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Identifying unique subgroups in suicide risks among psychiatric outpatients

Eun Namgung [a,1], Eunji Ha [b,1], Sujung Yoon [b,c], Yumi Song [b,c], Hyangwon Lee [b,c], Hee-Ju Kang [d], Jung-Soo Han [e], Jae-Min Kim [d], Wonhye Lee [f], In Kyoon Lyoo [b,c,g,*], Seog Ju Kim [f,**]

[a] Asan Institute for Life Sciences, Asan Medical Center, Seoul, South Korea
[b] Ewha Brain Institute, Ewha Womans University, Seoul, South Korea
[c] Department of Brain and Cognitive Sciences, Ewha Womans University, Seoul, South Korea
[d] Department of Psychiatry, Chonnam National University Medical School, Gwangju, South Korea
[e] Department of Biological Sciences, Konkuk University, Seoul, South Korea
[f] Department of Psychiatry, Sungkyunkwan University College of Medicine, Samsung Medical Center, Seoul, South Korea
[g] Graduate School of Pharmaceutical Sciences, Ewha Womans University, Seoul, South Korea

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ABSTRACT

Background: The presence of psychiatric disorders is widely recognized as one of the primary risk factors for suicide. A significant proportion of individuals receiving outpatient psychiatric treatment exhibit varying degrees of suicidal behaviors, which may range from mild suicidal ideations to overt suicide attempts. This study aims to elucidate the transdiagnostic symptom dimensions and associated suicidal features among psychiatric outpatients.

Methods: The study enrolled patients who attended the psychiatry outpatient clinic at a tertiary hospital in South Korea (n = 1, 849, age range = 18–81; 61% women). A data-driven classification methodology was employed, incorporating a broad spectrum of clinical symptoms, to delineate distinctive subgroups among psychiatric outpatients exhibiting suicidality (n = 1189). A reference group of patients without suicidality (n = 660) was included for comparative purposes to ascertain cluster-specific sociodemographic, suicide-related, and psychiatric characteristics.

Results: Psychiatric outpatients with suicidality (n = 1189) were subdivided into three distinctive clusters: the low-suicide risk cluster (Cluster 1), the high-suicide risk externalizing cluster (Cluster 2), and the high-suicide risk internalizing cluster (Cluster 3). Relative to the reference group (n = 660), each cluster exhibited distinct attributes pertaining to suicide-related characteristics and clinical symptoms, covering domains such as anxiety, externalizing and internalizing behaviors, and feelings of hopelessness. Cluster 1, identified as the low-suicide risk group, exhibited less frequent suicidal ideation, planning, and multiple attempts. In the high-suicide risk groups, Cluster 2 displayed pronounced externalizing symptoms, whereas Cluster 3 was primarily defined by internalizing and hopelessness symptoms. Bipolar disorders were most common in Cluster 2, while depressive disorders were predominant in Cluster 3.

Discussion: Our findings suggest the possibility of differentiating psychiatric outpatients into distinct, clinically relevant subgroups predicated on their suicide risk. This research potentially paves the way for personalizing interventions and preventive strategies that address cluster-specific characteristics, thereby mitigating suicide-related mortality among psychiatric outpatients.

* Correspondence to: In Kyoon Lyoo, Ewha Brain Institute and Department of Brain Cognitive Science, Ewha Womans University, 52 Ewhayeodae-gil, Seodaemun-gu, Seoul 03760, South Korea.
** Correspondence to: Seog Ju Kim, Department of Psychiatry, Sungkyunkwan University School of Medicine, Samsung Medical Center, 81 Irwon-ro, Kangnam-gu, Seoul 06351, South Korea.
E-mail addresses: inkylyoo@ewha.ac.kr (I.K. Lyoo), ksj7126@skku.edu (S.J. Kim).
[1] These authors contributed equally to the manuscript.

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1. Introduction

Accounting for over one million deaths annually, suicide poses a substantial public health challenge necessitating effective preventive and intervention methodologies [1,2]. Both suicidal ideation and suicide attempts, exhibiting a global lifetime prevalence of 9.2% and 2.7% respectively, are strong indicators of suicide death, representing 1.4% of all mortality cases [1,3,4]. Therefore, a comprehensive understanding of the risk factors tied to suicidal ideation and suicide attempts is of significant importance in preventing suicide-related fatalities [2,3].

Suicide is a behavioral consequence that emerges from complex interactions between psychosocial and clinical risk factors, encompassing lifetime stressors, family history, and the presence of psychiatric disorders [5,6]. Given the heterogeneous nature of suicidality, patients with suicidal risks might manifest a wide range of emotional and behavioral distress or dysfunction, leading to considerable inter-individual variations in clinical manifestations [2,3]. Additionally, cultural factors play a crucial role in influencing suicide risks and patterns across different societies [2,7–10]. Factors such as honor, shame, cultural stigma for mental illness, and religious beliefs are known to impact suicidal behaviors [2,7,11–13]. Furthermore, the nature of a society, whether individualistic or collectivistic, influences suicide risk by affecting the availability and strength of social support networks [7,14]. Therefore, comprehending the intricacies and heterogeneity of suicidality is pivotal in formulating individualized strategies to prevent suicide among high-risk psychiatric patients [2,3].

Mental illness is a significant risk factor for suicide, with many individuals who die by suicide exhibiting signs of various psychiatric disorders [2,15]. Research in a multi-ethnic Asian population revealed that conditions such as psychotic illness, borderline personality disorder, and insomnia can elevate the risk of repeated suicide attempts, often in conjunction with other sociodemographic and personal factors [16]. This underscores the complexity of suicide risk, as each psychiatric diagnosis presents a unique and multifaceted risk profile [15–19]. Concentrating exclusively on a single diagnosis or symptom falls short for precise prediction [2,3]. Conversely, the diverse manifestations of psychiatric symptoms are associated with a broad spectrum of suicide outcomes [5,15]. Therefore, a transdiagnostic approach is essential for accurately assessing suicide risk among psychiatric patients, providing a more comprehensive understanding of their suicidality.

To explore the complex interplay between clinical and psychosocial factors in suicidality and to implement a transdiagnostic approach, we propose employing data-driven agglomerative hierarchical cluster analysis. This unsupervised, bottom-up technique enables the discovery of latent patterns in multi-dimensional data without predetermined hypotheses [20,21]. Unlike traditional diagnostic categories, this method can identify specific subgroups (“phenotypes”) among psychiatric outpatients with suicidality based on their individual profiles.

The primary objective of our study was to identify discrete clusters of psychiatric outpatients with suicidality, focusing on individual suicide risk profiles. We employed an agglomerative hierarchical cluster analysis, an unsupervised and data-driven method, to examine an extensive range of psychiatric symptoms. Additionally, we conducted a comprehensive assessment of cluster-specific characteristics, including sociodemographic and clinical factors, as well as elements related to suicide, self-injury, stressors, and psychiatric diagnoses.

2. Material and methods

2.1. Study participants

In this study, we enrolled 1849 patients, each having a minimum of 11 available scale scores across 14 possible scales, during the period from June 2017 to December 2021. These participants were all attendees of the psychiatric outpatient clinic at a tertiary hospital, specifically Samsung Medical Center in Seoul, South Korea.

Prior to conducting cluster analysis, we divided the patients into two groups based on their suicidality: 1189 patients exhibiting suicidality (the suicidal group) and 660 without suicidality (the non-suicidal group). Suicidality was evaluated using a semi-structured questionnaire, which included questions about current and past suicidal ideation, past and present specific suicidal plans, and detailed accounts of previous suicide attempts. For more details, the specific items of this questionnaire are included in Supplementary Table 1. In this classification, individuals were labeled as “suicidal” if they reported any suicidal ideation, specific suicidal plans, or previous suicide attempts. The non-suicidal group reported no suicidal ideation, specific suicidal plans, or previous suicide attempts.

The suicidal group (n = 1189) then underwent cluster analysis to categorize them into clinically relevant clusters. The non-suicidal group (n = 660) served as the reference group for subsequent regression analysis aimed at identifying cluster-specific characteristics.

Demographic characteristics are summarized in Table 1. The study was conducted as a retrospective chart review and received approval from the Institutional Review Board of the Samsung Medical Center (No. 2020–11-107), which provided an exemption from the requirement for written informed consent.

2.2. Clinical measurements

Clinical characteristics associated with suicide, stressors, family history, and psychiatric history were determined using a semi-structured clinical interview, supplemented by a retrospective chart review, conducted by board-certified psychiatrists and clinical psychologists. The diagnosis of psychiatric disorders was conducted using the Structured Clinical Interview for DSM-5.

A set of 14 clinician-administered rating scales and self-reporting questionnaires were employed to assess a wide array of psychiatric symptoms, including mood, anxiety, attention, impulsivity, hopelessness, and alcohol use: Hamilton Depression Rating Scale (HDRS) [22,23], Hamilton Anxiety Rating Scale (HARS) [24], Beck Anxiety Inventory (BAI) [25,26], Beck Depression Inventory-2 (BDI-2) [27,28], Beck Hopelessness Scale (BHS) [29,30], Anxiety Sensitivity Index-3 (ASI-3) [31,32], Albany Panic and Phobia Questionnaire (APPQ) [33,34], Liebowitz Social Anxiety Scale (LSAS) [35,36], Obsessive-Compulsive Inventory-Revised (OCI-R) [37,38], Adult Attention Deficit/Hyperactivity Disorder (ADHD) Self-Report scale (ASRS) [39,40], Penn State Worry Questionnaire (PSWQ) [41,42], Mood Disorder Questionnaire (MDQ) [43,44], Hypomanic Symptom Checklist (HCL) [45,46], and Alcohol Use Disorder Identification Test (AUDIT) [47,48]. A detailed description of the scale measurements is provided in the Supplementary Methods.

The analyses involved the total scores from the aforementioned 14 scales. Among the 1849 patients, 104 subjects (5.6%) had missing data (1 missing variable, n = 60; 2 missing variables; n = 23, 3 missing variables, n = 21). The missing data was imputed through the utilization of the k-nearest neighbors (kNN) algorithm [49], a well-recognized method for managing such missing information in datasets. All scale scores were converted into standardized z scores for further analysis.

2.3. Cluster analysis

Our study employed an agglomerative hierarchical cluster analysis using Ward’s minimum variance method on 1189 patients presenting with suicidality. This approach aims to minimize the variance within clusters, thereby ensuring the formation of distinct and maximally dissimilar clusters. We employed squared Euclidean distances for constructing the dendrogram, which guided us in identifying the most theoretically interpretable and optimal cluster solution [21].

In the initial step of feature selection for our cluster analysis, Principal Component Analysis (PCA) was applied to 14 pre-defined standardized scale scores. Utilizing a correlation matrix and varimax

Table 1
Demographic and clinical characteristics of psychiatric patients in this study.

Characteristics	Total patients (n = 1849)	Patients without suicidality (*n* = 660)	Patients with suicidality (*n* = 1189)	*P*[*]
Age, years				
18–19	137 (7.4)	40 (6.1)	97 (8.2)	
20–39	1128 (61.0)	309 (46.8)	819 (68.9)	< 0.001
40–59	420 (22.7)	215 (32.6)	205 (17.2)	
≥ 60	164 (8.9)	96 (14.6)	68 (5.72)	
Sex				
Men	721 (39.0)	296 (44.9)	425 (35.7)	< 0.001
Women	1128 (61.0)	364 (55.1)	764 (64.3)	
Marital status[1]				
Single	1125 (61.0)	322 (48.9)	803 (67.7)	< 0.001
Married	319 (33.2)	294 (44.7)	319 (26.9)	
Separated or widowed	107 (5.8)	42 (6.38)	65 (5.48)	
Employment status[2]				
Employed	692 (38.0)	281 (43.4)	411 (35.0)	0.002
Homemaker or student	698 (38.4)	227 (35.1)	471 (40.2)	
Unemployed	430 (23.6)	139 (21.5)	291 (24.8)	
Education[3]				
High school graduate or higher	1697 (93.7)	594 (94.0)	1103 (93.5)	0.670
Diagnosis of psychiatric disorders[4]				
Schizophrenia or psychotic disorders	85 (4.6)	47 (7.1)	38 (3.2)	< 0.001
Bipolar disorders	518 (28.0)	86 (13.0)	432 (36.3)	< 0.001
Depressive disorders	910 (49.2)	248 (37.6)	662 (55.7)	< 0.001
Anxiety disorders	642 (34.7)	293 (44.4)	349 (29.4)	< 0.001
Substance use disorders	140 (7.6)	31 (4.7)	109 (9.2)	< 0.001
Somatoform disorders	109 (5.9)	57 (8.6)	52 (4.4)	< 0.001

Data are presented as number (%).
[*] *P* values were calculated using chi-square tests between patients with suicidality and those without suicidality.
[1] Data from 4 patients were not available.
[2] Data from 29 patients were not available.
[3] Data from 37 patients were not available.
[4] The diagnoses were not categorically exclusive, allowing for potential co-occurrence among clusters.

rotation, PCA played a crucial role in reducing dimensionality. This method effectively extracted principal components (PCs) representing distinct symptom domains [50], subsequently used as relevant features in the cluster analysis. This step was vital in minimizing information redundancy and in optimizing the variance explanation across all measures, significantly enhancing our study's precision and interpretability [50]. We retained PCs with eigenvalues exceeding 0.9 [51].

Prior to the cluster analysis, the tendency for cluster formation was assessed using the Hopkins statistic [52]. This statistic evaluates the likelihood of a given dataset being either uniformly distributed or containing cluster structures.

Following the cluster analysis, the stability of the derived cluster solution was evaluated using two complementary methods. Firstly, the Jaccard coefficient—a statistical measure of similarity and diversity between sample sets—was used to assess the reproducibility of the cluster results [53]. This analysis offered quantitative evidence for the internal consistency and robustness of the identified clusters. Additionally, discriminant function analysis with leave-one-out cross-validation (LOOCV) was implemented for further validation of the optimal cluster solution [54]. This method enabled us to evaluate the generalizability and external validity of the clustering by classifying individuals based on their characteristics and comparing them to their original cluster assignments. This rigorous validation process ascertained the reliability and predictive power of the derived clusters.

The cluster analysis was conducted using R version 4.1.1 (https://cran.r-project.org/bin/windows/base/).

2.4. Statistical analysis

Demographic and clinical characteristics were compared between psychiatric patients with suicidality and those without using an unpaired *t*-test or a chi-square test.

To determine cluster-specific characteristics, we utilized linear regression analysis to compare symptom domain scale scores across clusters. Patients without suicidality (non-suicidal group, $n = 660$) were the reference group in these analyses. We created dummy variables representing identified clusters for this reference group and included them in the multivariate models as independent variables.

For clinical characteristics of a categorical nature, we conducted logistic regression analysis, using the values from the reference group as baseline outcomes.

These tests were two-tailed and performed using STATA version 16.1 (Stata Corp, College Station, Texas).

3. Results

3.1. Characteristics of psychiatric patients with and without suicidality

Table 1 summarizes the demographic and clinical characteristics of the study participants.

The total sample ($n = 1849$) comprised patients with a mean age of 34.4 years (standard deviation [SD] = 14.3), 61.0% of whom were women ($n = 1128$). The majority of patients ($n = 1265$, 68.4%) were between 18 and 39 years old. Of the total psychiatric patient population (n = 1849), a notable 66.8% ($n = 1232$) were either unmarried or separated. Additionally, 62.0% (n = 1128) were categorized as unemployed, homemakers, or students. Individuals with at least a high school education made up 93.7% ($n = 1697$) of the sample. The distribution of psychiatric diagnoses among the study participants was as follows: 49.2% of patients ($n = 910$) had depressive disorders, 34.7% ($n = 642$) had anxiety disorders, 28.0% ($n = 518$) had bipolar disorders, 7.6% ($n = 140$) had substance use disorders, 5.9% ($n = 109$) had somatoform disorders, and 4.6% ($n = 85$) had psychotic disorders. These diagnoses were not mutually exclusive.

Significant demographic and clinical differences were observed between psychiatric patients with suicidality (suicidal group, $n = 1189$) and those without (non-suicidal group, $n = 660$). The suicidal group was younger (mean ± SD, 31.7 ± 13.1 years), had a higher proportion of females, a greater percentage of single individuals, and a lower employment rate compared to the non-suicidal group (mean age ± SD, 39.2 ± 15.3 years). Diagnoses of bipolar disorders, depressive disorders, and substance use disorders were more prevalent in the suicidal group, whereas diagnoses of psychotic disorders, anxiety disorders, and somatoform disorders were less prevalent compared to the non-suicidal group.

3.2. Cluster forming tendency

The Hopkins statistic, with a value of 0.74, indicated a significant tendency for our dataset to form clusters, suggesting the presence of a meaningful cluster structure [52,55]. Typically, values ranging between 0.5 and 1 suggest the presence of meaningful clusters [52,55].

3.3. Feature selection and decomposition (Supplementary Table 2)

PCA was conducted on 14 scale scores, yielding four significant PCs, labeled PC1 through PC4 (Supplementary Table 2). Each PC represented a unique dimensional symptom domain.

PC1, encompassing the ASI-3, BAI, APPQ, LSAS, OCI-R, and ASRS scales, represented a constellation of anxiety, panic, and phobic symptoms, social anxiety, obsessive-compulsive symptoms, and attention deficit/hyperactivity, collectively forming the "anxiety" symptom domain.

PC2, comprising the MDQ, HSC, and AUDIT scales, evaluated hypomanic/manic symptoms and alcohol use, thus constituting the "externalizing" symptom domain.

PC3, integrating the HDRS and HARS scales, assessed depression and anxiety, establishing the "internalizing" symptom domain.

PC4, including the BHS, PSWQ, and BDI-2 scales, explored hopelessness, worry, and depression, defining the "hopelessness" symptom domain.

Composite scores for each domain were calculated by averaging the standardized scale scores within each PC. These scores, representing the dimensional symptom domains, served as input features for subsequent cluster analysis.

3.4. Cluster analysis (Fig. 1 and Supplementary Fig. 1)

An agglomerative hierarchical cluster analysis was conducted to categorize 1189 patients with suicidality into three distinct clusters, each exhibiting unique psychiatric symptom profiles in anxiety, externalizing, internalizing, and hopelessness symptom domains (Fig. 1A, B). These tripartite cluster structures are depicted in the dendrogram and 3D cluster plot (Fig. 1A). Dimension 1 indicates the range of low-to-high suicidal risks, and Dimension 2 represents the externalizing-internalizing symptom profiles. A dissimilarity matrix is available in Supplementary Fig. 1 for additional reference.

Cluster 1, termed the "low-suicide risk cluster," comprised 563 individuals (47.4% of the 1189 patients), characterized by relatively lower scores in all four symptom domains.

Cluster 2, named the "high-suicide risk externalizing cluster," encompassed 223 patients with suicidality (18.8%) and exhibited the highest scores in the anxiety and externalizing symptom domains.

Cluster 3, known as the "high-suicide risk internalizing cluster,"

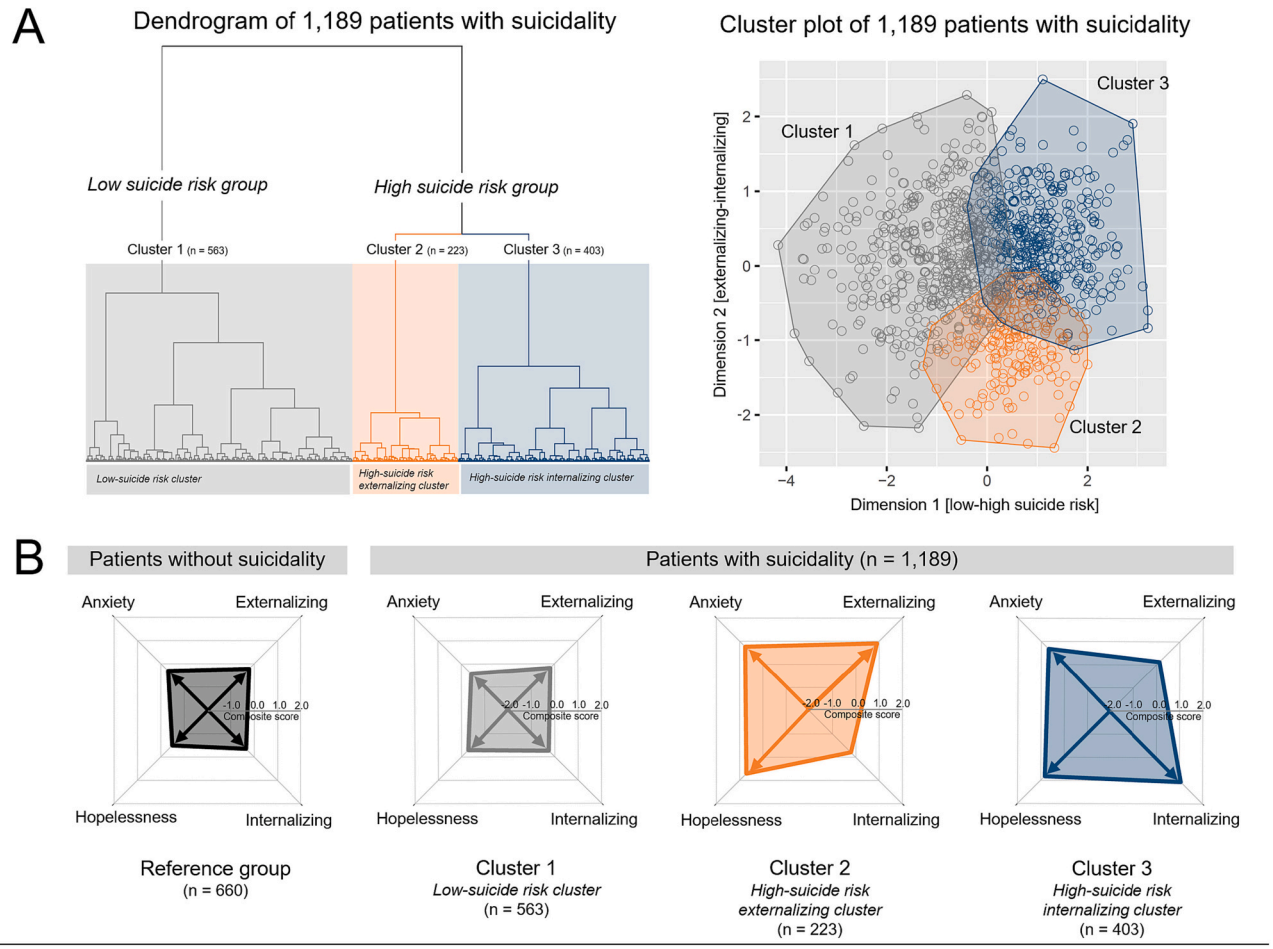

Fig. 1. Hierarchical clustering of 1189 suicidality patients (A) and their distinctive clinical characteristics (B).
(A) Using agglomerative hierarchical cluster analysis, three distinct clusters were identified among 1189 suicidality patients, including low- and high-suicide risk groups. The dendrogram and three-dimensional cluster plot, with dimensions 1 and 2 representing the low-to-high suicide risk continuum and externalizing-internalizing symptom profiles, respectively, illustrate the structural differentiation of these clusters.
(B) Each cluster among the suicidality patients exhibits unique psychiatric symptomatology profiles, encompassing domains of anxiety, externalizing behaviors, internalizing behaviors, and feelings of hopelessness.

consisted of 403 patients (33.9%) and demonstrated the highest scores in the internalizing and hopelessness symptom domains.

3.5. Cluster stability and validation

The mean Jaccard coefficient of 0.87 signifies strong stability of the cluster solution, as values above 0.6 indicate stability, and those below 0.5 suggest instability [56,57]. Discriminant function analysis with LOOCV substantiated cluster validity, achieving a 96.7% accuracy rate across clusters.

3.6. Cluster-specific presenting symptoms (Supplementary Table 3)

A linear regression analysis was conducted to compare the composite scores across four symptom domains among three clusters, and the results were indicated as the standardized beta coefficients (β) and *P*

Table 2
Cluster-specific clinical characteristics.

Characteristics	Patients without suicidality	Patients with suicidality					
	Reference group (n = 660)	*Cluster 1* (Low-risk, *n* = 563)		*Cluster 2* (High-risk externalizing, n = 223)		*Cluster 3* (High-risk internalizing, n = 403)	
	Values	Values	*P*	Values	*P*	Values	*P*
Age, years							
18–19	40 (6.1)	48 (8.5)		15 (6.8)		34 (8.4)	
20–39	309 (46.8)	343 (60.9)	< 0.001	183 (82.1)	< 0.001	293 (72.7)	< 0.001
40–59	215 (32.6)	117 (20.8)		22 (9.9)		66 (16.4)	
≥ 60	96 (14.6)	55 (9.8)		3 (1.4)		10 (2.5)	
Sex							
Men	296 (44.9)	198 (35.2)	0.001	87 (39.0)	0.129	140 (34.7)	0.001
Women	364 (55.2)	365 (64.8)		136 (61.0)		263 (65.3)	
Suicide-related characteristics[1]							
Suicidal ideation	not applicable	446 (79.2)	base outcome	193 (86.6)	0.018	376 (93.3)	< 0.001
Prior history of specific suicide plan	not applicable	127 (22.6)	base outcome	68 (30.5)	0.021	138 (34.2)	< 0.001
Prior history of suicide attempt	not applicable	383 (68.0)	base outcome	154 (69.1)	0.780	286 (71.0)	0.329
Multiple suicide attempts	not applicable	113 (20.1)	base outcome	62 (27.8)	0.019	120 (29.8)	0.001
Presence of current suicide plan	not applicable	56 (10.3)	base outcome	45 (20.5)	< 0.001	80 (20.5)	< 0.001
Methods of prior suicide attempts[1]							
Self-poisoning	not applicable	167 (47.2)	base outcome	87 (59.6)	0.012	139 (49.8)	0.508
Hanging	not applicable	109 (30.8)	base outcome	35 (24.0)	0.127	80 (28.7)	0.563
Drowning	not applicable	8 (2.3)	base outcome	9 (6.2)	0.035	11 (3.9)	0.224
Cutting and/or stabbing	not applicable	52 (14.7)	base outcome	18 (19.2)	0.214	59 (21.2)	0.035
Jumping from height	not applicable	67 (18.9)	base outcome	32 (21.9)	0.446	46 (16.5)	0.427
Others	not applicable	39 (11.0)	base outcome	7 (4.8)	0.033	33 (11.8)	0.750
Prior history of non-suicidal self-injury	98 (14.9)	174 (30.9)	< 0.001	112 (50.2)	< 0.001	163 (40.5)	< 0.001
Specific stressors							
Severe traumatic events	59 (8.9)	62 (11.0)	0.227	23 (10.3)	0.541	72 (17.9)	< 0.001
Any stressors other than severe trauma[2]							
Partner-related	60 (9.1)	91 (16.2)	< 0.001	48 (21.5)	< 0.001	75 (18.6)	< 0.001
Family-related	60 (9.1)	101 (17.9)	< 0.001	42 (18.8)	< 0.001	68 (16.9)	< 0.001
Job-related	103 (15.6)	85 (15.1)	0.806	36 (16.1)	0.849	96 (23.8)	0.001
Disease- or death-related	116 (17.6)	84 (14.9)	0.211	25 (11.2)	0.026	53 (13.2)	0.056
Others	152 (23.0)	132 (23.5)	0.864	58 (26.0)	0.367	103 (25.6)	0.349
Family history of psychiatric disorders[2]							
Suicide or suicide attempts	21(3.2)	42 (7.5)	0.001	15 (6.7)	0.024	27 (6.7)	0.009
Schizophrenia or psychotic disorders	25 (3.8)	21 (3.7)	0.958	9 (4.0)	0.868	9 (2.2)	0.169
Bipolar disorders	9 (1.4)	14 (2.5)	0.156	5 (2.3)	0.364	7 (1.7)	0.625
Depressive disorders	82 (12.4)	101 (17.9)	0.007	46 (20.6)	0.003	73 (18.2)	0.011
Anxiety disorders	30 (4.6)	29 (5.2)	0.623	15 (6.7)	0.203	20 (5.0)	0.755
Unknown or other psychiatric diseases	69 (10.5)	82 (14.6)	0.030	29 (13.0)	0.296	51 (12.7)	0.272
Diagnosis of psychiatric disorders[2]							
Schizophrenia or psychotics disorders	47 (7.1)	27 (4.8)	0.091	5 (2.2)	0.011	6 (1.5)	< 0.001
Bipolar disorders	86 (13.0)	179 (31.8)	< 0.001	127 (57.0)	< 0.001	126 (31.3)	< 0.001
Depressive disorders	248 (37.6)	313 (55.6)	< 0.001	91 (40.8)	0.391	258 (64.0)	< 0.001
Anxiety disorders	293 (44.4)	138 (24.5)	< 0.001	49 (22.0)	< 0.001	162 (40.2)	0.180
Substance use disorders	31 (4.7)	28 (5.0)	0.822	41 (18.4)	< 0.001	40 (9.9)	0.001
Somatoform disorders	57 (8.6)	28 (5.0)	0.013	4 (1.8)	0.002	20 (5.0)	0.027

Data are presented as number (%).
P values were calculated using logistic regression analysis, with reference group values serving as the base outcomes. In the case of suicide-related characteristics, *P* values were determined through logistic regression analysis, using Cluster 1 values as base outcomes.
Abbreviation: NA, not applicable.
[1] Data from 44 suicide attempters were unavailable.
[2] Data were not categorically exclusive, allowing for potential co-occurrence among clusters.

values. Patients in Cluster 1 displayed notably lower scale scores in all four symptom domains compared to those in Cluster 3 (anxiety, β = 0.56, $P < 0.001$; externalizing, β = 0.17, $P < 0.001$; internalizing, β = 0.57, $P < 0.001$; hopelessness, $\beta = 0.53$, $P < 0.001$). Additionally, Cluster 1 exhibited lower scale scores relative to Cluster 2 in all domains except internalizing symptoms (anxiety, β = 0.47, $P < 0.001$; externalizing, β = 0.46, $P < 0.001$; internalizing, β = 0.02, $P = 0.40$; hopelessness, β = 0.38, $P < 0.001$). In comparison to patients in Cluster 3, those in Cluster 2 had higher scores in the externalizing symptom domain (β = −0.42, $P < 0.001$), but lower scores in internalizing (β = 0.55, $P < 0.001$) and hopelessness (β = 0.06, $P = 0.031$) symptom domains. No statistically significant differences were observed in the anxiety symptom domain between Clusters 2 and 3 (β = −0.04, $P = 0.096$).

Detailed individual and composite scale scores for these symptom domains are presented in Supplementary Table 3. A comparative analysis between the scale scores of each identified cluster and those of the reference group is also provided in Supplementary Table 3.

3.7. Cluster-specific clinical characteristics (Table 2)

We examined the distinctive features of each cluster by comparing demographic and clinical variables among the three clusters and a reference group comprising individuals without suicidality ($n = 660$). For this analysis, logistic regression was utilized, and the findings are detailed in Table 2.

3.7.1. Age and gender distribution

The mean ages (SD) for Clusters 1, 2, and 3 were 34.2 (14.9), 28.0 (9.3), and 30.4 (11.3) years, respectively. These ages were significantly lower than the mean age of the reference group which was 39.2 (15.3) years (Cluster 1, $z = -5.91$, $P < 0.001$; Cluster 2, $z = -8.72$, $P < 0.001$; Cluster 3, $z = -9.04$, $P < 0.001$). Within the clusters, individuals in Cluster 1 were significantly older than those in Clusters 2 ($z = -4.41$, $P < 0.001$) and 3 ($z = -3.69$, $P < 0.001$). There was no statistically significant difference in age between Clusters 2 and 3 ($z = 1.30$, $P = 0.195$). In terms of gender distribution, Clusters 1 (64.8%, $z = 3.43$, $P = 0.001$) and 3 (65.3%, $z = 3.24$, $P = 0.001$) had a higher proportion of women compared to the reference group (55.2%). However, Cluster 2 (61.0%) showed no statistically significant difference in gender distribution when compared to the reference group ($z = 1.52$, $P = 0.129$).

3.7.2. Suicide-related characteristics

We conducted logistic regression analysis to ascertain how suicide-related characteristics varied among different clusters. In these analyses, values from Cluster 1 were used as the reference outcome, as suicidality-related data were unavailable for the non-suicidal group.

Compared to patients in Cluster 1, those in Cluster 2 exhibited significantly higher prevalence of suicidal ideation (86.6% vs. 79.2%, $z = 2.36$, $P = 0.018$), a prior history of specific suicide plans (30.5% vs. 22.6%, $z = 2.31$, $P = 0.021$), and the presence of a current suicide plan (20.5% vs. 10.3%, $z = 3.71$, $P < 0.001$). Similarly, Cluster 3 showed a higher risk of suicide compared to Cluster 1, with substantially elevated rates of suicidal ideation (93.3% vs. 79.2%, $z = 5.77$, $P < 0.001$), a prior history of specific suicide plans (34.2% vs. 22.6%, $z = 3.99$, $P < 0.001$), and the presence of a current suicide plan (20.5% vs. 10.3%, $z = 4.32$, $P < 0.001$).

Despite similar overall rates of previous suicide attempts across clusters (68.0%, 69.1%, and 71.0% for Clusters 1, 2, and 3 respectively), the frequency of multiple suicide attempts was significantly higher in both Clusters 2 (27.8% vs. 20.1%, $z = 2.34$, $P = 0.019$) and 3 (29.8% vs. 20.1%, $z = 3.46$, $P = 0.001$) compared to Cluster 1.

Across all three clusters, self-poisoning and hanging were the primary and secondary most common methods used in previous suicide attempts.

3.7.3. Other characteristics

Compared to the reference group, in which 14.9% had previously engaged in non-suicidal self-injury, all three Clusters demonstrated significantly higher prevalence rates: 30.9% in Cluster 1 ($z = 6.61$, $P < 0.001$), 50.2% in Cluster 2 ($z = 10.15$, $P < 0.001$), and 40.5% in Cluster 3 ($z = 9.11$, $P < 0.001$). Notably, Cluster 2 exhibited the highest prevalence of non-suicidal self-injury, significantly exceeding both Clusters 1 ($z = -5.02$, $P < 0.001$) and 3 ($z = 2.36$, $P = 0.018$).

While the reference group reported an 8.9% incidence of severe traumatic events, only Cluster 3 showed a significantly higher rate (17.9%, $z = 4.22$, $P < 0.001$). Conversely, the rates in Clusters 1 (11.0%) and 2 (10.3%) did not differ significantly from the reference group (Cluster 1, $z = 1.21$, $P = 0.227$; Cluster 2, $z = 0.61$, $P = 0.541$).

Regarding specific stressors, all three clusters experienced partner- and family-related stressors more frequently than the reference group. The prevalence of partner-related stressors increased to 16.2% ($z = 3.70$, $P < 0.001$), 21.5% ($z = 4.76$, $P < 0.001$), and 18.6% ($z = 4.44$, $P < 0.001$) in Clusters 1, 2, and 3, respectively, compared to 9.1% in the reference group. Similarly, family-related stressors were elevated in all three clusters (17.9%, 18.8%, and 16.9% for Clusters 1, 2, and 3, respectively; $z = 4.49$, 3.86, and 3.73, respectively; $P < 0.001$ for all comparisons) compared to the reference group (9.1%). Notably, Cluster 3 displayed the highest prevalence of job-related stressors (23.8%), distinguishing it from both Clusters 1 (15.1%, z = −3.40, $P = 0.001$) and 2 (16.1%, z = −2.24, $P = 0.025$), as well as from the reference group (15.6%, z = −3.31, $P = 0.001$).

3.7.4. Family history

All three clusters exhibited significantly higher rates of a family history of suicidal behavior (suicide or suicide attempts) than the reference group. Specifically, Cluster 1 showed a rate of 7.46% (z = 3.28, $P = 0.001$), Cluster 2 a rate of 6.73% (z = 2.26, $P = 0.024$), and Cluster 3 a rate of 6.70% (z = 2.62, $P = 0.009$), compared to the reference group's rate of 3.18%. Similarly, elevated rates of a family history of depressive disorders were observed in all clusters: 17.9% in Cluster 1 (z = 2.68, $P = 0.007$), 20.6% in Cluster 2 (z = 2.98, $P = 0.003$), and 18.2% in Cluster 3 (z = 2.55, $P = 0.011$), relative to 12.4% in the reference group. Notably, the prevalence of a family history of schizophrenia/psychotic disorders, bipolar disorders, and anxiety disorders did not show significant differences between the clusters and the reference group.

3.8. Cluster-specific psychiatric disorder diagnosis (Fig. 2 and Supplementary Table 4)

We systematically analyzed the prevalence of primary psychiatric disorders within each cluster (Fig. 2A and Supplementary Table 4). In the non-suicidal reference group ($n = 660$), anxiety disorders emerged as the most prevalent diagnosis (44.4%), followed by depressive disorders (37.6%) and bipolar disorders (13.0%). In contrast, both Cluster 1 (55.6%) and Cluster 3 (64.0%) were primarily composed of patients diagnosed with depressive disorders, with bipolar and anxiety disorders as the secondary prevalent diagnoses. Notably, Cluster 2 predominantly comprised bipolar disorder diagnoses, presenting a remarkably high prevalence of 57.0%.

More specifically, in comparison to the reference group, all three clusters demonstrated a significantly higher prevalence of bipolar disorders (Cluster 1, z = 7.73, $P < 0.001$; Cluster 2, z = 12.2, $P < 0.001$; Cluster 3, z = 7.04, $P < 0.001$). Particularly, Cluster 2 exhibited the highest incidence of bipolar disorders, exceeding both Clusters 1 (z = −6.41, $P < 0.001$) and 3 (z = −6.18, $P < 0.001$). This finding contrasts with the prevalence of depressive disorders, which showed a significant increase in Clusters 1 (z = −6.41, $P < 0.001$) and 3 (z = −6.18, $P < 0.001$), while remaining consistent in Cluster 2 (z = 0.86, $P = 0.391$) compared to the reference group. Substance use disorders were more prevalent in Clusters 2 (18.4%, z = 6.02, $P < 0.001$) and 3 (9.93%, z =

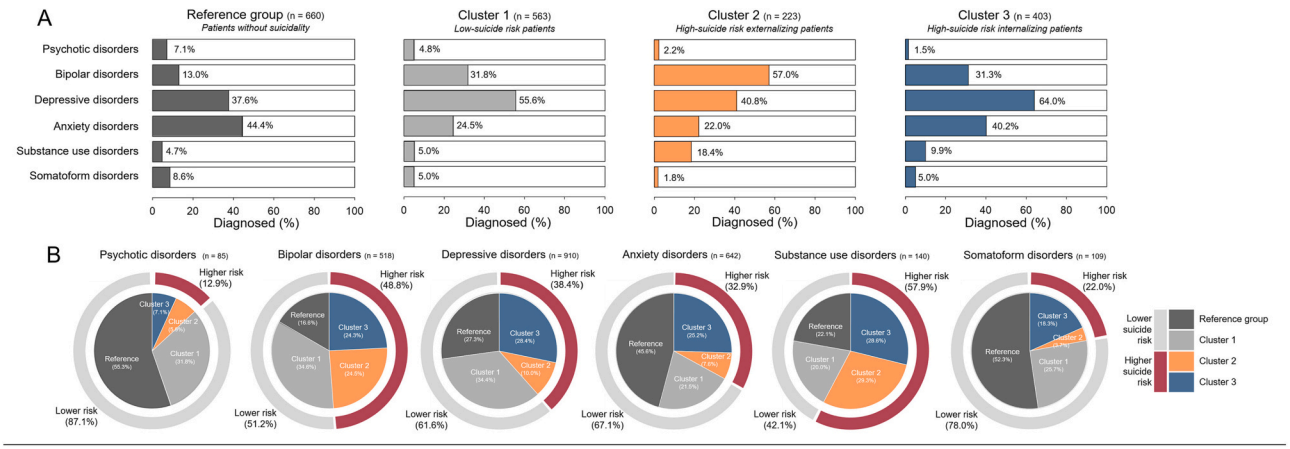

Fig. 2. Cluster-specific prevalence of primary psychiatric disorders.
(A) The prevalence of primary psychiatric disorders is illustrated for the reference group, and for each of the three distinct clusters.
(B) For each primary psychiatric disorder, the patient groups assigned to the reference group and individual clusters are represented by unique color markers and denoted as percentage proportions. Visual representations are also provided for the proportions of patients assigned to the low-suicide risk (depicted in gray) and high-suicide risk (depicted in red) groups. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

3.24, $P = 0.001$) than in the reference group, whereas Cluster 1 showed similar levels (4.97%, z = 0.22, $P = 0.822$). Regarding anxiety disorders, there was a notable decrease in Clusters 1 (24.5%, z = −7.17, $P < 0.001$) and 2 (22.0%, z = −5.80, $P < 0.001$) compared to the reference group, whereas Cluster 3 demonstrated similar levels (40.2%, z = −1.34, $P = 0.180$). Finally, the diagnosis of schizophrenia or psychotic disorders was less frequent in Clusters 2 (2.24%, z = −2.53, $P = 0.011$) and 3 (1.49%, z = −3.71, $P < 0.001$) compared to the reference group (7.12%).

We further explored the distribution of the high-suicide risk group (Clusters 2 and 3) across various patient groups, each diagnosed with a specific primary psychiatric disorder. Among individuals with bipolar disorder ($n = 518$), nearly half (48.8%) belonged to the high-suicide risk group. A higher percentage (57.9%) was observed in the substance use disorder group ($n = 140$), classified as high-suicide risk. Conversely, for patients with depressive disorders ($n = 910$) and anxiety disorders ($n = 642$), the proportions in the high-risk group were 38.4% and 32.9%, respectively. Notably, patients with psychotic disorders and somatoform disorders exhibited comparatively lower percentages in the high-suicide risk group, with respective proportions of 12.9% and 22.0%.

4. Discussion

4.1. Main findings

By employing hierarchical clustering analysis, we delineated three discrete clusters among psychiatric outpatients exhibiting suicidality, characterized by variations in both suicide risk and psychiatric symptomatology. These clusters were denoted as follows: the low-suicide risk cluster (Cluster 1, $n = 563$, 47.4%), the high-suicide risk externalizing cluster (Cluster 2, $n = 223$, 18.8%) and the high-suicide risk internalizing cluster (Cluster 3, $n = 403$, 33.9%). Anxiety, externalizing, internalizing, and hopelessness symptom domains were identified as four indicative psychiatric features that effectively differentiated the three distinctive clusters of suicidality. We additionally discerned patterns unique to distinct clusters, which included sociodemographic factors and characteristics associated with suicide. Moreover, our analyses highlighted that the prevalence of psychiatric disorders demonstrated marked variability contingent upon the distinct clusters identified. Taken together, these proposed clusters related to suicidality could contribute notably to our comprehension of the heterogeneous symptomatology and risk factors associated with suicidal tendencies. This enhanced understanding could facilitate the development of more targeted and individualized strategies for suicide prevention.

4.2. Interpretation of our findings regarding suicidality

As illustrated in Table 1, demographic characteristics such as younger age, female gender, unmarried status, and unemployment were found to be associated with the manifestation of suicidality. These demographic traits, postulated as risk factors contributing to elevated suicidality, may be indicative of the potential impacts of hormonal variations and socioeconomic status on the prevalence of suicidal tendencies [2–4].Corroborating this observation, existing literature has reported that young, unmarried women, possibly more susceptible to socioeconomic dependency, are prone to express heightened levels of suicidal ideation [2,3].This contrasts with the prevalence of suicide deaths predominantly among males, a phenomenon that often involves more violent attempts resulting in fatal outcomes [58,59].

Moreover, our findings demonstrated an elevated prevalence of psychiatric diagnoses—specifically depressive disorders, bipolar disorders, and substance use disorders—among psychiatric outpatients exhibiting suicidality compared to their non-suicidal counterparts. The higher incidence rates of depressive, bipolar, and substance use disorders within the population of patients experiencing suicidality might imply that internalizing and externalizing symptoms constitute heterogeneous manifestations of heightened suicide risk [60,61]. More specifically, depression, as a prominent internalizing symptom characterized by dysregulated mood and cognition, could serve as a robust predictor of suicidal ideation [60–62]. Conversely, bipolar disorders, which are characterized by pronounced fluctuation between mania and depression, together with substance use disorders, may contribute to suicidality as externalizing symptoms, primarily through the enhancement of behavioral disinhibition and impulsive aggression [60,63].

4.3. Interpretation of our findings regarding cluster characteristics

Psychiatric outpatients allocated to Cluster 1 ($n = 563$, representing 47.4% of the sample) were designated as the low-suicide risk group within the context of this study. While the prevalence of previous suicide attempts was analogous across the clusters, other suicide-related attributes—such as suicidal ideation, previous and current suicidal planning, and multiple suicide attempts—were observed to be less frequent among patients allocated to Cluster 1, in contrast to those assigned to the high-suicide risk groups, consisting of Clusters 2 and 3.

Patients grouped under Cluster 1 were older than those in the high-suicide risk groups, yet the gender distribution remained uniform across all clusters. In comparison to Cluster 3 (designated as the high-suicide risk internalizing group), Cluster 1 exhibited lower scores across all four symptom domains. Furthermore, this group also scored lower in anxiety, externalizing, and hopelessness symptom domains relative to Cluster 2 (designated as the high-suicide risk externalizing group).

Cluster 2, accounting for 18.8% of patients with suicidality (n = 223), is identifiable as the high-suicide risk externalizing group, with 86.6% of its members reporting suicidal ideation. This group was distinguished by exhibiting the highest scores within the externalizing symptom domain, compared to all other clusters and the reference group. Approximately 20% of patients categorized under Cluster 2 indicated the current presence of a specific suicide plan, a proportion approximately twice that observed within Cluster 1. Cluster 2, being the youngest group, suggests an association between younger age and the externalizing characteristics linked to high suicide risk [3,61,64]. However, specific gender did not act as a differential factor between Cluster 2 and the reference group without suicidality. Interpersonal stressors centered around partners and family, rather than severe traumatic events, were predominantly observed among patients attributed to Cluster 2. Within this group, instances of previous non-suicidal self-injury were reported more frequently as compared to other clusters. Notably, self-poisoning and drowning emerged as the predominant methods utilized in suicide attempts among patients assigned to Cluster 2. In particular, Cluster 2 is distinguished by the highest prevalence of both bipolar and substance use disorders. In alignment with this finding, the existence of either bipolar or substance use disorders has been identified as one of the strongest risk factors for suicide attempts [3,4,17,64]. Among our psychiatric outpatients diagnosed with either bipolar or substance use disorders, a substantial proportion, representing approximately half of the patients (48.8% and 57.9%, respectively), were assigned to the high-suicide risk group. Further, impulsivity and aggression, frequently observed in these psychiatric disorders [65–67], could be construed as critical triggering factors contributing to elevated suicide risk, especially among young adults [68–70].

Cluster 3, comprising 33.9% of patients with suicidality (n = 403), was designated as the high-suicide risk internalizing group. This classification was marked by the most pronounced reporting of suicidal ideation (93.3%), as well as a history of both current (20.5%) and previous (34.2%) suicidal planning, and multiple suicide attempts (29.8%). Cluster 3 is characterized by elevated scores across all psychiatric domains, inclusive of anxiety, externalizing, internalizing, and hopelessness symptoms, when compared with the reference group. Furthermore, Cluster 3 is differentiated from other clusters by a higher prevalence of diagnosed depressive disorders, accompanied by the most severe manifestations of internalizing and hopelessness symptoms. Cluster 3 was further characterized by a family history of suicide attempts and experiences of severe traumatic events. This observation suggests that the interplay between genetic predisposition and life adversity could intensify suicidal risks among patients assigned to this cluster, primarily by heightening stress vulnerability through amplification of depressive mood states [2,62,71,72]. In Cluster 3, a significant proportion (93.3%) of patients reported experiencing suicidal ideation and exhibited a preference for self-harm methods involving cutting or stabbing in their prior suicide attempts. Notably, this represents a less externally directed but potentially fatal pattern of behaviors [73–75].

The observations from Clusters 2 and 3 strongly suggest that bipolar/substance use and depressive disorders serve as indicative psychiatric features, correlating to the externalizing and internalizing symptomatology associated with high suicide risk. Similarly, within the context of suicidality, it has been postulated that psychological distress, including depression and hopelessness, in conjunction with behavioral dysregulation, such as manic symptoms and substance use, could play an interactive and interrelated role [2,3]. Furthermore, the simultaneous presence of internalizing and externalizing symptoms has been suggested as pivotal factors influencing the progression from suicidal ideation to actual suicidal behaviors [17,61].

It is imperative to recognize that therapeutic strategies for managing suicide risk should vary depending on whether symptoms are externalizing or internalizing, as noted in Clusters 2 and 3, respectively. Psychotropic medications, when targeted at specific symptom domains, can alleviate these symptoms and, consequently, diminish suicide risk [76–78]. Similarly, psychosocial interventions should be tailored to match the patient's unique symptomatology [2,79].

For patients exhibiting externalizing symptoms, which typically appear as outward behaviors such as aggression, impulsivity-inattention, substance abuse, and conduct problems, targeted therapeutic strategies are vital. Cognitive-behavioral therapy (CBT) and dialectical behavior therapy (DBT) have proven effective in these instances, especially when focusing on anger management, impulse control, and social skills training [80–82]. Furthermore, treating underlying conditions like ADHD and substance abuse with specific interventions can also play a significant role in lowering suicide risk in these patients [83,84].

Conversely, internalizing symptoms, often associated with anxiety and depression, necessitate a distinct therapeutic approach. Psychosocial interventions, particularly CBT and DBT, aimed at depression and anxiety, have shown benefits [85,86]. Training in coping skills to manage difficult emotions and stress healthily, and interpersonal therapy focusing on improving communication skills and interpersonal relationships, can be effective in reducing internalizing symptoms and decreasing suicide risk [87,88]. Additionally, mindfulness-based therapies can enhance emotional well-being and lessen suicide risk among patients with predominantly internalizing symptoms [89].

While suicide is a multifaceted issue with various contributing factors, requiring a combination of different treatment approaches [77], customized therapeutic strategies targeting specific symptomatology, such as externalizing and internalizing symptoms, are crucial in addressing individual symptoms and associated suicide risk factors [90].

Our findings from psychiatric outpatients partially align with prior studies conducted on individuals who attempted or completed suicide [91–93]. Research on male inmates identified subgroups characterized by either increased impulsivity or mental distress, correlating with a higher rate of suicide attempts [91]. This aligns with our findings of high suicide-risk clusters: Cluster 2 with marked externalizing symptoms and Cluster 3 with pronounced internalizing symptoms. A study on young suicide attempters identified the link between early-life transdiagnostic symptoms, such as depression, aggression, and anxiety, and earlier occurrence of suicide attempts [92], echoing our observations. Additionally, a cluster analysis of suicide victims identified a subgroup with female predominance, prevalent depressive disorders, and frequent past attempts [93], resembling the characteristics of our Cluster 3. Additionally, a study on depressed inpatients with suicidality and those with previous suicide attempts highlighted the importance of considering severity of depression and suicidal ideation for suicidality clustering [94]. Another study focusing on patients evaluated by psychiatrists in emergency departments found the crucial factors in categorizing suicide attempters: manifestation of suicide attempt, history of psychiatric treatments, experiences of childhood abuse, and presence of addiction [95]. Furthermore, recent neuroimaging research suggested that variations in the default mode and fronto-parietal network connectivity could differentiate the varying degrees of suicidality and predict the transition from suicidal ideation to suicide attempt [96]. Collectively, these findings indicate the importance of adopting a comprehensive approach that integrates both clinical and neurobiological elements, to effectively identify clusters within psychiatric patients who are at risk of suicide.

4.4. Limitations

There are certain limitations to consider when interpreting these

results. Considering that this study did not include psychiatric patients who died from suicide, the current estimated suicide risk may not fully reflect the actual risk for suicide-related mortality. Future studies encompassing patients with a wide range of suicidality outcomes, from complete psychiatric recovery to suicide-related mortality, may offer clues about the potential causal relationships between psychiatric phenotypes and suicidal outcomes.

The observed underestimation of psychotic disorder prevalence in the present study could be attributed to the real-world setting of the outpatient clinics at the tertiary hospital. Additionally, given the strong association between borderline personality disorder and increased suicide risk, as shown in previous research [16,97–99], the limited details on the diagnosis of personality disorders in our study are a notable limitation. Future studies should include comprehensive assessments of personality disorders, which are vital not only for enhancing our understanding of their relationship with suicide risk but also for generating more impactful and clinically relevant findings.

In the current study, the assessment of suicidality was conducted through a clinician-administered questionnaire that focused on suicidal ideation, plans, and attempts. While this method enabled the collection of relatively detailed data on past suicide attempts, it lacked sufficient quantitative measures for assessing suicide risk. Therefore, further research employing specific, standardized scales for evaluating individual suicidality is imperative. Such studies would be crucial for validating and augmenting our findings.

Furthermore, as our study primarily relied on questionnaires and interviews, integrating more objective neuroimaging and neurophysiological methods in future research would greatly enhance the strength of our results. This includes investigating the potential of functional near-infrared spectroscopy [100–105], brain magnetic resonance imaging [106–108], and electroencephalogram [109,110] in assessing suicide risk and psychiatric diagnoses.

It is essential to recognize that a significant portion of our study participants (1346 patients, representing 72.8%) were enrolled after the World Health Organization declared the COVID-19 pandemic in March 2020. This timing suggests the possibility of pandemic-related effects on our results. Our analysis showed no notable differences in the distribution of the three identified clusters between the pre-pandemic (Cluster 1, 45.6%; Cluster 2, 18.6%; Cluster 3, 35.8%) and pandemic periods (Cluster 1, 48.4%; Cluster 2, 18.9%; Cluster 3, 32.7%) ($\chi^2 = 1.28$, $P = 0.53$). However, considering the well-established impact of the COVID-19 pandemic on mental health and suicide risk [111–113], it is crucial for future research to specifically explore the pandemic's effects to corroborate our findings and further elucidate its potential nuances.

5. Conclusions

The present cluster analysis of examining levels of suicidality among psychiatric outpatients has yielded insightful results. We have identified distinct clusters of psychiatric outpatients that are differentiated by individual suicide risk profiles, with each cluster displaying unique characteristics and patterns related to suicidality. These findings enhance our understanding of the heterogeneity in suicide risk among psychiatric outpatients, which could serve as the foundation for targeted, efficacious preventive interventions tailored to the needs of these distinct clusters. In particular, our improved comprehension of suicidality has elucidated specific psychiatric clusters, namely those characterized by high suicide risk associated with externalizing and internalizing groups. These clusters may be the focus of personalized interventions, with the ultimate goal of reducing future suicide-related mortality.

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CRediT authorship contribution statement

Eun Namgung: Writing – original draft, Visualization, Validation, Formal analysis. **Eunji Ha:** Writing – original draft, Visualization, Validation, Formal analysis. **Sujung Yoon:** Writing – review & editing, Visualization, Validation, Methodology. **Yumi Song:** Writing – review & editing, Validation, Methodology, Investigation. **Hyangwon Lee:** Writing – review & editing, Visualization, Methodology, Investigation. **Hee-Ju Kang:** Writing – review & editing, Supervision, Data curation, Conceptualization. **Jung-Soo Han:** Writing – review & editing, Supervision, Resources, Conceptualization. **Jae-Min Kim:** Writing – review & editing, Supervision, Resources, Conceptualization. **Wonhye Lee:** Writing – review & editing, Validation, Resources, Methodology. **In Kyoon Lyoo:** Writing – review & editing, Validation, Supervision, Project administration, Funding acquisition, Conceptualization. **Seog Ju Kim:** Writing – review & editing, Validation, Supervision, Project administration, Methodology, Conceptualization.

Declaration of competing interest

All of the authors declare no conflicts of interest.

Data availability

The data are not publicly available because the participants in the protocol did not agree to share their data publicly.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.comppsych.2024.152463.

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