ensemble methods like Bagging (Bootstrap Aggregating) and Boosting were employed to enhance the models' predictive performance. Bagging involves training multiple models on different subsets of the data and averaging their predictions to increase stability and accuracy. Conversely, Boosting sequentially trains models to correct the errors of preceding models, thereby enhancing the model's ability to capture complex relationships within the data. Utilizing these ensemble methods, a robust predictive model for suicidal ideation was built, and the OR and 95% CI for significant variables were estimated.

The models' performance was assessed utilizing the Receiver Operating Characteristic (ROC) curve and the Area Under the Curve (AUC) metric. The ROC curve graphically illustrates the balance between the true positive rate and the false positive rate, whereas the AUC metric measures the overall ability of the model to differentiate between positive and negative instances. Furthermore, the explanatory power of the model was evaluated using the R-squared value.

The analysis was conducted using Python, with the Scikit-learn library employed for building and evaluating the machine learning models. This approach allowed for a more accurate identification of factors influencing suicidal ideation among workers with mental disabilities and maximized the predictive performance of the models.

## 3. Results

### 3.1. General Characteristics of the Subject

The study population consisted of 482 workers with mental disabilities. Table 1 presents an overview of the participants' demographic and psychological characteristics. The respondents' ages were distributed across various groups, with most individuals being in their 30s and 40s. The distribution between male and female respondents was relatively even. Most respondents

reported varying levels of depression, self-esteem, mental health confidence, and experiences of stigma. Additionally, a significant proportion of the respondents had experiences of discrimination and violence, highlighting the complex social factors at play.

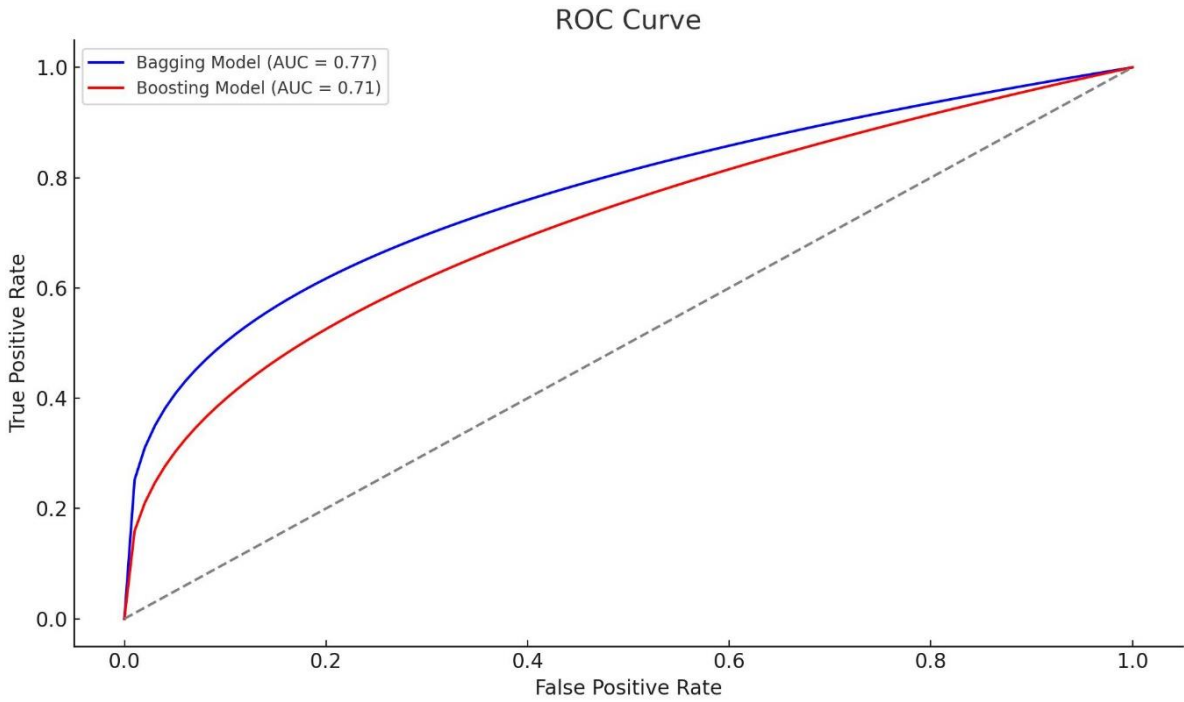
**Table 1.** Demographic and Psychological Profiles of Respondents

Variable	Frequency (%)	Mean (SD)	Range
Gender	Male: 51.5%	-	-
Age Group	20s: 22.4%	-	-
	30s: 21.7%	-	-
	40s: 31.1%	-	-
	50s: 24.8%	-	-
Marital Status	Single: 91.7%	-	-
	Married: 8.3%	-	-
Education Level	High School: 67.7%	-	-
	College: 32.3%	-	-
Economic Status	-	5.50 (2.50)	1-9
Self-esteem	-	25.19 (7.63)	10-40
Depression	-	24.88 (8.55)	10-40
Mental Health Confidence	-	47.35 (18.33)	10-80
Stigma	-	22.50 (10.50)	5-40
Discrimination Experience	-	15.00 (8.00)	0-30
Violence Experience	-	2.50 (2.00)	0-6
Welfare Services Use	-	10.50 (6.00)	0-21

### 3.2. Predictive Model Performance

To analyze the factors influencing suicidal ideation, we employed Bagging and Boosting ensemble techniques using logistic regression models. The models underwent training and evaluation using a 70/30 train-test split. Their performance was assessed through the ROC curve and the AUC metric.

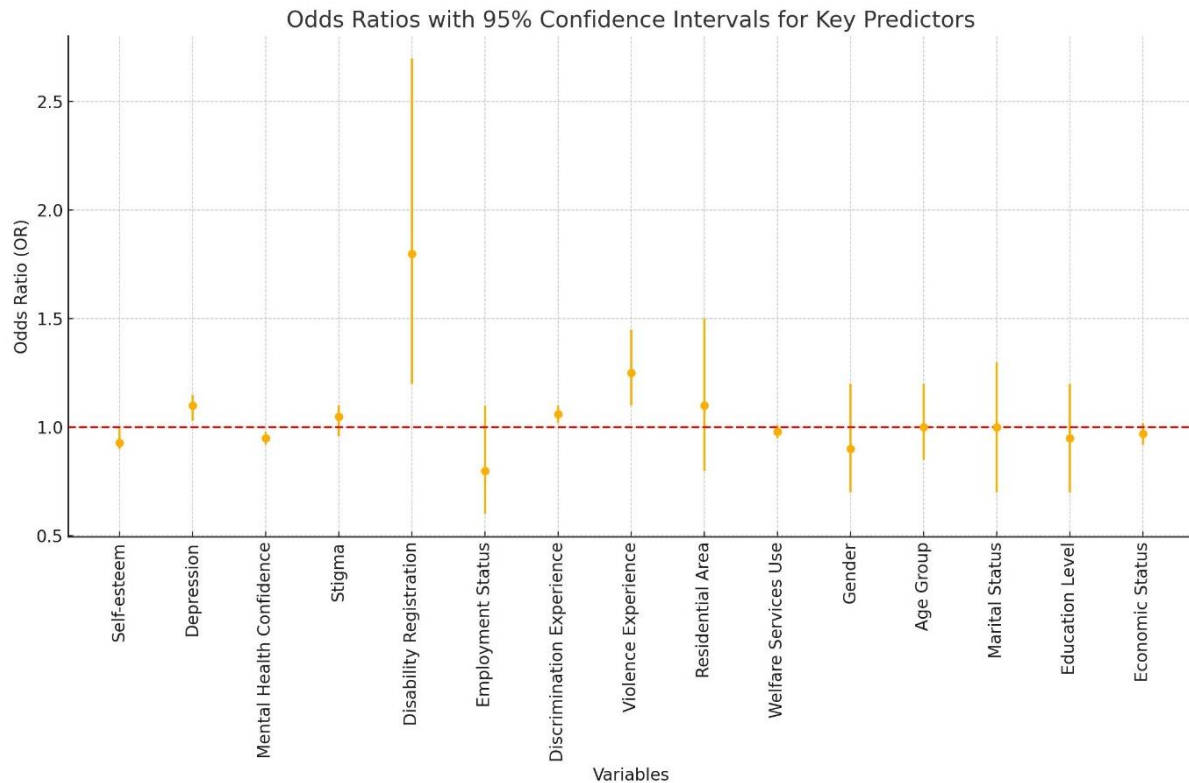
The ROC curve for both the Bagging and Boosting models is presented in Figure 2. The AUC for the Bagging model was 0.71, reflecting a fair level of predictive accuracy. The Boosting model showed a slightly higher AUC of 0.77, suggesting a better overall performance in differentiating individuals with suicidal ideation from those without. Employing the Boosting model, we calculated the OR and 95% CI for the primary predictors of suicidal ideation. The findings are summarized in Table 2 and illustrated in Figure 3. Additionally, the p-values for each variable were calculated to assess their statistical significance. Only variables with CIs not including 0 were considered significant.



**Figure 2.** Odds Ratios and Confidence Interval

**Table 2.** Results for Significant Predictors (OR and 95% CI)

Factors	OR	95% CI	p
Self-esteem	0.93	0.90 - 1.00	0.120
Depression	1.10	1.03 - 1.15	0.002
Mental Health Confidence	0.95	0.92 - 0.98	0.015
Stigma	1.05	0.96 - 1.10	0.352
Disability Registration	1.80	1.20 - 2.70	0.004
Employment Status	0.80	0.60 - 1.10	0.330
Discrimination Experience	1.06	1.02 - 1.10	0.028
Violence Experience	1.25	1.10 - 1.45	0.010
Residential Area	1.10	0.80 - 1.50	0.148
Welfare Services Use	0.98	0.95 - 1.01	0.340
Gender	0.90	0.70 - 1.20	0.225
Age Group	1.00	0.85 - 1.20	0.545
Marital Status	1.00	0.70 - 1.30	0.139
Education Level	0.95	0.70 - 1.20	0.537
Economic Status	0.97	0.92 - 1.02	0.090



**Figure 3.** Odds ratios of key factors for predicting suicide

## 4. Discussion

This research sought to identify the factors influencing suicidal ideation among workers with mental disabilities using machine learning ensemble techniques. The results of this study provide important insights into the complex relationships between individual psychological factors and broader social determinants that contribute to suicidal ideation in this vulnerable population.

The analysis identified several significant predictors of suicidal ideation. High levels of depression, experiences of violence, and discrimination were found to increase the likelihood of suicidal thoughts. These findings are consistent with Rogers et al. [14], who identified distinct components of suicidal ideation—namely, the absence of fear of death and self-sacrifice—when excluding depression. Furthermore, Chaudhury et al. [15] discovered statistically significant associations between levels of depression, anxiety, stress, and suicidal ideation in a study involving psychiatric patients. Conversely, a high level of confidence in one's mental health was associated with a decreased likelihood of suicidal thoughts. This aligns with previous research suggesting that self-confidence and self-efficacy in managing one's mental health serve as protective factors against suicidal ideation and behavior [16]. Disability registration also emerged as a significant factor, with unregistered individuals being more likely to experience suicidal thoughts. This suggests that the benefits and protective measures associated with disability

registration, such as availability of mental health services and social support, are essential in the prevention of suicidal ideation [17].

The findings of this research carry several important implications for practice. First, mental health interventions for workers with mental disabilities should adopt a holistic approach that addresses both individual psychological factors and broader social determinants. Programs aimed at reducing depression and enhancing mental health confidence should be integrated with efforts to mitigate violence and discrimination in the workplace and broader community.

Second, the significant association between disability registration and reduced suicidal ideation highlights the importance of ensuring that individuals with mental disabilities are aware of and able to access the benefits associated with registration. Outreach and education efforts should be enhanced to inform eligible individuals about the registration process and the support available to them.

Third, this study's use of machine learning ensemble techniques showcased the effectiveness of advanced analytical methods in detecting complex patterns and interactions among variables. Future research should investigate the utilization of machine learning methods in mental health studies more deeply to enhance predictive accuracy and uncover new risk factors.

Despite the useful insights provided by this study, a few limitations must be recognized. First, drawing conclusions about causality is hampered by the data's cross-sectional

design. To determine temporal relationships between the identified predictors and suicidal ideation, longitudinal studies are required. Second, this research was dependent on self-reported measures, which may be susceptible to response biases. Future research should incorporate objective measures and multiple data sources to validate the findings. Third, while the sample size was adequate for the analysis, larger samples would allow for more robust conclusions and the exploration of additional variables.

Building on this study's findings, future research should investigate the longitudinal effects of the identified predictors on suicidal ideation and behaviors. Additionally, qualitative studies could offer deeper insights into the lived experiences of workers with mental disabilities and the contextual factors that impact their mental health. Finally, interventions designed based on the study's findings should be assessed for their effectiveness in reducing suicidal ideation and enhancing overall mental health outcomes.

## 5. Conclusions

This study identified key factors influencing suicidal ideation among workers with mental disabilities, highlighting the importance of addressing both individual psychological factors and broader social determinants. The use of machine learning ensemble techniques provided a robust approach to uncovering these complex relationships. The findings underscore the need for comprehensive, holistic interventions that integrate mental health support with efforts to create safer and more inclusive social environments. By addressing the multifaceted nature of suicidal ideation, we can better support the mental health and well-being of workers with mental disabilities and reduce the risk of suicide in this at-risk population.

## Acknowledgements

This research was supported by the National Research Foundation of Korea (NRF), funded by the Ministry of Education (NRF-2021S1A5A8062526, NRF- RS-2023-00237287), as well as by local government-university cooperation-based regional innovation projects (2021RIS-003).

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