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Technology, isolation, and drug use: a social network analysis of suicide risk

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The purpose of this study is to identify the most influential variables in suicide among students, based on studies conducted from 2019 to 2024. Given the increase in suicide rates within this demographic group, 26 variables were identified, analyzed, and modeled in a social network. Indices of density, centrality, and closeness were used to assess the influence of each variable within the network. The results showed that the use of technologies, isolation, depression, and repeated exposure to traumatic experiences increase suicidal ideation and, therefore, the risk of suicide. These findings emphasize the need to develop multifaceted prevention programs tailored to student populations for more effective outcomes.

KEYWORDS

suicide, risk factors, mental health, depression, anxiety

1 Introduction

Suicide represents a major public health problem, causing nearly 800,000 deaths per year (Mamdani et al., 2022). It is among the top ten causes of death in the United States for individual aged ten to sixty-four years (Ehlman et al., 2022). It has a severe socioeconomic impact and significant public health challenge and burden (Deng et al., 2024), contributing to over-demand of health services for survivors, loss of work days and reduced productivity (Wang et al., 2024), medical expenses, legal fees, funeral expenses (Sui and Zhang, 2025). Young people have the highest rates of suicidal ideation and suicide attempts, with a prevalence of 10% to 12% for suicidal ideation and 4% to 7% for suicide attempts (Commisso et al., 2023; Altavini et al., 2023).

In the case of Mexico, in 2015, a suicide rate of 5.2 per 100,000 inhabitants was recorded, with a rate of 8.2 per 100,000 among young people aged 19 to 25 years, representing 41.3% of mortality in this age group (Granados-Cosme et al., 2020). In 2020, 7,826 suicides were reported in Mexico. Consistent with previous years, 81.7% of the total suicides in 2020 occurred among males, and 73.8% affected individuals younger than 45 years (Borges et al., 2022).

Despite advances in medical and psychological research in recent years regarding risk factors and prevention, suicidality remains one of the most prevalent, devastating,

and potentially preventable public health problems worldwide. It is therefore considered imperative to further explore the most recent contributions in the literature regarding factors associated with the progression from suicidal desire to suicide attempt (Sims et al., 2023). What has been widely reported in the literature is that suicidal ideation is one of the main predictors of suicide attempts and suicidal actions (Atreya et al., 2022).

From the perspective of social and personality psychology, suicide involves both cognitive and motivational components. In this view, it can be seen as a means of escaping the self -an act that may be interpreted as altruistic self-sacrifice, a ritual, or a gesture of honor intended to end deeply distressing thoughts and emotions (Baumeister, 1990). Postulates that suicide arises from the desire to escape from a painful conscience (Liu et al., 2024) or overwhelming emotional distress (Zhu et al., 2024), with overwhelming negative emotions that cannot be effectively regulated (Kobrinisky and Siedlecki, 2024). When the individual has lost hope of escaping suffering, suicide may be the only salvation (Yöyen and Keleş, 2024). In this sense, suicide is seen as a solution to pain at extremely severe levels where it is not known what the source is and how it can be helped (Pompili, 2024). The recovery process is long and even painful, it requires physical activation and coping activities, a radical change of attitude toward life, and above all, that the enthusiasm and this new vision be long-lasting.

Consequently, it is imperative to improve suicide risk assessment to identify and intervene in a timely manner among young people who are experiencing suicidal ideation, developing suicide plans, or making preparations to carry out a suicide attempt (Koh et al., 2023). Therefore, it is a priority to continue studies aimed at identifying modifiable risk factors in the development and persistence of suicidal thoughts and behaviors (Russell et al., 2019).

This section is divided into two parts. The first part describes some variables that, according to the current frontier of knowledge, influence suicidal ideation and behavior to some degree. These include (a) risk factors, (b) media and sensationalist news, and (c) depression. The second part briefly describes social network analysis, a tool used to characterize the relationships between the identified variables.

1.1 Risk factors for suicide

The reasons why people commit suicide are complex and multidimensional in etiology, making it impossible to rely on a single explanation that can be generalized (Casant and Helbich, 2022; Arowosegbe and Oyelade, 2023). Suicide risk involves a complex interaction of individual and contextual risk factors. However, as Weissinger et al. (2023) emphasize, none of these factors should be understood as a direct cause of suicide attempts or death by suicide. Given the emotional and economic burden associated with suicidal behaviors, further research into relevant risk and protective factors remains crucial (Rogers et al., 2021). Such research would enable decision-makers to implement evidence-based national strategies and educational programs to reduce risk. Although studies have made significant progress in identifying risk factors for suicide, suicidal ideation, and suicide attempts, the results remain disappointing (Martin et al., 2023), and many individuals continue to suffer from suicidal ideation or die by suicide.

Most studies have analyzed factors strongly implicated in the emergence of suicidal ideation in the university population, including anxiety, hopelessness, depression, stress (Martin et al., 2023; Xuan et al., 2023), low social support, affective dysregulation, alcohol use disorder, and depressive cognitive style (Han et al., 2022). However, these factors may stem from more severe underlying issues related to the life histories of young people, which place them in situations of extreme vulnerability. For example, having experienced physical or sexual abuse (Han et al., 2022), substance abuse, or parental abandonment during developmental stages can trigger difficulties in adapting to life, establishing healthy relationships, resolving interpersonal conflicts, or finding a way out (Davenport and Crepeau-Hobson, 2021).

From this perspective, it can be argued that sexual violence has been identified as a significant factor associated with suicidal ideation and suicide attempts among students (Baiden et al., 2024). Sexual abuse can lead to many of the risk factors that may subsequently result in a suicide attempt. For instance, an association has been reported between suicide and aggressive behavior (Xuan et al., 2023); however, the latter may have been triggered by a history of family violence or sexual abuse. The same applies to the potential association between demoralization and c The key is to analyze what in the young person's history has triggered demoralization and to intervene at the root of the problem, rather than merely addressing its consequences.

1.2 Media and sensational news about suicide

Several studies have shown that media reports of suicide are associated with an increase in suicide cases, this phenomenon has been defined as the Werther effect (Sinyor et al., 2025). It has been demonstrated that the media can have both a protective influence on suicide risk in the population (Niederkrotenthaler et al., 2010) and a negative influence, potentially encouraging and contributing to an increase in suicides (Lueck et al., 2024). However, recent studies have provided evidence that some stories spread in the media seem to reduce suicidal ideation. Specifically, when stories represent constructive coping with suicidal ideation, a Papageno effect is produced (Niederkrotenthaler and Till, 2020). This phenomenon has stimulated a new line of novel research based on the premise that media stories of hope and recovery may help reduce suicide attempts and increase the intention to seek help (Arendt et al., 2025).

A meta-analysis examined the impact of hope narratives on suicidal ideation and their effects on help-seeking intention. Although the effects can be considered small, the authors conclude that the massive dissemination of such messages could yield significant positive effect (Niederkrotenthaler et al., 2022). Although there has been significant evidence regarding the outcomes associated with both the Werther and Papageno effects, more evidence remains important in highly vulnerable populations. However, it has been limited by the potential ethical implications (Niederkrotenthaler and Till, 2019).

Sensational reports of suicide, particularly those involving celebrity suicides, are associated with a rise in suicide cases, a phenomenon known as the "Werther effect" (Till et al., 2023).

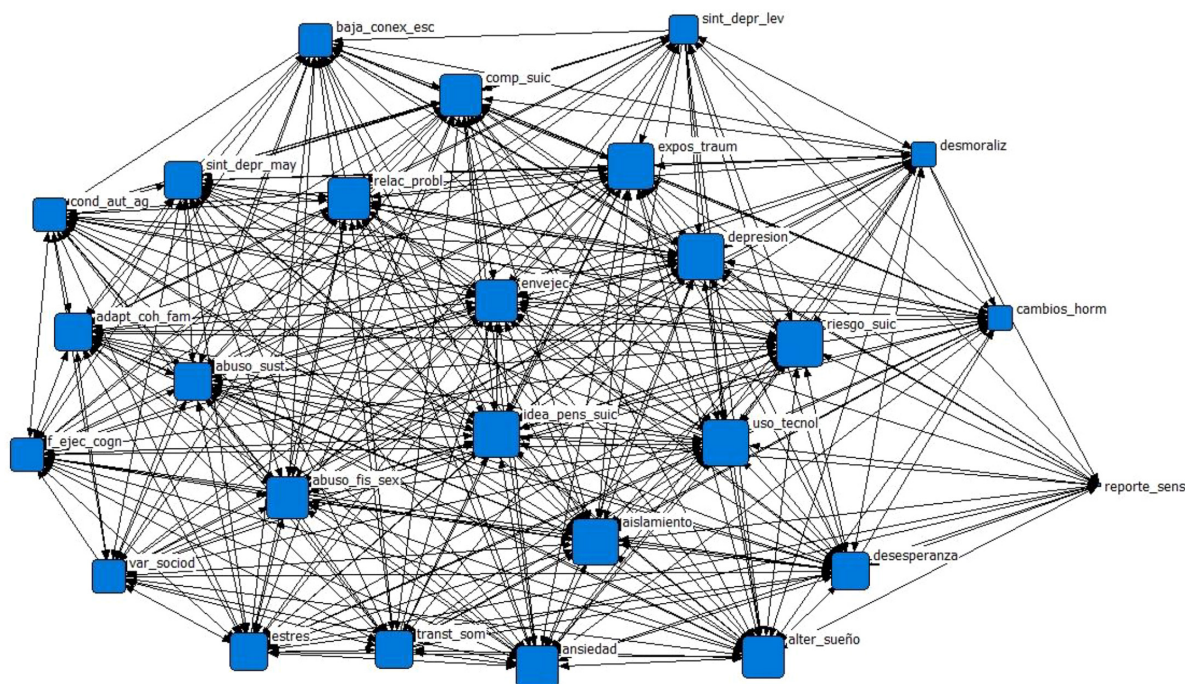


FIGURE 1

Network of variables related to suicide. Source: Created by the authors using UCINET 6 software (Borgatti, 2002).

Numerous studies have clearly shown that extensive media coverage of suicide is associated with a significant increase in suicide rates (Gould, 2001). To date, controversy remains regarding the relationship between suicide and the media. For example, suicide imitation through the media has been studied using before-after comparisons or time series designs, testing whether news stories were associated with subsequent changes in suicide rates (Niederkrötenhaler et al., 2020).

Public awareness of the problem of suicide has sparked a debate about its strengths and limitations. Messages can be transmitted through the media, but they can also be used to communicate important information to the public.

2 Materials and methods

A search was conducted in Google Scholar, which is specialized search engine that allowed us to locate articles from important databases in the literature such as PubMed, Taylor & Francis, ScienceDirect, Springer, APA PsycNet, Wiley, and Elsevier were identified. Articles published between 2019 and 2024—the last five years—were included. The search terms used were *suicide*, *suicide risk*, *suicide risk factors*, and *suicide students*. Theoretical and empirical articles, literature reviews, and meta-analyses that established relationships between risk factors related to suicide were considered. In order to avoid duplication, we prioritized primary studies. Meta-analyses and Systematic reviews were included to obtain a broader theoretical discussion.

The search using the keywords *suicide risk factors* yielded approximately 27,900 results. The inclusion criteria were as follows: the studies had meet methodological quality, to be indexed to the

databases mentioned above, the title had to indicate a relationship between specific variables and suicide, the article had to be written in English. The articles were then filtered based on the alignment between the title and the research focus. Eighty articles were identified and systematically analyzed to identify the main variables associated with suicide.

Among the exclusion criteria, articles that did not address risk factors directly related to suicidal ideation or that lacked methodological rigor were eliminated from the review.

The identified variables were then integrated into a network to characterize the interactions between them and to identify the most prevalent variables surrounding the phenomenon of suicide. The relationships between the variables were weighted according to the results of each study, using a scale from 0 to 5. A weight of 5 was assigned if the variable significantly influenced or contributed to the induction of suicide, while a weight of 0 indicated no influence, with intermediate values assigned accordingly. These data were used to construct an adjacency matrix, which served as input for building the network in the UCINET 6 software (Borgatti, 2002).

2.1 Statistical analysis

The approach of this study is exploratory and systemic, since the focus consists of the integration of variables of diverse nature that the literature has considered relevant in the studies of the suicide phenomenon and have been associated through their interactions.

Given that the risk factors for suicide are within a complex system that without a deep analysis would be difficult to understand due to its varied interconnections and structure. The use of network

analysis allows for a visual representation to identify key patterns and relationships to understand the dynamics of this system of risk factors (Rogers et al., 2019).

3 Results and discussion

The network in Figure 1 was developed using the UCINET 6 software (Borgatti, 2002). It is a Mode 1 network, consisting of 26 variables identified in Table 1, with their corresponding nomenclature displayed in the network.

3.1 Network density

Equation 1 shows the calculation of the network density (ρ) based on its variables v_{ij} , where r_{pr} represents the total number of possible relationships and r_{re} represents the existing relationships. In the network shown in Figure 1, 26 actors were identified, with a total of 504 existing relationships out of 650 possible relationships. The network has a density of 77%, indicating that it is highly connected. This means that all variables are connected to at least one other variable, although not necessarily with the same weight.

$$\rho_{V_{ij}} = \frac{\sum_i^j r_p}{\sum_i^j r_e} \quad (1)$$

(a) Centrality Equation 2 shows the calculation of the centrality level for each actor in the network, where,

$$C_D(n_i) = d(n_i) = \sum_j x_{ij} \quad (2)$$

$d(n_i)$ refers to the degree of node ii , and this is calculated for each actor ii up to jj . In the case of the graph or network in Figure 1, the degree is 25 units, which is the highest magnitude compared to the rest of the nodes in the network. This corresponds to the following variables: (1) repeated exposure to traumatic experiences, (2) suicide risk, (3) technology use, (4) isolation, (5) depression, and (6) suicidal ideation and thoughts.

(b) Intermediation

Equation 3 shows the calculation of betweenness for each node, expressed as the sum of probabilities estimated over all pairs of actors, excluding actor ii , where ii is distinct from jj and kk .

$$C_B(n_i) = \sum_{j < k} \frac{g_{jk}(n_i)}{g_{jk}} \quad (3)$$

In this sense, the nodes with the highest betweenness index are those that connect pairs of nodes, thereby facilitating communication between them. These nodes are precisely the ones with the highest centrality identified in the previous calculation, but in this case, they have a magnitude of 1.552.

(c) Closeness

The degree of closeness refers to a node's capacity to reach all other actors in the network. In this case, it is calculated using

TABLE 1 Nomenclature of variables according to the network in Figure 1.

No.	Variable name	Networklabel
1	Hopelessness	Desesperanza
2	Suicide risk	riesgo_suicidio
3	Demoralization	demoralize
4	Aging	envejec
5	Suicidal behaviors	comp_suic
6	Substance abuse	abuso_sust
7	Cognitive executive functioning	f_ejec_cogn
8	Self-harm and aggressive behavior	cond_aut_ag
9	Mild depressive symptoms	sint_depr_lev
10	Major depressive symptoms	sint_depr_may
11	Suicidal ideation and thoughts	idea_pens_suic
12	Sleep disturbances	alter_sueno
13	Hormonal changes	cambios_horm
14	Depression	depression
15	Social isolation	aislamiento
16	Technology use	uso_tecnol
17	Low school connectedness	baja_conex_esc
18	Low family adaptability and cohesion	adapt_coh_fam
19	Sociodemographic variables	var_sociod
20	Physical and sexual abuse	abuso_fis_sex
21	Dysfunctional relationships	relac_probl
22	Repeated exposure to traumatic experiences	expos_traum
23	Sensationalist reporting	reporte_sens
24	Anxiety	ansiedad
25	Stress	estres
26	Somatic symptom disorders	transt_som

Source: Created by the authors.

Equation 4, where $d(n_i, n_j)$ refers to the elements of a $g \times g$ distance matrix, and $g-1$ represents the minimum possible total distance.

$$C_C(n_i) = g - 1 / \sum_i^g d(n_i, n_j) \quad (4)$$

The actors or nodes with the smallest magnitude, 25 units of geodesic distance in this case, would be the closest to the centralizing nodes and therefore coincide with those calculated in the previous sections.

The parameters calculated above are verified in the software results in Figures 2, 3.

According to the network topology in Figure 1, which resembles a partial mesh, since not all nodes are connected to each other, it can be observed that the most relevant variables are relatively close and centered on the right side of the network. This reflects that the nodes that are less relevant, but that are directly related to the most important ones (with a degree of centrality of 24) are anxiety, sleep disorders, suicidal behavior, physical and

Node Attribute Editor							
File Edit							
	1	2	3	4	5	6	7
	ID	Degree	Betweenne	Closeness	HarmonicCl	Eigenvector	2-Local
1	expos_trau	25	1.552	25.000	25.000	0.211	571.000
2	envejec	24	1.413	26.000	24.500	0.203	550.000
3	desesperan	23	1.233	27.000	24.000	0.195	529.000
4	desmoraliz	20	0.863	30.000	22.500	0.170	463.000
5	riesgo_suic	25	1.552	25.000	25.000	0.211	571.000
6	abuso_fis_s	24	0.861	26.000	24.500	0.205	557.000
7	adapt_coh_	23	0.592	27.000	24.000	0.198	538.000
8	relac_probl	24	0.861	26.000	24.500	0.205	557.000
9	reporte_se	15	0.391	35.000	20.000	0.130	354.000
10	var_sociod	22	0.455	28.000	23.500	0.191	518.000
11	ansiedad	24	1.352	26.000	24.500	0.203	551.000
12	estres	23	1.083	27.000	24.000	0.196	532.000
13	transt_som	23	1.083	27.000	24.000	0.196	532.000
14	comp_suic	24	0.861	26.000	24.500	0.205	557.000
15	cond_aut_a	22	0.496	28.000	23.500	0.190	516.000
16	f_ejec_cog	22	0.386	28.000	23.500	0.191	519.000
17	abuso_sust	23	0.655	27.000	24.000	0.198	538.000
18	uso_tecnol	25	1.552	25.000	25.000	0.211	571.000
19	aislamiento	25	1.552	25.000	25.000	0.211	571.000
20	depresion	25	1.552	25.000	25.000	0.211	571.000
21	baja_conex	22	1.366	28.000	23.500	0.186	503.000
22	alter_sueño	24	1.413	26.000	24.500	0.203	550.000
23	cambios_ho	20	0.547	30.000	22.500	0.173	471.000
24	idea_pens_	25	1.552	25.000	25.000	0.211	571.000
25	sint_depr_	23	0.655	27.000	24.000	0.198	538.000
26	sint_depr_l	21	1.122	29.000	23.000	0.178	483.000

FIGURE 2

Network variable indicators. Source: Information extracted from the UCINET tool (Borgatti et al., 2014).

sexual abuse, and aging. On the other hand, the most distant nodes, with less impact on the central ones, are hormonal changes and sensationalist reports, with a degree of centrality of 20.

According to the network topology in Figure 1, which resembles a partial mesh (since not all nodes are connected to each other), it can be observed that the most relevant variables are relatively close and centered on the right side of the network. This reflects that the less relevant nodes, which are directly connected to the most important ones (with a centrality degree of 24), include anxiety, sleep disorders, suicidal behavior, physical and sexual abuse, and aging. On the other hand, the most distant nodes, which have less impact on the central ones, are hormonal changes and sensationalist reports, with a centrality degree of 20.

It is noteworthy that the relationship between drug use and suicide, has been extensively documented and studied (Borges and Loera, 2010; Brockie et al., 2015; Gibbons et al., 2009;

Ohberg et al., 1996; Yerevanian and Choi, 2013), however, this relationship did not demonstrate relevance in our study. Within network theory framework, connections represent relationships of dependency or influence, where higher the degree of connection between nodes, the greater mutual influence (Newman, 2018; Wasserman and Faust, 1994). In this context, the nodes or variables that showed the greatest association with suicide did not include substance abuse as a predominant node. Notably, substance use and abuse have a weight of 23 (only two points less than the most relevant variables). Conversely, the variables with the greatest influence on the network (degree indicator of 25) are excessive use of technology, isolation, depression, and repeated exposure to traumatic experiences. Given their topologically proximity (lower closeness indicator across the entire network with a value of 25) centered on the right in the network, one can think of a highly cohesive cluster. These results coincide with studies from

1	# of nodes	26
2	# of ties	504
3	Avg Degree	19.385
4	Indeg H-Index	19
5	K-core index	19
6	Deg Centralization	0.090
7	Out-Centralization	0.234
8	In-Centralization	0.234
9	Indeg Corr	-0.321
10	Outdeg Corr	-0.258
11	Density	0.775
12	Components	1
13	Largest Component	26
14	Component Ratio	0
15	Connectedness	1
16	Fragmentation	0
17	Transitivity/Closure	0.846
18	Avg Distance	1.225
19	Prop within 3	1
20	SD Distance	0.417
21	Diameter	2
22	Wiener Index	796
23	Dependency Sum	146
24	Breadth	0.112
25	Compactness	0.888
26	Small Worldness	1.251
27	Mutuals	0.634
28	Asymmetrics	0.283
29	Nulls	0.083
30	Arc Reciprocity	0.817
31	Dyad Reciprocity	0.691

FIGURE 3

Global network indicators. Source: Information extracted from the UCINET tool (Borgatti et al., 2014).

recent years, which have identified novel findings due to changes in lifestyles influenced by technology and which now provide empirical evidence of its effects on human behavior. For example, Keles et al. (2020) found that excessive use of social media and digital technologies is related to high levels of anxiety and suicidal thoughts in young people, due in part to exposure to negative content and cyberbullying.

Excessive technology use promotes social isolation, which exacerbates depression and increases the suicide risk among youth (Twenge et al., 2018). This isolation, leads to depression and suicidal behavior in young people (McCoy et al., 2024; Orben and Przybylski, 2019; Santos et al., 2023). Even the excessive use of technologies is comparable to prolonged exposure to traumatic events of abuse and violence (Holman et al., 2020; Richards et al., 2017).

The findings are consistent with those of Shiratori et al. (2014), who conducted a network analysis to examine the reasons for suicide across populations of all ages. They found that depression and physical ailments are factors related to suicide but play distinct roles. These authors suggest that not all suicide attempts occur during depressive episodes. Factors such as traumatic events and hopelessness should also be taken into account. Meanwhile, Giabbanelli et al. (2022) analyzed suicide risk factors related to Adverse Childhood Experiences. In this study, the authors found that parents' financial difficulties may influence the likelihood

of children being exposed to such experiences, which, in turn, increases the risk of suicidal ideation.

These findings open a new line of research to analyze the relationship between technological trends and suicide. Although there are already studies on this topic (Dunlop et al., 2011; Ruder et al., 2011; Sedgwick et al., 2019), it would be interesting to examine the micro-factors that build this relationship in future research. On the other hand, it is worth mentioning that the use of computational tools based on graph theory, in this case, has allowed for the modeling of a qualitative phenomenon to describe the relationships between variables. This adds value and contributes to the frontier of behavioral science literature, as there is currently not a wide body of work on its application.

This study has several implications, highlighting the need to implement multifaceted interventions. The authors recommend focusing attention on students who, due to excessive use of technology, may be experiencing isolation, desolation, or depression. It is important to regulate the content of mobile applications, specifically short videos that have no viewing limits. Digital platforms should identify accounts that spend excessive time watching short videos and develop algorithms to present them with productive, motivational content that encourages positive imagination and supports the learning of new skills. Schools should promote more healthy, creative and fun content for young audiences.

Adolescents who suffer from social isolation and depression need care, support groups, feeling integrated. This could be achieved if educational institutions promoted the creation of digital projects through multimedia workshops that foster integration, social interaction, and initiatives that transform digital engagement into purposeful social connections, enriched with creativity and cognitive stimulation.

Data availability statement

The original contributions presented in this study are included in this article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

BG-J: Writing – review and editing, Software, Writing – original draft, Formal Analysis, Methodology. MA-F: Writing – review and editing, Methodology, Investigation, Software, Validation, Formal Analysis. MS-M: Writing – review and editing, Investigation, Methodology. IG-M: Formal Analysis, Methodology, Supervision, Writing – original draft, Investigation. EL-R: Methodology, Supervision, Conceptualization, Writing – original draft, Investigation, Writing – review and editing, Formal Analysis.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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