Identifying Depression and Suicide Displays on Twitter: Key Search Terms and Characteristics

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Abstract

Depression is a pervasive health issue, which often goes untreated. The social media website, Facebook, has been examined as a potential innovative tool to identify and engage individuals in treatment. Twitter, another social media website, has yet to be examined. The purpose of this study was to examine if and how depression and suicide references are being displayed on Twitter. Text analytics software, Discover Text, was used to collect public tweets using the search terms "depressed" and "depression" during one week in 2013. Within this sample, suicide-related terms were used to identify suicide-related tweets. A subsample of 1,000 "depression" and 324 suicide-related tweets were randomly selected for content analysis. The tweets were examined by three trained coders for categories of clinical relevance, tweet originality, format, and subject, and were examined using a validated depression symptom code-book. A total of 297,107 "depression" tweets (which icludes tweets identified with both search terms of "depressed" and "depression") and 7,538 suicide-related tweets were collected over seven days. The suicide-related search terms yielding the most clinically relevant references to suicide ideation included: "suicide", "kill myself", and "want to die". The "depression" tweets most commonly were comprised of unoriginal content (60.4%), personal experiences with depression (49.4%), and referenced depression in relation to the self (45.1%). The "suicide-related" tweets most commonly referenced original content, and similar to the "depression" tweets, most commonly referenced personal experiences and the self. Of the subsample of "depression" tweets that included original content and referenced the self, 60.4% referenced one or more symptoms of depression. In conclusion, references to depression and suicidality occur on Twitter. They are expressed in a personal manner, and can include depression symptoms. Healthcare providers should be aware that Twitter is a potential outlet for discussing depression and suicide disclosures. Future research should examine acceptability and feasibility of contacting these potentially at-risk individuals.

Introduction

Depression is a pervasive health issue and a major public health concern. The probability of developing depression during one's lifetime is 5-12% for males and 10-25% for females [1]. At any given point in time approximately 2-3% of males and 5-9% of females in the population suffer from Major Depression. [1] Additionally, there are many consequences of depression; one of the most common consequences is role impairment (e.g. reduced work performance), and a major consequence of depression is suicide [2]. Depression is one of the common risk factors for suicide

[3], another large public health concern.

Many individuals with depression struggle to receive treatment; only 1/3 of those who ever seek treatment do so in the same year as their first onset [2]. Moreover, the median delay of treatment seeking is more than 5 years [2]. Reasons for lack of treatment seeking include: confidentiality concerns, employment-related discrimination, and negative social judgment [4]. In addition, only around 20% of all people with depression received adequate treatment [2]. Nonetheless, innovative ways to identify depression need to be explored in order to help individuals obtain the services they may need.

Prior studies have investigated using Facebook to identify individuals with depression, and results show promise [5-8]. In one study that examined displays of depression on Facebook, 25% of profiles had references to one or more symptoms of depression and 2.5% displayed references that met criteria for a Major Depressive Episode [MDE] [7]. Another study, done by Moreno and colleagues, found a correlation with those who displayed depression on their Facebook profiles and their score on the Patient Health Questionnaire screen, a depression screen commonly used in clinics in the United States [6]. These findings support social media's potential as a source of information about individuals with depression.

Another potential for innovative approaches may be Twitter. Twitter is a social media website, popular among all age groups, but most popular among individuals 18-29 and teenagers [9]. This website allows users to create and post text blurbs or "tweets" made up of 140 characters or less. These tweets can also include photos, videos, or links, and content is typically "an expression of a moment or an idea" [10]. Tweets are shared in real time, and it is standard for content on this site to be public as the main purpose of this site is to "help individuals share information with the world" [10]. In the past, studies have examined how various health behaviors are being displayed on Twitter [11-16]. To date, only one study has investigated depression on this social media website. This study examined depression groups on Twitter and found that 64.3% of groups identified were self-help groups, 15.1% were created for supporting people affected by depression, and 9.7% were for promoting awareness of depression [14]. Twitter has potential to provide insights to both the identification of depression as well as factors affecting this behavioral health issue.

The purpose of this study was to explore Twitter further and examine if and how depression and suicide are discussed. The goals of our study were to: 1) examine prevalence of displays of depression on Twitter, 2) examine prevalence of displays of suicide-related disclosures within the context of depression on Twitter, and identified key search terms to identify displays of suicidal ideation, and 3) explore the specific content and context of how depression and suicide are being displayed on Twitter.

Materials and Methods

Setting

This cross sectional study took place from June 2013 to June 2014 and data collection specifically took place over one week in July 2013. Public data was collected for this study from the social media website, Twitter. The study received exemption from the Institutional Review Board of the University of Washington.

Content Selection

We collected data for this study using software called DiscoverText. DiscoverText is an Application Programing Interface software, commonly known as an API. This software is able to obtain posts from various public social media profiles, as well as information about the posts (i.e. metadata).

References to Depression

We collected public tweets using DiscoverText displayed during a one week period in July 2013. We selected for English language tweets and used the search terms "depressed" and "depression" to identify our content. We decided to use these search terms as we felt they would identify a broad range of tweets, yet be specific to the topic of our study. We randomly selected a subsample of 1,000 tweets from the total sample to analyze for categories listed in Table 1.

Additionally, a subsample of the depression tweets (those with the terms "depressed" or "depression in them") that included original content (created by user) and referenced the self were analyzed for depression symptoms. The investigators felt these tweets were the most critical to analyze for symptoms.

Suicide-Related References

Within the set of tweets that included search terms "depressed" or "depression, we were interested in identifying tweets that displayed suicide-related information, given the close relationship between suicide and depression, as well as recent media coverage of multiple suicide disclosures on social media [17-20]. A previous study done by Cash and colleagues (2012) was used in defining key search terms in identifying suicide-related content on MySpace[21] Additional terms were added to the list after discussion amongst investigators. We decided on 12 suicide-related search terms that would be used in identification of suicide-related tweets. We manually and randomly selected the tweets from our total sample. The suicide-related search terms used to select suicide content were as follows: "be dead", "can't go on", "end my life", "kill myself", "never wake up", "rock bottom", "suicide", "want to die", "death", "the end", "it's over", and "giving up". Of note, we used the root word of "suicide" so that in addition to obtaining tweets with the term suicide in them, we would discern any tweet containing the term "suicidal" as well. Additionally, we included any search terms that were contractions as both the search term with the apostrophe as well as the term without the apostrophe. In doing this, we felt we would gather the most accurate, yet broad portrayal of

references to suicide on Twitter. A subsample of 324 tweets was randomly selected from the tweets identified via the suicide-related search terms for content analysis. See Figure 1.
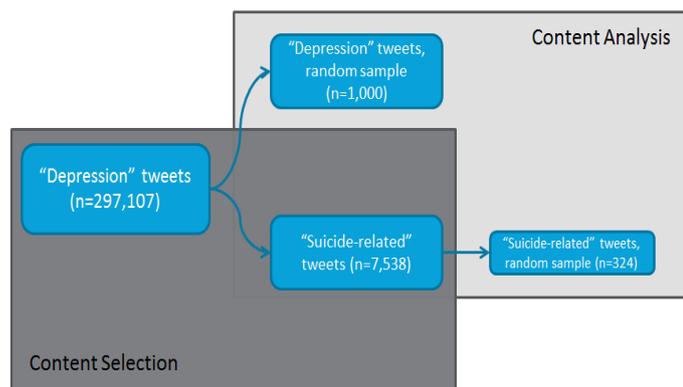

Figure 1. Tweet Sampling.

Content Analysis Variables

Metadata

The metadata about the tweets that we examined included: number of favorites (i.e. similar to a "like" on Facebook), geolocation, location listed on their profile, type of device used to post, as well as what other social media the post was coming from. We examined this specific metadata because we felt these characteristics were important to report on in the context of our study.

Suicide-Relevance

To determine tweets identified with the suicide-related search terms that may be clinically relevant (i.e. tweets about a band with "suicide" in the name would not be clinically relevant), the category of clinically relevant suicide information was defined. This was useful in examining the suicidal ideation tweets and identifying "key" or useful search terms. This category was defined as: text indicating discussion of suicide, defined as deliberate self-harm leading to death [22]. This category would include suicidal thoughts, suicidal intention or suicidal gestures or actions either in the past, present or planned for the future.

Originality, Format, and Subject

To help illuminate the patterns in communication about depression and suicide-related information, we analyzed both the subsample of depression tweets and the subsample of "suicide-related" tweets across certain categories. These categories included: tweet originality, tweet format, and tweet subject. Within originality of tweet, the subcategories included: original content tweet, unoriginal content tweet, and both. Within format

of tweet, the subcategories included: personal experience, belief, fact/research, tip/resource, and news. Within subject of tweet, subcategories included: self, other, and general. A subcategory of other was used to identify those tweets that could not be categorized. See Table 1 for the specific category definitions.

CATEGORY	DEFINITION	INCLUSIONS	EXCLUSIONS
Originality			
Original	Original content created by the user who posted online		
Unoriginal (retweet or quote)	Content created by another user		
Both	Both "Original" and "Unoriginal" content, see above	Quotations, tweet with RT in front of the main text of the tweet	Text beginning in @username
Format			
Fact/research	Information about depression/suicide, stated as a fact or known knowledge	Research study results	Personal experience or belief about depression
Tip/resource	Advice or tip to help treat symptoms of depression/suicidal behavior or text with intention of making a person feel better	Hotline numbers, article talking about ways to feel better, a person asking "why are you depressed?"	
News	Information about a current event related to depression/suicide		
Belief	An attitude or opinion about depression/suicide or people who are depressed/suicidal	Horoscope text	Fact/research
Personal experience	A person's own thoughts and feelings about an event, themselves, or a person in their life and depression/suicide		
Subject			
General	Unspecified person or people which are connected to the "depressed" or "depression" term in the tweet	Advice/personal opinions, news/advertisements without a specific subject	
Self	First person subject connected to depression term in tweet	Song lyrics, retweets, using "I"	
Other	Specific person or specific group as subject connected to depression term tweet	When a person or group is defined in tweet (e.g. women, intelligent people, people with certain disorder like depression or an eating disorder)	

Table 1. Definitions of Tweet Categorizations.

Depression Symptomology

The text of the tweets were examined using a codebook, which was developed and used in previous work evaluating displayed depression symptom references in status updates on Facebook [6, 7]. The codebook was based on the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition [DSM-IV], criteria for a Major Depressive Episode [MDE] [22]. The symptoms included in a MDE can include: depressed mood, loss of interest or pleasure in activities, appetite changes, sleep problems, psychomotor agitation or retardation, energy loss, feelings of worthlessness or guilt, decreased concentration, and suicide ideation [22].

This codebook was adapted to be used with Twitter. Example tweets of symptoms included: depressed mood- "so down and depressed for so many f-ing months", loss of interest- "needing reassurance, a cure for depression? In a bad, dark and isolated place. #givinguponeverything", appetite changes- "can't smile, can't drink, and can't eat. The depression.", and sleep problems- "sleeping too much, depression. Great." Any references to synonyms

of criteria for a MDE were coded as well. For example, the word "hyperinsomnia" would be coded as a reference to sleep problems.

Content Analysis Procedure

All tweets and metadata were imported from DiscoverText into an Excel spreadsheet.

Suicide-Relevance and Characteristic Categorization

For categorization of tweets, we used Classic Content Analysis [23]. Three investigators used a deductive approach and defined categories or "codes", apriori, to examine within the tweets. These categories were defined based on what information the investigators felt would be necessary to know about the tweets (i.e. if the tweet referencing a personal experience with depression or talking about someone else, etc.).

Investigators participated in four rounds of practice categorization of same 10 tweets. Discrepancies were discussed after each round of categorization. An interrater agreement of 0.60 was obtained before categorization of the full subsample. The remaining tweets were then divided among the three investigators and an open categorization approach, typically known as an open coding approach, was used to categorize the total subsample of tweets. As ambiguous or unclear cases emerged, they were discussed and assigned the category agreed on by all three investigators.

Depression Symptomology

All coders participated in four rounds of practice coding using the adapted codebook before coding the full subsample of tweets. During this practice coding, coders were be assigned a group of 10 tweets to code every round. After each round, the codes were reviewed and any discrepancies were discussed and resolved. An interrater agreement of 0.72 among the three coders was reached before the full sample was coded. The three coders then coded the complete subsample of "depression" tweets, which was divided equally among them. Date of reference to symptom was recorded as well.

Statistical Analysis

Metadata (which includes results listed in "Content Selection and Metadata" as well as Table 2) was summarized using descriptive statistics. We generated binary variables to represent the presence or absence of each depression symptom code and category, and then descriptive statistics were used in summarizing displayed depression symptom codes and categories

among displays of depression and suicide-related tweets.

Results

Content Selection and Metadata

A total of 297,107 tweets that contained the terms "depressed" or "depression" were collected over seven days. These tweets were "favorited" an average of 1,642.1 times (SD=7,787.3, MEDIAN=414.5), and 40.3% of the tweets included a geolocation and/or the user who posted the tweet, listed a location on their profile. The tweets were most commonly tweeted from the users' phone (70.1%), and 2.0% of the tweets came from a social media management platform or a bot. See Table 2 for more detail.

	"depression" tweets, n(%)	"depressed" tweets, n(%)	all tweets, n(%)
*Tweets identified**	137,764 (46.4)	159,341 (53.6)	297,105 (100)
Basic Tweet Information			
Reposted tweets	108,768 (80.0)	92,442 (58.0)	201,210 (67.7)
Tweets directed at someone	112,246 (81.5)	107,950 (67.7)	220,196 (74.1)
Tweets w/ location	57,885 (42.0)	61,700 (38.7)	119,585 (40.3)
Geo locations	830 (0.6)	2,254 (1.4)	3,084 (1.0)
User location listed	57,055 (41.4)	59,446 (37.3)	116,501 (39.2)
Device and Platforms Tweeted From			
Phone	96,248 (69.9)	112,111 (70.4)	208,359 (70.1)
iPhone	58,787 (42.7)	77,298 (48.5)	136,085 (45.8)
Android	28,101 (20.4)	34,813 (21.8)	62,914 (21.2)
Blackberry	9,360 (6.8)	9,186 (5.8)	18,546 (6.2)
Web	22,052 (16.0)	23,099 (14.5)	45,151 (15.2)
iPad	4,217 (3.1)	4,492 (2.8)	8,709 (2.9)
Management platforms	2,667 (1.9)	1,697 (1.1)	4,358 (1.5)
Bots	930 (0.7)	668 (0.4)	1,598 (0.5)
Other common social media	1,184 (0.9)	776 (0.5)	1,960 (0.7)

*Amounts listed in row labeled "Tweets identified" are the denominators for "Basic Tweet Characteristic" category amounts and "Device and Platforms Tweeted From" category amounts

Table 2. Tweet Metadata.

Suicide-Relevance

The 12 suicide-related search terms identified 7,538 tweets (2.7% of the original sample). See Table 3. The search terms that identified the most tweets with references to clinically relevant suicide ideation included: "suicide" (12.0%), "kill myself" (11.7%), and "want to die" (11.1%). Some examples of these types of tweets are as follows: "got depressed, told friends i hated them, went all #suicidal", "people make me want to kill myself, forever #depressed", "so sad (depressed to be specific) and want to die, really sorry God".

Search term	n(%)	Example tweet
Be dead	30 (0.4)	RT: yeah... pretty sure that I'll be dead by tomorrow by depression
Can't go on/cant go on	10 (0.1)	@[handle] the photos are making me so depressed.. I can't go on anymore!
End my life	7 (0.1)	RT @[handle]: Being in a depression is the worst, sometimes I just really want to end my life.
Kill myself	152 (2.0)	RT: Please star this tweet before I become sad & depressed & kill myself with a fork
Never wake up	62 (0.8)	RT: I just want to go to bed and never wake up. #depression #cantdoanythingright
Rock bottom	21 (0.3)	#InHighSchool everybody disliked me and I was the most depressed ever in my life. I hit rock bottom and I've stayed there. ☹☺
Suicid	5,846 (77.6)	can't help if we feel depressed or suicidal, and they're right. we can't help ourselves ever.
Want to die	69 (0.9)	I dont want to go tomorrow i'm so sad (depressed to be specific) and i want to die. i'm really sorry God
Death	807 (10.7)	RT @[handle]: people say I've never been this much in a depression over a celebrity's death... first of all Cory was not just a celebrity to me...
The end	471 (6.2)	RT @[handle]: maybe if i add "lol" to the end of every message they won't realize I'm depressed lol
It's over/its over	206 (2.7)	I don't always watch Netflix. when I do I find a show I like, watch 10 seasons in two days and go into depression when it's over.
Giving up	139 (1.8)	RT @[handle]: Sad? Pray. 🙏 Thinking a lot? Pray. 🙏 Giving up? Pray. 🙏 In pain? Pray. 🙏 Depressed? Pray. 🙏 Struggling? Pray. 🙏

Table 3. Suicide-related Search Term Results (n=7,538).

Characteristic Categorization

Of the 1,000 depression tweets analyzed for content, 60.4% were comprised of unoriginal content, 36.6% were original content, and 3.0% contained both unoriginal and original content. In the category of format, 49.4% of tweets referenced personal experiences regarding depression, 22.4% referenced beliefs about depression, and 20.9% referenced facts or research relating to depression, 5.6% tips or resources, 1.0% news stories, and 0.7% other. In the category of subject, 45.1% referenced the self-related to depression in the tweet, 34.0% referenced a general audience, 19.9% referenced a specific group or person other than the self, and in 1.0% of tweets we were unable to identify in a subcategory of subject. Of the 324 suicide-related tweets analyzed, 58.3% were comprised of original content, 74.5% personal stories, and 72.5% self-referential suicide ideation references. See Figure 2 for
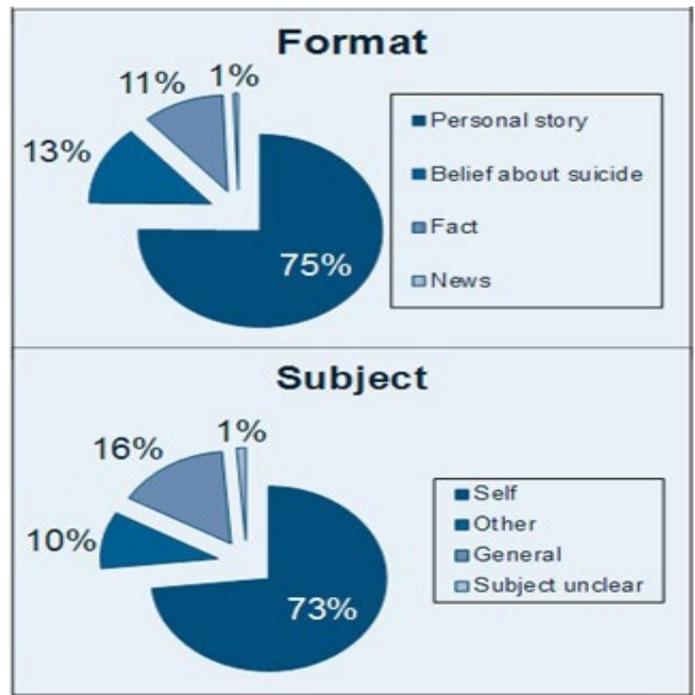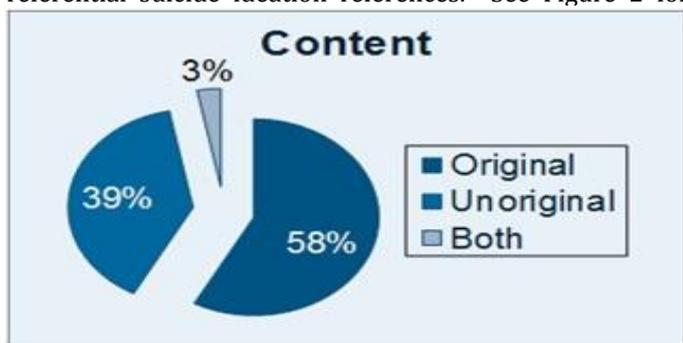
Content

- Original
- Unoriginal
- Both

3% / 39% / 58%

Figure 2. Content, Format, and Subject of a Subsample of Suicide-Relevant Tweets (n=324).

Depression Symptomology

Of the subsample of depression tweets that included original content (created by user) and referenced the self (n=212), 60.4% referenced one or more symptoms of depression within the tweet. The tweets referenced depressed mood-"head hurts, nauseous, #depression, oh no ugh no" (60.0%); other symptoms referenced included feelings of guilt or worthlessness-"self-doubt, self-blame...#depressed" (5.2%), and decreased interest or pleasure-"nothing else to look forward to anymore, hello depression" (4.8%). See Figure 3. Additionally, 4.7% of the tweets expressed that they felt their symptoms were increasing in severity-"feel the slow creep of
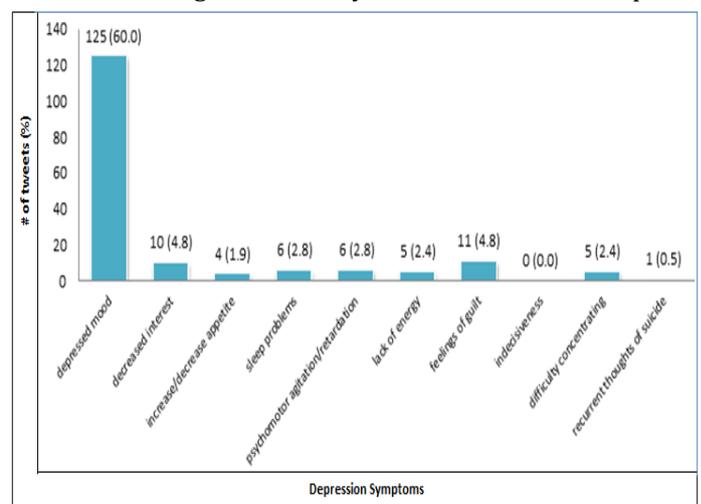
Figure 3. Depression symptoms within Depression Subsample of

Tweets (n=212).

Conclusion

In conclusion, our study found that displays of depression and suicide can be identified on Twitter. In one week, we identified 297,107 tweets that included the search terms of "depressed" or depression" and among these, 7,538 suicide-related tweets. Additionally, we found that some search terms may be better at identifying clinically relevant references to suicide on Twitter than others. Furthermore, tweets containing depression and suicide content are commonly discussed in a personal manner; however, depression seemed to be more broadly distributed among subcategories in comparision to tweets referencing suicide content. Finally, references of symptoms of depression were identified within the text of the "depression" tweets.

Search term identification plays an important role in using social media websites to identify depression. When examining tweets with our selected "suicide-related" search terms, we found that "suicide", "death", and "the end" were the most common among the full sample of "depression" tweets. However, once we examined these tweets, we found that "kill myself" and "want to die" along with "suicide" yielded the most concerning suicide-related information. Refining phrases to contain words pertaining to the identity of the poster, such as "I", "me", "my", "myself" may be worth considering when defining key search terms or phrases in identifying depression.

References to suicide-related information within tweets were commonly more personal, when compared to tweets that just referenced depression information on Twitter. Suicide-related tweets were comprised of more original content (58.3% to 36.6%), more personal experiences (74.5% to 49.4%) and more self-referential text (72.5% to 45.1%). Thus, tweets relevant to suicide may be more easily deciphered as concerning or in need of urgent support and connection to resources. In contrast, depression is more commonly discussed in different formats on Twitter, such as beliefs or opinions about the concept of depression (22.4%), facts or research (20.9%), and tips or resources (5.6%), similar to what Martinez-Perez and colleagues found in their examination of depression social groups on Twitter [14]. Also, tweets referencing depression primarily consisted of content that had been found on another person's profile or website and reposted on their own. These varied displays may create difficulty in clearly identifying those who actually need help. Last, results indicated majority of tweets in this sample came from a type of cell phone. Twitter, compared to other social media not as commonly used on a cell phone, may be able to provide the quick contact necessary in prevention of suicide attempts.

Limitations

First, it is important to note that the mental health status of the user who posted the tweets identified in our study is not known. Although it is possible that we may be identifying individuals with depression or may be suicidal who are in turn displaying about depression or suicide, it is impossible to know from our study if the people posting on Twitter are actually experiencing depression or suicidal feelings. Second, our study was limited to the public Twitter sphere; therefore this study cannot be applied to privately posted tweets. However, it is worth acknowledging that Twitter tends to be more public in nature compared to other sites, and majority of content on Twitter is public. Additionally, our study is limited by the fact that we sampled from one week in the summer of 2013. While it is astonishing that nearly 300,000 tweets were identified in just one week, these results cannot be generalized to what references to depression or suicide look like every week of the year on Twitter. Our results do not take into account other external factors, such as the seasons, that could potentially be influencing the types of tweets posted on Twitter. Finally, our approach yielded more references to the symptom of depressed mood. This was likely due to our choice in search terms. Again, this reiterates the importance of choosing search terms. It may have been beneficial to do multiple searches using keywords within each symptom to portray an accurate display of depression symptoms on Twitter.

Implications

Healthcare workers and researchers should be aware that Twitter is a social media website in which references to depression and suicide ideation are present, and that this may be a place where patients go to express themselves about their health issues. Future studies should examine the depression status of the people who post this type of content on Twitter, as well as the acceptability and feasibility of connecting with individuals with depression and suicidal-relevant content on Twitter. Finally, studies should examine how to best design tools to use these informative websites to appropriately contact the users and provide them the services they may need.

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