

## REVIEW ARTICLE

# Understanding the emotional response to COVID-19 information in news and social media: A mental health perspective

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**Abstract**

The impact of the COVID-19 pandemic and ensuing social restrictions has been profound, affecting the health, livelihoods, and wellbeing of populations worldwide. Studies have shown widespread effects on mental health, with an increase in stress, loneliness, and depression symptoms related to the pandemic. Media plays a critical role in containing and managing crises, by informing society and fostering positive behavior change. Social restrictions have led to a large increase in reliance on online media channels, and this can influence mental health and wellbeing. Anxiety levels, for instance, may be exacerbated by exposure to COVID-related content, contagion of negative sentiment among social networks, and “fake news.” In some cases, this may trigger abstinence, leading to isolation and limited access to vital information. To be able to communicate distressing news during crises while protecting the wellbeing of individuals is not trivial; it requires a deeper understanding of people's emotional response to online and social media content. This paper selectively reviews research into consequences of social media usage and online news consumption for wellbeing and mental health, focusing on and discussing their effects in the context of the pandemic. Advances in Artificial Intelligence and Data Science, for example, Natural Language Processing, Sentiment Analysis, and Emotion Recognition, are discussed as useful methods for investigating effects on population mental health as the pandemic situation evolves. We present suggestions for future research, and for using these advances to assess large data sets of users' online content, to potentially inform strategies that enhance the mental health of social media users going forward.

**KEYWORDS**

artificial intelligence, coronavirus, COVID-19, data science, emotions, mental health, natural language processing, news, pandemic, social media

## 1 | INTRODUCTION

The mental health impact of the Coronavirus (COVID-19) pandemic and the social restrictions imposed in response to it have been profound. Almost all countries and sections of society have been adversely affected. Schools have been closed, families have been divided, healthcare systems have been severely challenged, as have

many industries and livelihoods. The ripple effect of the pandemic will continue to be felt for years to come, even if vaccines prove to be effective in halting the spread of the virus. Social restrictions and “lockdowns” might have been essential, but they have triggered isolation, unemployment, and increased levels of stress, anxiety, fear, and loneliness among broad swathes of the global population. The enduring effects of this in terms of longer-term mental health impact are

only just starting to emerge and will undoubtedly challenge societies over the coming years. While prevalence of mental health issues was already high in many populations pre-pandemic, incidence of these spiked in 2020. A meta-analysis by Salari et al. (2020) found consistent evidence that the pandemic triggered significantly increased levels of stress, anxiety, and depression across studies and populations, and this might have become more profound as the situation evolved. For example, Shah et al. (2021) found this incidence was considerably higher than that reported in the very initial stages of the pandemic (C. Wang et al., 2020). The authors attribute this increase in prevalence to the social restrictions that were in place in most countries by Spring 2020; they also highlight the potential negative impact of cumulative exposure to COVID-related news and media. A consistent finding across studies is that younger age groups seem to have been more affected in terms of their mental health (Wang, Kala, & Jafar, 2020). There are various possible reasons for this: socio-economic uncertainty regarding current and future employment has differentially impacted younger age groups, for example. Another explanatory factor could relate to social media usage and online news consumption, which is highest among young adult age groups. In recent years, social media and online news platforms have revolutionized how we communicate and interact, and how we access information and share it with others, and the COVID-19 pandemic has massively accelerated this trend. Online platforms became even more integral to our lives: in April 2020, 18–24 year olds in the UK spent on average over 5 h a day online; across all adults, time spent online increased by 15% compared to September 2019 (source: Ofcom). Social media allowed us to communicate and remain socially connected despite social restrictions, and online news provided us with up-to-the-minute access to information in a fast-evolving situation, but their use also presents risks for mental health and wellbeing. This is the focus of the current review.

With usage of these platforms at record levels, it is more important now than ever to develop an understanding of their impact on mental health. Social media has the potential to be a useful tool in combating the mental health toll of the pandemic, but the risks and downsides associated with its use need to be understood and mitigated against. In 2020 mental health support services were halted or disrupted in over 90% of countries (World Health Organisation, 2020). Although many of these services moved quickly to try and adapt to the social distancing rules, many such services were already under-resourced and now lack the capacity to cope with the COVID-related surge in mental health issues. The UK's Centre for Mental Health created a forecasting model, predicting that approximately 20% of the UK's population will require new or additional mental health support as a direct consequence of the pandemic (O'Shea, 2020). Deepening our understanding of how the pandemic has impacted mental health is crucial for informing effective support strategies: to achieve this at scale, valuable insights can potentially be derived from analyzing people's behavior, engagement, and responses on social media. Considering the impact of exposure to online media content is also an important factor that deserves close scrutiny. The complex relationship of both social media and online news

consumption with users' mental health needs to be better understood so that these channels can be leveraged to benefit the health and wellbeing of society, and safeguard users as much as possible.

This review sets out to provide a selective overview of research into the mental health impact of social media and online news consumption, with a particular focus on studies conducted during the pandemic, and studies that have made use of recent advances in data science methodologies. It is structured as follows: first we summarize research into the general impact of social media usage on mental health, then consider studies that have considered this in the context of the pandemic. Then we do the same, but for online news consumption. Then we describe relevant advances in artificial intelligence and data science methods, and how these have been applied by researchers during the pandemic, to characterize the emotions expressed by social media users and draw inferences regarding the mental health of user groups. We conclude that these methods have generated useful insights into users' emotional responses and mental health; as such they represent valuable tools for researchers in the field.

## 2 | SOCIAL MEDIA USAGE AND MENTAL HEALTH

The use of social media to communicate, interact, and share content with others increased significantly in 2020. In the face of social restrictions, social media became even more central in people's lives, representing a vital form of social connection for many. Social media platforms played a multitude of roles during the pandemic; keeping children connected to their peers and teachers, keeping businesses afloat, and allowing access to support and medical advice, to name a few. It is estimated that pre-pandemic, 53% of the world's entire population used social media and that this increased by almost 13% in 2020 (Kemp, 2021). Studies tracking the amount of content generated by users on social media platforms by country report a large spike in posts and content coincident with significant local events such as state of emergency declarations and imposition of social distancing measures Iglesias-Sánchez et al. (2020). Social media is a phenomenon which has been increasingly studied since the origins of the key players like Facebook and Twitter in the early 2000s. Although media platforms and how users engage with them is constantly changing (which presents difficulties for research), studies pre-pandemic indicated positive effects of social media use on self-reported levels of social connectedness (Grieve et al., 2013). Upon reviewing relevant research findings, Best et al. (2014) point to the positive effects of social media via expansion of social networks and connections with peers. Additionally, social media can provide access to a supportive online community for those with mental health needs. These communities can provide support through the sharing of coping strategies and can give a sense that the sufferer is not struggling alone. They can also help combat stigma by raising awareness of mental health disorders (Berry et al., 2017). These benefits provide opportunities not just for those struggling with mental health issues, but also health

providers and policy makers. Due to its popularity (70% of young people in the United States use social media multiple times a day; Rideout & Robb, 2018), social media presents opportunities to rapidly disseminate positive mental health narratives to a broad audience, connect users with prevention groups, and facilitate access to treatment via digital mental health interventions and initiatives (Rice et al., 2016). Iglesias-Sánchez et al. (2020) analyzed thematic and emotional pandemic-related content posted via Twitter, YouTube, and Instagram: much of this related to strong opinions as well as coping strategies. Sentiments spread dynamically across users, and the authors concluded that social media channels offer the opportunity for “social therapy” by capitalizing on this emotional contagion effect. This could serve to spread positive emotional reactions among online communities, promote resilience, and disseminate effective coping strategies, in times of crisis. Thus, evidence suggests that social media can benefit social connectedness among isolated individuals and groups, and be a useful source of information and community support for those facing difficulties.

However, not all studies identify positive relationships, and some commentators have raised concerns around potential for harm. Indeed, emotional contagion across social networks applies to negative, as well as positive emotions (Goldenberg & Gross, 2020). In 2019, concern around self-harm imagery on social media prompted platforms to actively monitor and remove such content. Some studies have found evidence for links between suicide risk and social media usage in young people, with heavy/addictive social media and internet use increased risk of suicide attempts in many of the studies reviewed by Sedgwick et al. (2019). However, cyberbullying likely plays a prominent role in this. Also, confounding factors need to be considered, including the sleep disturbance and lack of physical exercise resulting from heavy use of computers and mobile devices (Viner et al., 2019). These factors need further scrutiny. Ultimately, strategies to mitigate against these, and also limit exposure to self-harm and suicidal content (e.g., through moderated discussion forums), would allow the benefits of social media for to fully emerge. Ideally, social media should allow beneficial social connections and let individuals share their experiences and access support, within a protected online environment (Biernesser et al., 2020).

Thus, social media use has both drawbacks and advantages, and effects are not clear-cut. Effects are heavily dependent on the population under study, usage patterns and user experiences. They are also contingent on measurement techniques. The limitations imposed by cross-sectional studies have led to conflicting results in the literature. For example, a survey study by (Grieve et al., 2013) used factor analysis to show that levels of Facebook connectedness were distinct from levels of offline connectedness, suggesting that social media might be a valuable source of social connection and support for those unwilling, or unable to engage in offline interactions. Further, Facebook connectedness was associated with lower depression and anxiety and greater satisfaction with life. In contrast, Primack et al. (2017) surveyed nearly 2000 young adults in the United States and found that those who used social media platforms for more than 2 h a day were about twice more likely to report being socially isolated, compared to

those who used for 30 min a day or less. Clearly, engagement with platforms is important: light users probably engage more passively, while heavier users are more engaged and thus more exposed to, and more emotionally impacted by, negative social media experiences such as cyberbullying, disputes, or being “unfriended.” Other cross-sectional studies have found no association between social media use and depression symptoms (Berryman et al., 2018), and a very large study based on data from UK and United States (total  $n = 355,358$ ) concluded that the association between time spent using digital technology and adolescent wellbeing is negative but very small, accounting for less than 0.4% of variance (Orben & Przybylski, 2019). Indeed, factors such as bullying, getting enough sleep, and regularly eating breakfast had far stronger associations with wellbeing. Likewise, findings from longitudinal studies have tended to be neutral. Heffer et al. (2019) followed more than 1000 young adults over 6 years and found that social media use did not associate with or predict depressive symptoms over that time. Orben et al. (2019) analyzed large-scale representative cohort study data and found no significant relationship between adolescent social media use and wellbeing over 7 years. On the other hand, Coyne et al. (2019) found that problematic cell phone use among 17–19-year olds did associate with, and predict depression, measured over 3 years. It seems effects are nuanced and complex, and likely dependent on individual factors. Neutral findings in cohort studies could reflect averaging of positive and negative effects present in distinct subgroups. This point is supported by studies using more objective measures. For example, Faelens et al. (2021) assessed nearly 100 predominantly female young adults 6 times per day over 2 weeks using experience sampling, alongside a monitoring app to measure Facebook and Instagram usage. Facebook use had immediate negative impact on mood; unidirectional relationships between usage and reduced wellbeing and self-esteem at later time points were observed. Likewise, Instagram use predicted higher levels of social comparison, insecurity, and lower mood at later time points. Levels of repetitive negative thinking appeared to somewhat mediate these relationships. Further, a recent pre-pandemic experiment on social media abstinence on participants who use social media daily ( $n = 61$ ) found that a 7-day break from social media led to a significant benefit in terms of both self-reported mental wellbeing and social connectedness (Brown & Kuss, 2020). Thus, overall, despite some evidence that social media can benefit connectedness and wellbeing, the potential for harmful effects is also evident: as noted, of the valence of effects could depend on individual differences within the populations under study, including levels of engagement and personality characteristics.

### 3 | SOCIAL MEDIA USAGE DURING THE PANDEMIC

The potentially harmful effects of social media use during the pandemic have begun to be investigated, underlining that this has played a role in exacerbating levels of stress (First et al., 2021), anxiety (Liu, Zhang, & Huang, 2020), and poorer wellbeing, for young people in particular (Liu et al., 2021). Geirdal et al. (2021) investigated effects of

social media use frequency while social distancing measures were in place (April/May 2020) in 3810 participants from the UK, United States, Norway, and Australia. Samples were representative of their respective countries' age and education distributions, but the participants were 80% female. Surveys were collected via Facebook, Instagram, and Twitter. Psychological distress was measured using the General Health Questionnaire 12 (GHQ-12), Loneliness scale, Psychosocial wellbeing survey (PSW), and Cantril's self-anchoring ladder (CL). Social media usage was measured subjectively via questionnaire. The sample was split according to high and low social media use, and while high levels of psychological distress were found across all participants, high social media use was associated with significantly poorer mental and psychosocial health, higher loneliness scores, poorer wellbeing, and poorer quality of life (Geirdal et al., 2021). Being a cross-sectional study however, causality cannot be inferred. Indeed, according to theoretical models, higher social media use could reflect a compensatory response by individuals to difficult situations and anxiety (Kardefelt-Winther, 2014); the experience of anxiety and a desire to compensate for unmet needs are key factors in the model by Wegmann and Brand (2019). Additionally, the I-PACE (Interaction of Person-Affect-Cognition-Execution) model (Brand et al., 2019) describes how mental health conditions might undermine self-control when using social networking sites, leading to higher levels of use. More thorough empirical investigations are therefore needed to ascertain direction of causality.

#### 4 | ONLINE NEWS CONSUMPTION AND MENTAL HEALTH

In past disasters such as the Boston Marathon Bombings of 2013, studies found evidence of mental health symptoms being directly triggered by exposure to online media content relating to the incident. Those who viewed graphic images of the attack online were subsequently at higher risk of showing Post Traumatic Stress Disorder (PTSD) symptoms (Holman et al., 2014, 2020). Longitudinal evidence by Silver et al. (2013) also demonstrated the mental health impact of media exposure following the 9/11 attacks, in a US sample ( $n = 2189$ ). The study measured PTSD symptoms and health issues via online survey annually for 3 years after the event. Higher exposure to media coverage about 9/11 was associated with increased stress and poor health (Silver et al., 2013). It could be argued however that such effects might be bidirectional. Indeed, Thompson et al. (2019) provided longitudinal evidence for such a relationship, following a US representative sample ( $n = 4165$ ) after both the Boston bombings in 2013 and again after the Pulse nightclub attacks of 2016. They found via surveys that the relationship between trauma and media exposure is reciprocal, in that those showing symptoms of trauma after the incidents were more likely to view media coverage of the event, which in turn exacerbated and perpetuated their trauma. These studies provide strong longitudinal evidence of the direct impact media can have in times of distress. However, these studies relied on self-report measures of both media exposure and mental health; work using objective measures would be useful so as to confirm these relationships. Also, it

should be noted that these studies focused on exceptional world events that involved graphic and traumatic incidents: findings might not be generalizable to more typical media reports. Nevertheless, these studies are informative regarding the potentially powerful and harmful psychological impact media can have, especially during a time of fear, anxiety and stress. While not a single isolated incident like 9/11, the COVID-19 pandemic has had a wider global impact than perhaps any other phenomenon in recent history, and it has produced a stream of imagery that would have been traumatic for many (e.g., of overwhelmed hospitals). Also, the pandemic has affected all corners of the globe; it therefore feels more immediate and closer at hand to the entire world's population, compared to localized incidents such as 9/11.

#### 5 | EFFECTS OF ONLINE NEWS CONSUMPTION DURING THE PANDEMIC

Consistent with the findings discussed in the previous section, evidence is emerging that supports a connection between online news media consumption and poorer mental wellbeing during the pandemic. Using self-reported survey responses from a US sample ( $N = 10,606$ ) in March 2020, Stainback et al. (2020) found that news consumption was associated with higher self-reported psychological distress. They controlled for other relevant variables such as economic impact: participants were questioned about whether they or someone they knew had lost a job because of the pandemic. Those who followed the news "very closely" reported nearly 25% higher distress levels compared to those who followed the news less closely (Stainback et al., 2020). Being a cross-sectional study, the direction of causality here is not clear: higher distress individuals could simply be watching more news, but bidirectional effects seem likely. It seems fitting that the word "doomscrolling" was added as a word of note in the Oxford Dictionary in 2020, meaning: "obsessively checking online news for updates, especially on social media feeds, with the expectation that the news will be bad, such that the feeling of dread from this negative expectation fuels a compulsion to continue looking for updates in a self-perpetuating cycle." Other similar cross-sectional studies that focused specifically on online news consumption during the pandemic have likewise found correlations with negative affect, anxiety, and stress (Gao et al., 2020; Moghanibashi-Mansourieh, 2020; Zhao & Zhou, 2020). For example, Gao et al. questioned nearly 5000 individuals in China regarding their frequency of exposure to news and information about COVID-19 on social media channels in early 2020: frequent exposure was associated with risk of significant depression and anxiety with an odds ratio of nearly 2. However, whether these effects are specifically due to how news channels have presented COVID-related information is unclear. Disinformation and false reports about COVID-19 have been prevalent across social media channels and among user comments posted in response to online news, exacerbating fear and anxiety. Contagious negative sentiments among these user comments likely also play a role, as does the characteristics of users more likely to seek out and post responses

to COVID news items. Another cross-sectional survey study measuring anxiety and depression symptoms in 6233 German participants between March and April 2020 found a significant correlation between symptoms and time spent seeking out COVID-related information and news (Bendau et al., 2021); thus effects might be at least partially attributable to the personality characteristics/personal circumstances that drive some individuals to seek out COVID-related information, rather than media presentation of it per se. For example, some recent work has shown that individual differences in trust attitudes has contributed to wellbeing levels during the pandemic: Lee (2020) showed that higher self-reported trust levels towards national institutions (including the media) was linked to better coping and higher wellbeing. More detailed work is needed to unpick these relationships and the directions of causality and determine how individual differences in personality characteristics and mental health status impacts the relationship between online news consumption and users' mental health.

## 6 | NATURAL LANGUAGE PROCESSING

As described above, the impact of social media use and online news consumption on mental health has been fairly extensively studied but the majority of investigations have relied on cross-sectional self-report data to detect associations. This precludes inferences regarding causality, and self-report survey data has limitations including social desirability and sampling bias, but does allow associations with specific variables of interest to be tested. However, larger sample sizes would be helpful to infer effects across populations.

An alternative approach is to simply consider the content being generated by users, and draw inferences from the emotions expressed within it. One method for doing this is sentiment analysis and emotion recognition, forms of natural language processing. Rather than recruiting participants to engage with self-report survey studies, this approach involves analyzing very large datasets of user comments using automated means, to extract patterns and trends in emotions expressed. Sentiment analysis measures the polarity of the text, by coding language to produce a ratio of how negative or positive emotion levels are. Emotion recognition takes this a step further to identify specific emotions, such as those found on the wheel of emotions (Plutchik, 1962, 1980). These emotions include eight basic emotions of anger, anticipation, disgust, fear, joy, sadness, surprise, and trust. Another useful element of NLP is a task called thematic analysis or topic classification. This works to classify text into a set of preselected topics or themes. By classifying the data into themes or topics, more analysis can then be done to understand what users care about, what evokes certain emotional responses, and whether certain users care more (or less) about certain topics. The capacity of these tools to process data on such a large scale adds significant power to studies. It allows broader generalizations, although of course this approach does not allow analyses that consider individual-specific variables since the characteristics of the users providing the content are largely unknown. Other drawbacks of this approach include contamination of the data by bot accounts and false identities.

## 7 | PANDEMIC-RELATED RESEARCH USING NLP TOOLS

Research using natural language processing has provided insight into how users have reacted and been affected by the pandemic; see Table 1 for an overview of these studies. Various published studies used these tools to investigate the general reactions to the pandemic based on Twitter posts, during the earlier stages of the pandemic (Abd-Alrazaq et al., 2020; Boon-Itt & Skunkan, 2020; Chandrasekaran et al., 2020; Chang et al., 2020; Das & Dutta, 2020; de las Heras-Pedrosa et al., 2020; Hung et al., 2020; Q Liu et al., 2020; Medford et al., 2020; Sesagiri Raamkumar et al., 2020; Tan et al., 2020; Xue et al., 2020; Zhao et al., 2020). Unsurprisingly, these studies generally portray a picture of heightened emotions at timepoints in the first half of 2020, with high levels of negatively coded sentiments (e.g., anger, fear, sadness). Thematic analyses of the content highlighted economy, lockdowns, and health as prominent topics. Other studies have tracked sentiments over time, providing insight into change in feeling across the online population, with studies emphasizing the increase in negative sentiment, and an increase in emotions connected to poor wellbeing such as increased stress, isolation and anxiety (Hung et al., 2020; Iglesias-Sánchez et al., 2020; Low et al., 2020; Shi et al., 2020; Valdez et al., 2020). Valdez et al. (2020) specifically downloaded 354,738 individual twitter timelines of twitter users, to investigate how their feeds changed over time. They found a general increase in user engagement over the pandemic. A recent study by Basile et al. (2021) used sentiment analysis tools to determine online emotional reactions to events (via Redditt) between January and June 2020, comparing reactions from the UK, Italy, Germany, Sweden, The Netherlands, and New York City. They identified all "mega threads" on Reddit which had headings specifically about COVID-19 during this period. They found an increase in negative sentiment when cases of COVID-19 increased, with sentiment also being connected to cultural and governmental responses. Fear was found to be one of the most frequent emotions identified across the threads identified. Trust was also frequently coded, which was against expectations: the authors theorized that perhaps there was a motivation for individuals to trust that the governmental response would be effective, as a means of coping (Basile et al., 2021). Clearly, these tools have provided useful insights, allowing researchers to access and analyze sentiment across diverse populations of social media users, including up to millions of posts in their analyses.

## 8 | USING NLP TO STUDY THE MENTAL HEALTH IMPACT OF THE PANDEMIC

Regarding mental health implications, some work is emerging using these tools to study the psychological impact of the pandemic on Twitter users (Crocamo et al., 2021; Valdez et al., 2020) and users of other social media platforms. Using sentiment and thematic analysis, these studies provided insights into how users' emotional responses and topics of interest evolved as the pandemic unfolded.

**TABLE 1** Summary of studies reviewed which exploited NLP techniques during the pandemic

Author	NLP tools used	Social media platform	Data collection period	Sample country	Impact studied
Aslam et al. (2020)	Sentiment analysis and emotion recognition	News Headlines	January–June 2020	Multiple–global news headlines	Emotional
Su et al. (2021)	Sentiment analysis, emotion recognition	Weibo	January–April 2020, divided into four stages	China	Emotional
Abd-Alrazaq et al. (2020)	Topic classification and sentiment analysis	Twitter	February–March 2020	International English language tweets	General reaction
Basile et al. (2021)	Sentiment analysis, emotion recognition	Reddit	January–June 2020	Multiple countries – UK, Italy, Germany, Sweden, The Netherlands, and New York City	General reaction
Boon-Itt and Skunkan (2020)	Topic classification and sentiment analysis	Twitter	December 2019–March 2020	International English language tweets	General reaction
Chandrasekaran et al. (2020)	Topic classification and sentiment analysis	Twitter	January–May 2020	International English language tweets	General reaction
Chang et al. (2020)	Thematic analysis, machine learning tool designed to link stigma and blame to certain words/targets	News websites, discussion forums, one social network, and media sharing networks	December 2019–March 2020	Taiwan	General reaction
Crocamo et al. (2021)	Sentiment analysis and emotion recognition	Twitter	January–March 2020	International tweets in English language	General reaction
Das and Dutta (2020)	Sentiment analysis and emotion recognition	Twitter	March–April 2020	“COVID in India” related Tweets	General reaction
de las Heras-Pedrosa et al. (2020)	Emotion recognition and sentiment analysis	Twitter, YouTube, Instagram, official press websites, and internet forums	March–April 2020	Spain	General reaction
Hung et al. (2020)	Sentiment analysis, geographical analysis and thematic analysis	Twitter	April–May 2020	United States	General reaction
Liu, Zhang, and Huang (2020)	Topic classification	News articles via WiseSearch Database	January–February 2020	China	General reaction
Medford et al. (2020)	Sentiment analysis and topic modeling	Twitter	January 2020	International English language tweets	General reaction
Sesagiri Raamkumar et al. (2020)	Sentiment analysis, topic classification/thematic analysis, trend analysis	Facebook	January–March 2020	Singapore, United States, and England	General reaction
Tan et al. (2020)	Sentiment analysis	Twitter	March–April 2020	United States	General reaction
Xue et al. (2020)	Sentiment analysis and thematic analysis	Twitter	January–March 2020	International English language tweets	General reaction
Zhao and Zhou (2020)	Sentiment analysis and thematic analysis	Sina Microblog	December 2019–February 2020	China	General reaction
Iglesias-Sánchez et al. (2020)	Emotion recognition	Twitter, YouTube, Instagram	March–May 2020	Spain	Psychological

(Continues)

TABLE 1 (Continued)

Author	NLP tools used	Social media platform	Data collection period	Sample country	Impact studied
Li, Chaudhary, et al. (2020)	Algorithm identifying lexicon from PHQ-9 for stress	Twitter	January–April 2020	United States	Psychological
Li, Wang, et al. (2020)	Sentiment analysis, extracting risk judgment and life satisfaction, Thematic analysis	Weibo	January 2020 – compared same individual feeds over two weeks	China	Psychological
Low et al. (2020)	Thematic analysis, sentiment analysis, trend analysis	Reddit	January–April 2018, January–April 2019, compared with January–April 2020	International support groups	Psychological
Valdez et al. (2020)	Thematic and sentiment analysis?	Twitter	January–April 2020	United States	Psychological
Berkovic et al. (2020)	Content analysis and sentiment analysis	Twitter	Over one month (March–April 2020)	International tweets English Language	Psychological – of arthritis sufferers
Chivers et al. (2020)	Thematic and sentiment analysis	Online parenting forum	January–May 2020	Australian online support group	Psychological – of perinatal groups
Talbot et al. (2021)	Thematic and sentiment analysis	Twitter	March–June 2020	International tweets	Psychological – of perinatal groups

Nevertheless, in a recent review, Tsao et al. (2021) highlight the paucity of studies leveraging analyses of social media posts to make inferences into how the pandemic has affected users' mental health; they also note the value (but underuse) of machine learning methods compared to traditional statistical methods. However, an exception is Li, Wang, et al. (2020) who analyzed posts from nearly 18,000 Weibo users using machine-learning tools, including sentiment analysis and extracting indicators of social risk judgment and life satisfaction. A paired-sample *t*-test assessed differences in the user group, from before to after the COVID-19 crisis was declared in January 2020. Levels of negative emotions and sensitivity to social risks increased, while levels of positive emotions and life satisfaction decreased. Thematic analysis showed that users became more concerned about their health/family, and less about leisure/friends, post declaration. Likewise, Su et al. (2021) conducted a similar analysis among Weibo users and found the use of negative emotion words (e.g., fear, disappointment, guilt, and anger), increased considerably over the outbreak period, while panic words decreased significantly once prevention and control measures were instigated. This demonstrates the powerful insights that can be generated based on such analyses. Other studies have focused on specific groups of users including Arthritis sufferers (Berkovic et al., 2020) and perinatal groups (Chivers et al., 2020; Talbot et al., 2021). Low et al. (2020) used natural language processing at different stages pre and during the pandemic to make inferences about the mental health status of Reddit users in support groups online, including groups for suicide, schizophrenia, and depression. Through this analysis, they found heightened negative emotions and risky behavior during the pandemic compared to before, finding more users asking for suicidal planning advice and advice on how to stop eating. Comparing content posted by these groups over time (between 2018 and April 2020) revealed heightened negative emotions and increased regularity of such themes. For example, they found an increase in the use of words related to isolation such as “lonely,” and a decrease in lexicon connected to movement, such as “walk.” From the data, Low and colleagues inferred that the pandemic had increased levels of health anxiety and suicidality specifically among those with pre-existing mental health problems. This insight lays the foundation for action; it provides evidence of poor mental health in certain groups of society or in reaction to certain events, guiding policy makers and health providers in where help is needed. Interestingly, they found a decrease of usage of these support groups in 2020 compared to pre-pandemic (November 2018–November 2019). Disengagement with online support groups at the time when need is likely highest is problematic and deserves further research attention. It could be connected to the increased levels of negativity and anxiety-provoking content which appeared on social media channels during the pandemic, discussed above. This encourages more work into why some people might choose to abstain from the news or social media: users' with greater awareness of a negative impact on their wellbeing, lower engagement, and higher self-control, might be more able to abstain as a protective strategy.

Sentiment analysis and emotion recognition tools have provided a means to study emotional response to local events. Li, Chaudhary,

et al. (2020) analyzed Twitter data to estimate levels of stress in major US cities alongside the number of local COVID cases, finding a correlation between these. Stress was estimated using an algorithm incorporating the lexicon from the Patient Health Questionnaire (PHQ-9) to produce an algorithm that recognized stress-relevant words from the PHQ-9. The authors also identified certain topics in the news, such as political announcements, as being directly linked to an increase in PHQ levels, concluding that online news media content and exposure to has a direct influence on stress levels among users. With media outlets competing for our attention, sensationalism has become commonplace: this study provides evidence that anxiety-inducing local events and their reporting by online media outlets have a direct impact on wellbeing. Aslam et al. (2020) compared 141,208 news headlines between December 2019 and June 2020, across 25 global news organizations. By using sentiment analysis, it was found that during this time period 52% of headlines containing the word COVID were negative in terms of emotional polarity: only 30% were likely to evoke positive sentiments while a mere 18% were neutral. Whether this balance has shifted since vaccines became available and restrictions partially lifted in many countries is currently unknown, but the finding does highlight the highly emotionally charged and predominantly negative content of online news headlines in the earlier stages of the pandemic. This will have undoubtedly influenced the prevailing emotional responses of users, discussed previously.

## 9 | CONCLUSION

The online world can provide insight into the lives and minds of the global population on a mass scale. As we have discussed, social media and online news channels have become even more central to people's lives due to the COVID-19 pandemic, and evidence points to considerable impact of online news consumption and social media usage on mental health and wellbeing. While much work exists cross-sectionally, using online surveys to understand subjective mental health in relation to news and social media usage, more can be done to fully understand the underlying factors. The relationships are not clear-cut, and vary according to individual factors and usage characteristics. On the one hand, while social media has considerable potential to support wellbeing and alleviate loneliness, high social media use and news consumption can also cause stress, anxiety, and perpetuate trauma. In some studies, abstinence from social media was linked to better wellbeing; likewise, excessive online news consumption can negatively impact mental health. However, the direction of causality, and potential mediating factors, require more in-depth study. In the context of COVID-19, research has emphasized how the online world might have fostered stress and anxiety through stress-inducing news and social media content. The pandemic has engrained and intensified the impact of social media and online news consumption, with reliance on online interactions and news sources increasing due to social restrictions. Therefore, it is more important than ever to study how heavy use of social media and online news impacts on users.

Natural language processing techniques represent excellent tools to characterise levels of emotions expressed amongst users, and understand how these are affected by news content. These tools facilitate large-scale investigations into the impact of online media consumption on users' psychological wellbeing. They provide us with a way of objectively measuring emotion levels and polarity to identify patterns in populations over time, to help us understand emotional responses to events. Future research could focus on specific user groups and populations, both to identify at-risk groups and also inform intervention strategies, allowing us to leverage the significant potential of online platforms to support wellbeing and mental health.

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## PEER REVIEW

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## DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analysed in this study.

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