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Breaking the Silence: A Social Network Analysis of Self-Harm on X

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ABSTRACT

Background: Self-harm, commonly referred to as non-suicidal self-injury (NSSI), is a severe mental health issue impacting millions of people worldwide. In addition, Social Network Analysis (SNA) is an effective tool for examining social interactions and connections on social media platforms such as X in order to examine the diffusion of information, development of communities, identification of important influencers, and the analysis of sentiment on social media.

Purpose: This research aims to analyze the communication, actions, and attitudes of X users around self - harm. To accomplish this objective, social network analysis was used to explore the link between self-harming behaviors and social media by studying the interactions between people and groups.

Methods: This research collected data using NodeXL Pro software (Social Media Research Foundation, Redwood City, CA) that allows for collecting tweets from X.

Results: This research gives insight into X conversations, habits, and feelings around self-harm. Research on social networks revealed that individual and news media accounts dominate self-harm material, sources, trends, and patterns. The data also indicate that self-harm is strongly associated with cyberbullying victimization, teen dating violence, and sexual abuse, all of which predominantly impact adolescents.

Conclusion: The significance of health organizations and experts engaging in social media dialogues in order to deliver accurate information and services to those in need.

Keywords: psychiatry, self-harm, social network analysis, X

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BACKGROUND

Non-suicidal self-injury (NSSI) refers to the practice of intentionally inflicting physical harm on oneself without the intent of ending person's life (Hawton, Saunders, and O'Connor 2012; World Health Organization 2019). Suicide by tissue destruction is described as the deliberate and direct destruction of one's own bodily tissue for reasons other than suicide (Hawton, Saunders, and O'Connor 2012). Self-harm is a broad concept that includes a wide range of actions, such as cutting, burning, obsessive scratching, and drug use (Greyer, Gray, and Townsend 2016). As compared to the general population, those who self-inflict injuries have a 30-100-fold increased chance of suicide the following year (Hawton et al. 2015; Whitlock et al. 2013). According to recent research, the rate of self-harm among young people is rising (Brown and Plener 2017). Disorders of the mentality, such as those of the mood or personality, are often seen in tandem with this (Chapman, Gratz, and Brown 2006), low self-esteem (De Leo and Heller 2004), greater impulsivity (Hawton, Saunders, and O'Connor 2012), experiences of sexual or physical abuse (Palmer and Martin 2016), bullying (Dhungana Sainju et al. 2021; Meltzer et al. 2011), alcohol and drug abuse (Brunner et al. 2007), depression and anxiety disorder (Hawton, Saunders, and O'Connor 2012) as well as is considered a risk factor for suicide (Hawton et al. 2015). In recent years, self- harm has risen to prominence as a widely debated topic in online communities (Scherr 2022).

The importance of social media in people's daily lives has increased significantly in recent years (Fuchs 2021). In fact, a staggering 97% of American teenagers and 72% of American adults say they regularly engage in some type of social media (Anderson and Jiang 2018), indicating a tremendous growth in the popularity of social networking sites over the previous two decades (Twenge, Martin, and Spitzberg 2019). Considering the pervasive nature of social media, it is crucial to investigate any correlations between such usage and psychological distress. The way in which social media like X is used may either increase or decrease the likelihood of its user engaging in self-harm (Freeman et al. 2019). Current research suggests that negative social media activities, such witnessing self-harm, participating in social comparison, and excessive usage, and bad social media experiences, like cyberbullying, cyber- victimization, or social exclusion, may increase the risk for unfavorable mental health consequences (Biernesser et al. 2020; Hamm et al. 2015; John et al. 2018; Nesi et al. 2021; Notredame et al. 2019; Sedgwick et al. 2019). In addition, studies conducted in the United Kingdom have uncovered the public's perspective on self-harm on X, where a disproportionate percentage of tweets use stigmatizing language (Hawton et al. 2015).

OBJECTIVE

This study aims investigate the people communication, behaviors and sentiment regarding self-harm using social network analysis on X. Social Network Analysis (SNA) is a powerful methodology for studying social interactions and relationships on social media platforms like X to analyze the spread of information, formation of communities, identification of key influencers, and the analysis of sentiment on social media (PJ, J, and S 2005). This study will be analyzed using various SNA measures to identify top domains/sources, top words, top word pairs, top mentioned, top tweeters (influencer), sentiment-related words (positive or negative or neutral words), and centrality measures, i.e., degree, betweenness, and eigenvector centrality will be employed. (Otte and Rousseau 2002). Using a node's degree of connectivity or its relative relevance in the network, centrality measurements may be used to determine which nodes are the most pivotal. The following is a definition of a measure.

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A node's importance is quantified by its "degree," or the number of connections that link it to every other node. With a significant number of connections to other nodes in the network, central nodes play a pivotal role in the system (Zhang and Luo 2017). There are two components to degree centrality: in-degree and out-degree centrality. In a network, a node's degree of popularity, or in-degree centrality, is proportional to the number of connections it receives, while its degree of activity, or out-degree centrality, is proportional to the number of connections it makes (Golbeck 2015). In this study, degree centrality will be used to identify users who are actively participating in the self-harm discourse on social media by having many followers or followers.

A node's betweenness centrality is measured by how often it mediates connections between other nodes in the network. Connecting various areas of a network, nodes with high betweenness centrality play a key function (Golbeck 2015). Using betweenness centrality, this research will pinpoint the social media individuals who are pivotal in bridging various subcultures discussing self-harm online.

Eigenvector centrality: This measure is based on the principle that a node is considered important if it is connected to other important nodes. Eigenvector centrality assigns a score to each node based on the centrality of its neighbors. Nodes with high eigenvector centrality have many connections to other nodes that also have many connections (Golbeck 2015). In this study, eigenvector centrality will be used to identify users who are central to the self-harm discourse on social media because they are connected to other influential users.

These measures will be employed to identify the most influential nodes in the network and to understand the connectivity patterns among users discussing self-harm on social media. Sentiment analysis will be applied to the tweets to classify the opinion of self-harm as positive, negative, or neutral. The language used in the tweets will be analyzed to understand the topic of discussion and the sources of information and support available to individuals who self- harm on X. We confirmed our result using Azure Machine Learning to calculate sentiment scores on X (Harfoushi, Hasan, and Obiedat 2018). We categorized the sentiment analysis into three categories.

Category Positive (individuals view self-harm in a more positive light, i.e., motivation, coping of expression, and personal experiences of recovery and resilience), Category Negative (traditional view of self-harm as a harmful and destructive behaviour which reflect the concerns and worries of individuals who are affected by self-harm or are close to someone who is affected by it), and Category Neutral (neutral or unidentified).

METHODS

This research collected data using NodeXL Pro software (Social Media Research Foundation, Redwood City, CA) that allows for collecting tweets from X. The results of the analysis with nodes and edges were created in Microsoft -Excel software and was further imported into Gephi software (Version 0.1.0.), a network visualization software (Grandjean 2015). The visualization will include the user-tweet network, with users represented as nodes and tweets represented as edges. The size of the nodes will represent the number of followers, and the color of the nodes will represent the sentiment of the tweets. YifanHu Multilevel layout in Gephi software was used to visualize edges networks (Hu 2005).

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RESULTS

Data collection

The data for this study was collected from tweets on X that contained the spesific keyword "self-harm". The total number of tweets which were gathered (worldwide) was n = 68,753 tweets, retweets, and replies retrieved in this study.

Social network analysis (SNA)

Figure 1 shows groups of X users as social network graphs. Each node in the network graph represents a X user, and each line connecting nodes indicates an edge. Collectively, the network and significant groupings of people who tweeted about self-harm can be understood. The sizes of the nodes are ordered according to their betweenness centrality score (BCS), which measures how influential a node is in the distribution of information among all other nodes in the network under the assumption that data travels down the shortest paths (White and Borgatti 1994). Figure 1 incorporates circles of varying sizes and colors to emphasize the five most important users. Each circle represents a set of X users, and the lines connecting them show how well connected these people are to one another.

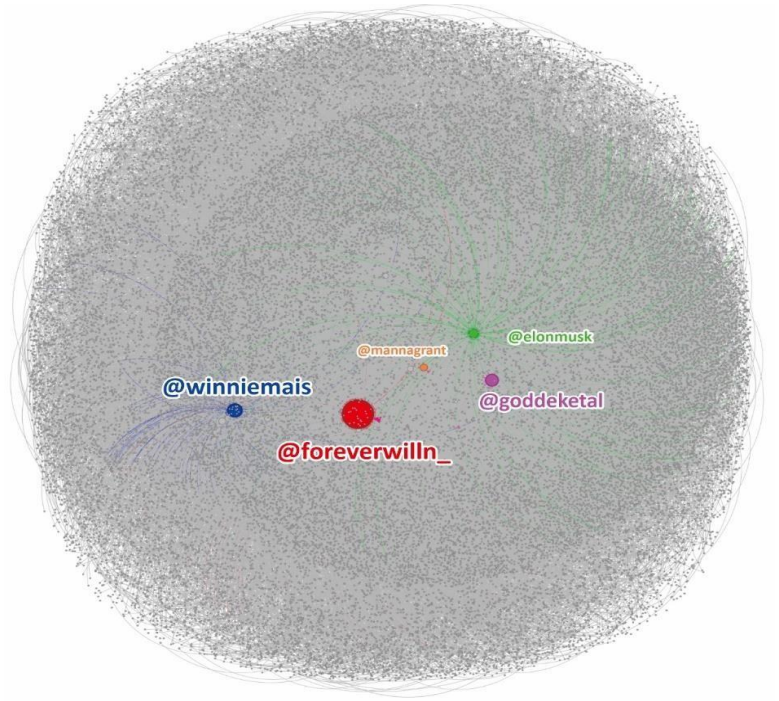

Figure 1. Social network graph of self-harm on X

The results from this finding indicated the top 5 X users with the highest betweenness centrality scores when analyzing the social network of self-harm behaviors on NodeXL and visualized by Gephi. The five following X users with the highest betweenness centrality score, i.e., @foreverwilln_ (red), @winniemais (blue), @goddeketal (purple), @elonmusk" (green), and @mannagrant" (orange). These users have a high centrality value in the network, which means that they have a strong influence on the flow of information and have a significant impact on the network and could be considered a key opinion leaders or influencers on the topic of self-harm on X.

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Patterns or Trends on Self-harm Tweets

The data collected provided insight into the patterns and trends of self-harm-related tweets on X. The results of patterns and trends by SNA can indentified based on the the top 10 domains (source) in tweets, tweeters and hashtag shown in Table 1.

Table 1. Top 10 of domains (source) and hashtags

Top Domains (Source)	N	Top Words	N	Top Words Parts	N	Top Hashtags	N
X.com	543	self	18147	self,harm	17718	teensandtech	70
time.com	475	harm	17918	form,self	8169	Scotland	37
co.uk	293	form	8187	new,form	7955	Brexit	34
org.uk	115	new	8147	generation,new	7950	generalelectionnow	27
sky.com	76	dating	8012	dating,generation	7942	Edtwt	25
youtube.com	42	generation	7973	tw,self	983	onlinesafetybill	25
amnesty.org	41	abuse	1670	torture,self	717	3dtwt	24
theguardian.com	39	people	1509	sexual,abuse	713	toriesdestroyingourcountry	24
bylines.scot	37	ช	1453	act,self	542	Chanjin	24
trib.al	33	amp	1405	harm,incest	500	Csaqt	23

The results of this study in table 1 indicate that the top domains that were used in tweets discussing self-harm were X.com (n=543), followed by time.com (n=475) and co.uk (n=293). The presence of X.com as the top domain suggests that the majority of the tweets discussing self-harm originated from users on the X platform. The high number of tweets from news media such as time.com, amnesty.org, theguardian.com, and bylines.scot may indicate these sources were being shared and discussed among users on X.

We observed the majority of the top domains are from the United Kingdom (UK), specifically co.uk and org.uk, indicating that self-harm is a prevalent topic of discussion among UK X users. The presence of amnesty.org in the top domains may indicate that users are also seeking information and resources from organizations that specialize in mental health and self-harm awareness. Interestingly, most of the accounts in this list are from the United Kingdom and dominated from organization, which suggests that self-harm is a prevalent issue in that region, as also shown the organizations are actively engaging in the conversation on social media.

The findings of this analysis show that self-harm is a prevalent topic among X users, as evidenced by the high frequency of the words "self" and "harm" appearing in tweets. The high frequency of the word pair "self, harm" also reinforces this observation. Additionally, the presence of related words such as "form," "new," "generation," and "dating" suggest that the discussion around self-harm related with youth life such as dating. Interestingly, the frequency of the word "abuse" and the word pair "sexual abuse" indicate that some

individuals may be discussing self-harm in the context of prior abuse experiences. Surprisingly, the appearance of the word "incest" in the word pair "harm, incest" also highlights the connection between self- harm and abusive experiences for some individuals.

Tweeters and hashtags most often used in tweets on self-harm were also found by SNA, with the top 10 being recognized by both measures. In decreasing order, the top tweeters are as follows: @tomthunkitsmind (n=3,353,135), @threadreaderapp, @kompascom, and @teamyoutube, respectively. X has been shown to have the most engaged users, and these people may be mined for information on who to follow for updates about self-harm. Table 3 displays the most popular hashtags together with our other data. Of the most frequently used hashtags in the tweets (n=70), "#teensandtech" ranked first. Researchers and medical experts are increasingly worried about the effects of technology and social media on the relationships, conduct, and well-being of teenagers. Some of the most popular self-harm-related hashtags on X are "#edtwt" (eating disorder X) and "#csaqt" (Child Sex Abuse Question Time).

Key Influencers on Self-harm Tweets

In this study, an analysis of self-harm tweets on X using SNA was conducted to identify key influencers in the conversation. Key influencers in the conversation were identified, and their impact on the spread of information and discussion of self-harm on X was evaluated. The results of this analysis provide insight into the individuals and entities that are driving the conversation surrounding self-harm on the social media platform. The in-degree, out-degree, betweenness centrality, closeness centrality, and eigenvector centrality of each vertex (or X user) were measured the key influencer. Betweenness centrality is the main findings that a widely used to indentify the key influencer that captures a person's role in allowing information to pass from one part of the network to the other (see table 1). Our results show the X user @foreverwilln_ has the highest in-degree, out-degree, betweenness centrality, and eigenvector centrality scores. This indicates that this user significantly impacts the self- harm conversation on X, as this has a large number of followers and is frequently mentioned by others in the network, thus highly central in terms of the flow of information within the network.

Table 2. The top 10 X users with the highest score of degree and centrality

In-Degree	Out-Degree	Betweenness Centrality	Closeness Centrality	Eigenvector Centrality
foreverwilln_	rec777777	foreverwilln_	foreverwilln_	foreverwilln_
parismarx	doctorsh8me	Winniemais	edtwtlizzie	hearteyez444him
beartaeby	stephen1010102	Goddeketal	alexfairy5	brad15616721
doublebubble_24	martin020455	Elonmusk	allentweets_	static2456
winniemais	Toastedvideo	Mannagrant	mcdamons	yonderretweets
keir_starmer	dpprally2018	Alexhallhall	hearteyez444him	momo_mon214
billyperrigo	georgettesaysno	Xraypat	xxdropdeadlean	samy_bhadie
bussytrain	Thesafecityapp	Yhvhlives	c_tourtellot	_w0nderhill
sonofr	Ruchiangrish	keir_starmer	capeofwonders	soalries
goddeketal	Nornirishbrit	Styrosforever	sadshawtyyy	scorpiomoonbby

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Another notable finding is the X user with the highest out-degree, or the number of outgoing edges, was @rec777777. This indicates that this user is actively tweeting and sharing information related to self-harm with other users in the network.

Sentiment Analysis

Figure 2. represent the results of Azure Machine by Microsoft to conduct a sentiment analysis of the user's tweets that expressed their opinions, attitudes, and emotions toward self-harm. We found 44% were classified as positive, 41% were classified as negative, and 15% were classified as neutral. This finding suggests that there is a relatively even distribution of sentiment expressed towards self-harm on X, with a slight inclination towards positive sentiment. The positive sentiment may be expressed by individuals who have personally been affected by self-harm and have overcome it or people who have seen the positive impact of self-harm recovery in their friends and family. Surprisingly, the gap between negative and positive sentiment is very close. It is important to note that high negative sentiment could also indicate that there is a lot of stigmatization and blame towards self-harm and the people who engage in it, which can lead to the reluctance of people who suffer from self-harm to seek help.

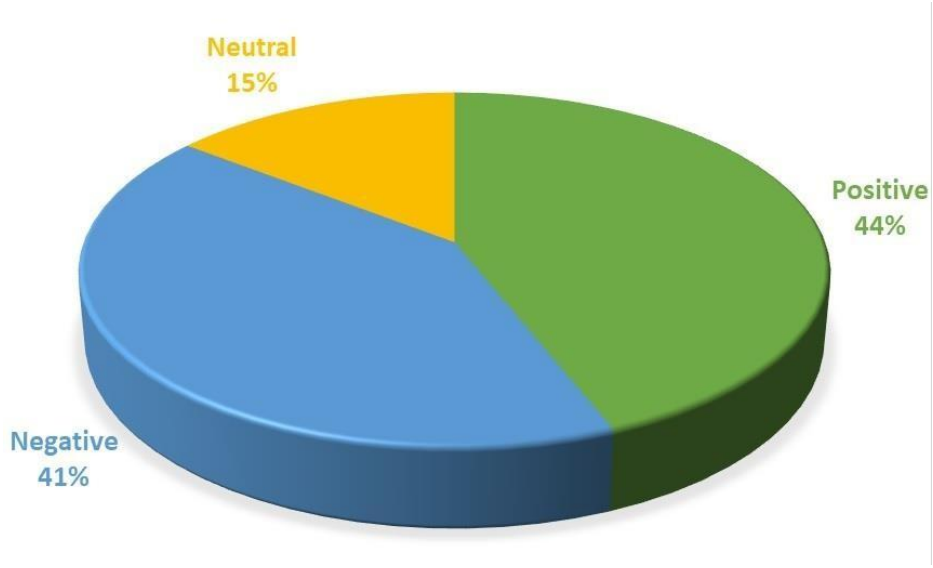

Figure 2. Sentiment analysis of retweeted posts

DISCUSSION

To the best our knowledge, this research is the first study that investigate the people communication, behaviors and sentiment regarding self-harm using social network analysis on X. Our findings provide valuable insights that have considerable influence on health decision making. The general characteristics of the social network discovered in our investigation were analyzed by assessing the correlations between epidemiological data and overall network metrics collected on X over a two-year period.

An interesting finding was that the majority of information about self-harm on X is being disseminated by individuals who are not mental health professionals or health professionals. Previous study from USA has found that information favored by celebrities and entertainment media spreads rapidly on social media [38,39]. However, this fact raises some concerns about the accuracy and reliability of the information being shared especially on false or misleading health information which health misinformation spread more easily than scientific knowledge through social media (Daine et al. 2013; Levy and Strombeck 2002; Moretta et al. 2023; Pagoto, Waring, and Xu 2019; Vosoughi, Roy, and Aral 2018). It is important to consider the limitations of non-mental professional expertise and the potential

harm that could result from spreading incorrect information that have affect decision-making and health behaviors (Pagoto, Waring, and Xu 2019). The internet may have both positive and bad effects on young people who self-harm or who are suicidal; positive effects include helping them find support and coping mechanisms, while negative effects include normalizing self-harm and preventing disclosure or professional help-seeking (Daine et al. 2013; Moretta et al. 2023). This is supported by studies in USA (Alao et al. 2006), Canada (Szumilas and Kutcher 2009) and Sweden (Durkee et al. 2011) which reported how the internet is used by suicidal people and what information is available. The involvement of health organizations and health professionals who work with people with potential self-harm or mental health to participate in a conversation through social media is alternative to overcome this issue to provide certain channels (social media, video/image sharing) might be utilized in treatment and recovery (Marchant et al. 2017).

We identified the patterns or trends on self-harm based on domains, words and word parts. Interestingly, the top domain related to self-harm comes from the United Kingdom (UK). This could suggest that self-harm is a significant issue in the UK and that individuals are using social media, such as X, to discuss their experiences and connect with others who have gone through similar struggles. This fact was supported by the report from Office of National Statistics 2019 which describe the rising statistics in rates of suicide in the United Kingdom (Iacobucci 2020). Recent study shows the greater severity of mental illness and increasing incidence of non-fatal self-harm and suicide in the UK especially during the COVID-19 pandemic (Carr et al. 2021; Choudhuri and Saraswat 2023; CL 2014; Iob, Steptoe, and Fancourt 2020; Singh et al. 2020). There is an independent association between problematic use of social media/internet, cyberbullying, and sleep disturbance toward suicide attempts in young people in the United Kingdom (Sedgwick et al. 2019). Due to the fact that cyberbullying and cybervictimization are risk factors for SH and suicidal behaviors. The intervention from policy makers, academics, parents, physicians, and psychotherapist to make informed decisions in the safeguarding of children and young people when use social media is essential to minimize the suicide risk and SH (John et al. 2018).

Social media and news media platforms are the most active user related self-harm caused by several reasons. These platforms reach a large audience to get support and valuable information about self-harm, it can raise awareness of self-harm and its effects on individuals, families, and communities. These platforms can also reduce self-harm stigma and encourage help-seeking. In short, social media and news platforms are effective channels for sharing information, resources, and advocacy for self-harm (CL 2014). Interesting findings related to patterns and trends of discussion on X related to self-harm was found “new”, “generation,” and “dating” as the top words. This finding is in line with the fact that cyberbullying victimization tends to occur at new generation i.e., children and adolescents, because they spend more time on their mobile phones and social networking sites (Choudhuri and Saraswat 2023). Youth life such as teen dating violence (TDV) also have close correlation with self-harm. Teens described incidents in which they and their partners engaged in NSSI (i.e., SH) and suicide attempts associated with extreme alcohol and drug use that occurred during the break-up stage of the relationship. Prevention and intervention programs are required that consider the intersections of TDV, substance use, and self-harm (Baker et al. 2015).

Surprisingly, the high frequency of the word and word pairs such as "abuse";"sexual abuse" and “incest";"harm, incest", respectively, indicate that majority individuals discussing self- harm in the context of prior sexual abusive and incest experiences in some individuals. This fact supported by the top hashtags findings that "#teensandtech" and "#csaqt" (Child Sex Abuse Question Time) which reinforces that Child Sex Abuse (CSA) has the potential to cause

of self- harm. Recent studies show the close correlation between CSA and self harm (Hodge and Baker 2021; O'Hare, Shen, and Sherrer 2014; Santa Mina and Gallop 1998) and majority was mediated by dissociation (Talmon and Ginzburg 2021). Emotional pain, particularly when it is born of the trauma of CSA attacks against the body among survivors will transforms their body into something other than the self, into a soiled memorial of the horror that causes self-harm to their body (Le Breton 2018). In addition to CSA, the eating disorder also found as the top hashtag related self harm. Previous study in USA explained that sexual abuse triples the risk of lifetime diagnosis of eating disorders (Chen et al. 2010). A systematic review and meta-analysis from Italy also found that around 50% of individuals with an eating disorder diagnosis reported emotional and/or physical neglect in their childhood (Pignatelli et al. 2017). Approaches and methods frame the basis through to understand trauma, silence, violation, emotions, and the body in the context of CSA and eating disorders is essential to respond to, and make sense of, and resist trauma, while living a livable life thus keeping them from the risk of self-harm (Hodge and Baker 2021).

Over the past two decades, sentiment analysis research has grown as more efficient sentiment classification models have been developed and studies have compared automated social media conversation analysis to manual methods (Canhoto and Padmanabhan 2015). Our results show the sentiment positive and negative almost similar was 44% vs 41%, respectively. Related studies on sentiment analysis to self-harm was reported from Instagram and Facebook platform that describe the increasing of anger and sadness expression (negative) than positive (Smith and Cipolli 2022). Self-harm is a complex issue that can evoke strong emotions, but individuals may express those emotions differently. Some may view self-harm as a negative and destructive behavior, while others may see it as a form of coping mechanism or as a way to release negative emotions. Previous research suggests that social media users tend to interact with others who share common beliefs and ignore or argue with individuals who have opposite views (Yuan, Schuchard, and Crooks 2019). Thus, social support use positive sentences on tweet may be an important target for intervention to overcome on the development and course of self-harm thoughts and behaviors. X should be considered by psychiatrists to intervene and offer support to individuals struggling with self-harm. By leveraging the potential of X to reach a wider audience, the development and course of self-harm thoughts and behaviours can be overcome by psychiatrists through the provision of information, resources, and counselling (Peek et al. 2015; Peters, Uible, and Chisolm 2015).

CONCLUSION

This study sheds light on the communication, behaviors, and sentiments surrounding self-harm on X. Social network analysis found that self-harm content, sources, trends, and patterns are dominated by individual and news media accounts. The findings also suggest that self-harm is closely related to cyberbullying victimization, teen dating violence, and sexual abuse, which primarily affect teenagers. Importance of health organizations and professionals participating in social media conversations to provide accurate information and resources to those in need. The study emphasizes the need for further research on online behaviors across various social media platforms such as Facebook and YouTube to gain a deeper understanding of the issue. The results of the study provide valuable insights for policymakers, healthcare decision- making, and underline the importance of social media and news media as channels for sharing information, resources, education, advocacy and give health promotion to reduce the self-harm prevalence.

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