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Association of Logic's hip hop song "1-800-273-8255" with Lifeline calls and suicides in the United States: interrupted time series analysis

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ABSTRACT

OBJECTIVE

To assess changes in daily call volumes to the US National Suicide Prevention Lifeline and in suicides during periods of wide scale public attention to the song "1-800-273-8255" by American hip hop artist Logic.

DESIGN

Time series analysis.

SETTING

United States, 1 January 2010 to 31 December 2018.

PARTICIPANTS

Total US population. Lifeline calls and suicide data were obtained from Lifeline and the Centers for Disease Control and Prevention.

MAIN OUTCOME MEASURES

Daily Lifeline calls and suicide data before and after the release of the song. Twitter posts were used to estimate the amount and duration of attention the song received. Seasonal autoregressive integrated moving average time series models were fitted to the pre-release period to estimate Lifeline calls and suicides. Models were fitted to the full time series with dummy variables for periods of strong attention to the song.

RESULTS

In the 34 day period after the three events with the strongest public attention (the song's release, the MTV Video Music Awards 2017, and Grammy Awards 2018), Lifeline received an excess of 9915 calls (95% confidence interval 6594 to 13 236), an increase of 6.9% (95% confidence interval 4.6% to 9.2%, P<0.001) over the expected number. A corresponding model for suicides indicated a reduction over the same period of 245 suicides (95% confidence interval 36 to 453) or 5.5% (95% confidence interval 0.8% to 10.1%, P=0.02) below the expected number of suicides.

CONCLUSIONS

Logic's song "1-800-273-8255" was associated with a large increase in calls to Lifeline. A reduction in suicides was observed in the periods with the most social media discourse about the song.

WHAT IS ALREADY KNOWN ON THIS TOPIC

The increase in suicides after media stories about suicides by celebrities is referred to as the Werther effect

Much less is known about the protective effects of media stories of hope and recovery in the context of suicidal crises

Some evidence from randomised controlled trials shows a beneficial effect of media narratives of hope and recovery on suicidal thoughts and help seeking intentions

WHAT THIS STUDY ADDS

During 34 days of wide scale public exposure to Logic's song "1-800-273-8255," Lifeline received 9915 excess calls (95% confidence interval 6594 to 13 236): 6.9% over the expected number

In the same period, 245 fewer suicides (95% confidence interval 36 to 453) occurred: 5.5% below the expected number

A media event intended to tell a "suicide prevention story" was associated with both an increase in calls to the National Suicide Prevention Lifeline and a simultaneous reduction in suicides in the United States

Introduction

Repetitive reporting on suicide deaths or potentially lethal actions has been shown to trigger further suicides, known as the Werther effect.[1] A recent meta-analysis found that news reporting on celebrity suicides—often highly repetitive over the following weeks[2]—was associated with a 13% increase in suicides.[1]

Some other suicide related narratives might have preventive effects—media stories of people who managed to cope with suicidal crises without dying by suicide have been associated with reductions in subsequent suicides.[3] The possible protective effects of stories of hope and recovery from suicidal crises is referred to as the Papageno effect.[3] In contrast with studies on the Werther effect, most studies on the Papageno effect have used experimental designs. These trials typically use suicidal thoughts rather than suicide death as the outcome. Consistent with the research evidence for the Papageno effect, some of these studies indicate that media narratives of hope and recovery from a suicidal crisis are associated with reduced suicidal thoughts, particularly in people with some risk factors for suicidal behaviour.[4-6] A noted limitation of these studies is that findings about suicidal thoughts do not necessarily generalise to suicidal behaviours and, most importantly, suicides.

Suicide prevention and education efforts must harness positive media to educate the general public and high risk groups about suicide prevention without doing harm to individuals at risk. But a major dilemma for research in this area has been that stories of hope and recovery receive much less media coverage than stories of suicide death.

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On 28 April 2017, the American hip hop artist Logic released his song "1-800-273-8255," prominently featuring the number of the US National Suicide Prevention Lifeline (referred to as Lifeline). The narrative of the song is centred around someone calling the 1-800 number for Lifeline and then telling the counsellor that they don't want to live anymore. The accompanying music video, which was released four months later and has since received more than 419 million views on YouTube, depicts a young black man struggling with discrimination and bullying from peers and adults for being gay. He prepares for his suicide, but ultimately takes his phone and calls Lifeline, which marks a turning point towards improvement and mastery of his crisis.[7]

The release of the song in April 2017 marked the start of a series of media events promoting the story of hope and recovery featured in the song, along with the phone number of Lifeline. The song was performed at the MTV Video Music Awards in late August 2017 to 5.4 million viewers and ultimately marked a breakthrough for "1-800-273-8255."[8] The song, which was labelled a "suicide prevention anthem" by the media, entered the top 10 of the Billboard Hot 100 music charts in the US, remaining there for several weeks and ranking as high as number 3 in September 2017.[9 10] The song's release was also associated with a nearly 10% uptick in online Google searches for Lifeline in the 28 days after its release.[11] By the end of 2020, the song had surpassed one billion streams on Spotify.

Logic's song likely represents the broadest and most sustained suicide prevention messaging directly connected to a story of hope and recovery in any location to date and is thus a serendipitous event for research. To assess whether the song was associated with help seeking or suicides, we conducted a time series analysis examining the associations between Logic's song and daily calls to the Lifeline number as well as daily suicides in the US.

Methods

Public attention to Logic's song

Three known distinct events directed strong public attention to Logic's song: the release of the song on 28 April 2017, Logic's performance at the MTV Video Music Awards on 27 August 2017, and his performance at the Grammy Awards on 28 January 2018. All these events gave widespread public attention to the message of the song—that help from Lifeline is available and effective. To obtain estimates for the timespan of public attention related to each of the events as a proxy for assessment of the impact period, we retrieved all original tweets geolocated to the US that contained the search terms "Logic" and "1-800-273-8255" from Brandwatch (www.brandwatch.com). Our approach was similar to previous studies estimating exposure periods for suicide related media events.[2] Brandwatch is a data reseller that stores the entire historical Twitter stream of more than 350 million tweets per day, giving us access to all public tweets, retweets, and replies across the total observation period. More than 90% of tweets can be successfully matched to a country of origin.

This search allowed us to generate an exhaustive dataset with all mentions specifically related to Logic's song, excluding tweets produced by accounts that Twitter considered malicious bots, from 1 March 2017 to 30 April 2018, covering the entire period before the release and during the song's presence in the Billboard Hot 100.

We visually inspected the daily time series of tweets to identify peaks in tweeting behaviour qualitatively. Consistent with our study preregistration, we were mainly interested in the three events that were most relevant to dissemination of Logic's song (song release April 2017, MTV Video Music Awards August 2017, and Grammy Awards January 2018), but explored the time series of tweets for further peaks as well. Subsequently, we visually assessed the duration of any peak to capture the period until the day that attention wore off. In addition, we performed a post hoc change-point analysis to assess whether findings from visual inspection differed from quantitative assessment of change-points in the time series data (see supplementary text S2 for details on the methodological approach for identifying peaks and their duration).

Lifeline calls and suicide data

We obtained the total number of calls to Lifeline across the US directly from Lifeline. Call data were provided as daily aggregates for the period 1 January 2010 to 31 December 2018. National suicide data were obtained from the National Center for Health Statistics (part of the US Centers for Disease Control and Prevention). Suicide was defined using ICD-10 (international classification of diseases, 10th revision) underlying cause of death codes X60–X84, Y87.0, and U03. Data were provided as daily aggregates for the period 1 January 2010 to 31 December 2018.

Statistical analysis

Seasonal autoregressive integrated moving average models to estimate baseline trends in calls and suicides were fitted to the data up to 6 April 2017. This cut-off date was selected to allow for a three week preparatory period before the release of the song on 28 April, consistent with the observation that the first tweets about the song were posted as soon as three weeks before the release. The selection of models was aided by the SPSS Expert Modeler function, version 26 (IBM), choosing models with the lowest bayesian information criterion value, highest stationary R^2 value (that is, variance attributable to the fitted time series model), and, when possible, a non-significant Ljung-Box Q statistic (indicating whether residuals could be assumed white noise, with stated degrees of freedom). The models derived from the baseline data were subsequently fitted to the full set of data for each series.

Based on the time periods of strong social media attention on the song, we investigated the temporary

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association between each of the identified song related events and calls to Lifeline and suicides. We used dummy variables to model these associations as discrete pulses (that is, we modelled them as sudden changes from the baseline, starting and ending with the previously identified duration of the event of interest). These pulses were coded as binary variables, with a value of 0 before the onset of the event of interest, 1 during the event of interest (for 30 days, for example) and 0 thereafter. After fitting our models, we used model estimates to calculate the number of excess calls and suicides for each event (see supplementary text S1 for details of the statistical model. Supplementary table S7 provides an annotated syntax for the time series analyses).

As a further step, planned in our preregistration, we repeated the analyses of Lifeline calls and suicides using a single dummy variable to combine the effect of the three main media events that captured the most public attention.

Possible confounding exogenous events

Because of possible confounding by the release of *13 Reasons Why*, a Netflix show that sparked strong criticism for violating media recommendations for safe portrayals of suicide,[12-14] we included a dummy variable (coded 1 from the release date of *13 Reasons Why* (31 March 2017 to 30 June 2017, and 0 otherwise).[12] Notably, previous research found that the show was associated with a noticeable increase of 5.5% in suicides (95% confidence interval 5.5% to 21.1%) in the US among 10 to 19 year olds in the three months after its release.[12] Our use of a three month period was consistent with social media data indicating that the show received the strongest attention in that period.[12]

To identify any further events that might be associated with Lifeline calls and suicides, we used a list of Wikipedia entries of suicides by well known people between 7 April 2017 (immediately before the song's release) and 31 December 2018 (end of observation period). We accessed and assessed tweet volumes for all the identified (American and international) celebrities to identify the suicides that received strong public attention so that we could adjust for the occurrence of these confounding events in the model (supplementary table S1). Variables were subsequently added for the suicides of Chris Cornell (18 May 2017), Kate Spade and Anthony Bourdain (5 and 8 June 2017, respectively),[15] Chester Bennington (20 July 2017), and Avicii aka Tim Bergling (20 April 2018).[2] Consistent with research on the association between celebrity suicides and subsequent suicide prevalence in the general population, suicides of lesser known celebrities (Chris Cornell, Tim Bergling) were coded as dummy variables, with value 0 before their deaths, 1 for the 30 days after their deaths, and 0 thereafter. For Chester Bennington, Anthony Bourdain, and Kate Spade, a 60 day period was used,[15] because these suicides continued to receive considerable public attention in the second month after their deaths (supplementary table S1).

Finally, World Suicide Prevention Day is held annually on 10 September to promote awareness of suicide prevention.[16] In the US, World Suicide Prevention Day is part of the annual National Suicide Prevention Week. We included dummy variables for the seven day period of these events in 2017 (10-16 September) and 2018 (9-15 September).

Sensitivity analyses

We performed three (not preregistered, exploratory) sensitivity analyses. First, we used daily unique calls to Lifeline (as opposed to total calls) to assess whether patterns were similar after removing repeat callers. Second, we changed the pre-intervention period to end by the day before the song's release (27 April 2017) to investigate whether this affected key findings. Third, we conducted an additional analysis combining all song related media events (including events that emerged only from visual inspection) into a single variable and assessed its associations with calls and suicides.

Patient and public involvement

No patients or members of the public were directly involved in this study because of time constraints in planning, owing to the long period between the song's release and the setting up of this research. We did, however, speak to patients about the study and we asked a member of the public to read our manuscript after submission.

Results

Public attention as indicated by tweets

Logic's song generated 81953 tweets by 55471 unique users, posted between 1 March 2017 and 30 April 2018 (fig 1). Daily tweets reached three peaks corresponding to the three main events—the song's release in April 2017, the MTV Video Music Awards in August 2017, and the Grammy Awards in January 2018. Two smaller peaks were identified; based on a qualitative assessment of a sample of specific tweets in those periods: one peak occurred around the time of the song's video release (17 August 2017) and the second one alongside media reports of an increase in calls to Lifeline associated with the song (aired on CBS on 10 October 2017).[17] All peaks emerged rapidly, reaching their maximum within one day of the event. The duration of all five peaks was estimated, using the first day of the increase as the start of the impact period and ending the day the peak had worn off.

Figure 1 shows the estimated impact periods for each event (see supplementary figure S1 for a large version of this figure showing the time series of tweets, Lifeline calls, and suicides, and the identified impact periods).

Attention to the song was strongest immediately after Logic's performance at the 2017 MTV Video Music Awards, with an average of 1324 daily tweets over a 28 day period. More time limited peaks were seen after the song's release (1151 tweets a day for three days) and after the 2018 Grammy Awards (1883 tweets a day for another three day period). Overall, 56.3% of tweets

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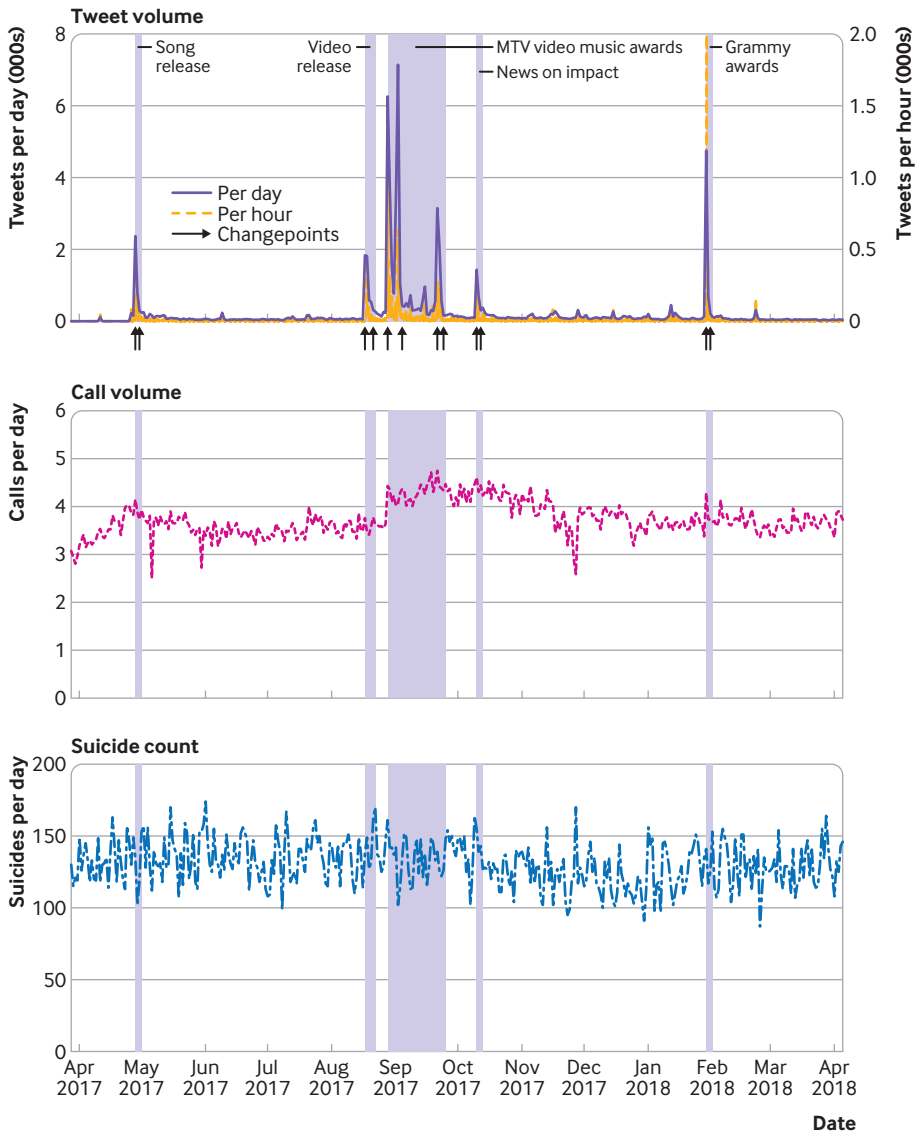


Fig 1 | Daily number of tweets including "Logic" and "1-800-273-8255," calls to the National Suicide Prevention Lifeline, and suicides in the United States from March 2017 to April 2018. Coloured areas represent the duration of impact, as identified through visual inspection and used in the analysis. Dates are based on the findings of the change-point analysis (supplementary text S2). Source of suicide data: Centers for Disease Control and Prevention; suicide defined by ICD-10 underlying cause of death codes X60–X84, Y87.0, and U03

about Logic's song between March 2017 and April 2018 were posted in the 34 day high impact period covering these three media events (table 1).

Association with Lifeline calls

Descriptive information about Lifeline users (gender, age, and demographic distribution of calls) is not routinely collected and thus was not available for the entire dataset; supplementary text S3 provides a breakdown of a not fully representative subsample).

A statistically significant association was found for calls to Lifeline for the 34 day period covering the three main events, but not for the two minor events (the video release and news about the apparent effect of the

Table 1 | Media events related to Logic's song "1-800-273-8255"

Event	Date	Duration of public attention	No of tweets	Mean (SD) No of tweets per day in impact period
Song release	28 April 2017	28-30 April 2017 (3 days)	3454	1151 (1085)
Video release	17 August 2017	17-21 August 2017 (5 days)	5080	1016 (745)
MTV Video Music Awards	27 August 2017 (evening; end 11 pm)	28 August to 24 September 2017 (28 days)	37 060	1324 (1822)
News on impact of song	10 October 2017	10-12 October 2017 (3 days)	2401	800 (577)
Grammy Awards	28 January 2018 (evening; end 11 pm)	29-31 January 2018 (3 days)	5649	1883 (2493)
13 Reasons Why	31 March 2017	31 March to 30 June 2017 (92 days)	1 673 655	18 192 (24 124)

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song). The strongest increase was seen immediately after the MTV Video Music Awards. The increase was smallest for the period after the song's release. This pattern was consistent with the observed public attention to these events, which was most pronounced for the MTV Video Music Awards (fig 1).

The observed number of calls during the periods of song related media events exceeded the range of forecasted calls (based on baseline data) for the song's release (5.3%, 95% confidence interval 0.53% to 10.0%, three day period), the performance at the MTV Video Music Awards (8.5%, 5.1% to 11.9%, 28 day period), and the performance at the Grammy Awards (6.5%, 1.7% to 11.2%, three day period) (table 2, fig 1). No significant associations were found for the two smaller spikes in public attention. A combined analysis across the three main media events indicated an excess of 9915 calls (95% confidence interval 6594 to 13236), corresponding to an increase of 6.9% (95% confidence interval 4.6% to 9.2%, P<0.001). Supplementary table S2 provides the parameter estimates for all model components.

Association with suicides

The observed number of suicides in the periods of Logic related media events were within the range of forecasted values, using the model fit to the baseline data. Estimates for the three major media events pointed to a decrease in suicides, but these estimates were not significantly different from the expected number of suicides (table 3, fig 1). Combining the data for all three major events into a single variable yielded an observed number of suicides that was below the range of the model forecasts. Models including a discrete pulse for these events indicated a significant reduction in suicides, amounting to a decrease of 245 suicides (95% confidence interval 36 to 453 suicides). This corresponded to a reduction of suicides of 5.5% (0.8% to 10.1%, P=0.02) in the 34 day period. Supplementary table S3 provides parameter estimates for all model components.

A sensitivity analysis using daily unique Lifeline calls (rather than total daily calls) showed similar patterns to the original analysis (supplementary table S4). A further sensitivity analysis, using a pre-intervention cut-off date of 27 April 2017, showed no deviations from the original analysis (supplementary table S5). A third sensitivity analysis, combining all Logic related media events (including those not individually associated with daily Lifeline calls) into a single model, indicated that the association with Lifeline calls remained significant, whereas there was no significant association with suicides (supplementary table S6).

Discussion

This interrupted time series analysis found that Logic's song "1-800-273-8255" was associated with a noticeable increase in calls to Lifeline (an additional 9915 calls or increase of 6.9%) during the 34 day period when public attention to the song was substantial. Over the same period, there was some evidence of a reduction in suicides, amounting to 245 fewer suicides (decrease of 5.5%).

These findings are consistent with a possible Papageno effect[3] and are important from a suicide prevention perspective. Media campaigns for suicide prevention have received a groundswell of support internationally, but evaluations are scarce and often limited in terms of scope.[18] Our finding of a substantial increase in actual help seeking and a possible decrease in suicides during the period of high public attention to Logic's song support the real world effectiveness of this intervention. Previous peaks in calls to Lifeline were almost always associated with harmful media events, such as celebrity suicides.[19] These events were often associated with increases in suicides,[1 20] indicating that both increases in calls to Lifeline and increases in suicides might reflect considerable distress in the community from these media events. The overall patterns found for suicides by celebrities included as covariates in this analysis were largely consistent with previous research. Most notably, the suicides of Kate Spade and Anthony Bourdain,[15] which received the strongest and most sustained attention across all celebrity deaths in the post-intervention period, were clearly positively associated with Lifeline calls, and increases of suicides were close to the boundary of significance. In contrast, the patterns observed for Logic's song, consistent with the song's narrative, indicated an increase in help seeking behaviour accompanied by a slight reduction in suicides.

Table 2 | SARIMA model fit and excess calls to the National Suicide Prevention Lifeline during media events related to Logic's song "1-800-273-8255"

	Raw association		Adjusted for all exogenous events			
Dummy variable	Estimate (SE)	P value	Estimate (SE)	P value	No of excess calls (95% CI)	% increase (95% CI)
Song release	191.59 (96.69)	0.048	205.84 (94.45)	0.03	617.52 (62.15 to 1172.89)	5.25 (0.53 to 9.97)
Video release	76.29 (92.46)	0.41	60.27 (90.51)	0.51	301.35 (−585.65 to 1188.35)	1.67 (−3.25 to 6.60)
MTV Video Music Awards	373.34 (77.97)	<0.001	364.82 (74.76)	<0.001	10214.96 (6112.13 to 14317.79)	8.46 (5.06 to 11.86)
News impact	152.67 (96.33)	0.11	158.71 (95.15)	0.10	476.13 (−83.35 to 1.035,61)	3.57 (−0.62 to 7.75)
Grammy Awards	263.16 (95.51)	0.006	252.88 (95.00)	0.008	758.64 (200.04 to 1317.24)	6.45 (1.70 to 11.22)
Three main events	256.65 (51.81)	<0.001	291.62 (49.83)	<0.001	9915.08 (6594.41 to 13235.75)	6.87 (4.57 to 9.18)

SARIMA=seasonal autoregressive integrated moving average; SE=standard error.
Data pre-7 April 2017 (1 January 2010 to 6 April 2017) were checked for additive and innovative outliers and level shifts, which were integrated when necessary. A SARIMA(1,1,2)(1,0,1) model (see supplementary text S1 for an explanation of these parameters), stationary R^2=0.61, Box-Ljung Q=42.99, degrees of freedom=13, P<0.001, was fitted to the pre-7 April 2017 data. This model was subsequently used for the analysis of the whole time series. In total, there were 24 outliers in the pre-April data, some related to specific events, others to possible technical anomalies in call registration. Despite modelling these, the Box-Ljung statistic remained significant. This was most likely related to a continuous but slight increase in variance over time (heteroscedasticity). The increase in variance was small and the analysis had sufficient power to detect even tiny effects in the residuals. Nonetheless, the time series model used was well adjusted for the outliers in these time series data (see supplementary appendix for detailed descriptions of the model, all model parameters, and further adjusted analyses).

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Table 3 | SARIMA model fit and excess number of suicides during media events related to Logic's song "1-800-273-8255"

	Raw association		Adjusted for all exogenous events			
Dummy variable	Estimate (SE)	P value	Estimate (SE)	P value	No of excess suicides (95% CI)	% decrease (95% CI)
Song release	−10.62 (7.53)	0.16	−11.02 (7.55)	0.15	−33.06 (−77.45 to 11.33)	−9.29 (−21.76 to 3.18)
Video release	7.90 (6.17)	0.20	7.41 (6.19)	0.23	37.05 (−23.61 to 97.71)	5.23 (−3.33 to 13.80)
MTV Video Music Awards	−4.12 (3.72)	0.27	−5.37 (3.89)	0.16	−150.36 (−363.84 to 63.12)	−4.03 (−9.75 to 1.69)
News impact	11.29 (7.53)	0.13	11.76 (7.54)	0.12	35.28 (−9.06 to 79.62)	8.07 (−2.07 to 18.22)
Grammy Awards	−10.22 (7.54)	0.18	−10.12 (7.54)	0.18	−30.36 (−74.70 to 13.98)	−7.93 (−19.50 to 3.65)
Logic main events	−6.23 (3.06)	0.04	−7.20 (3.13)	0.02	−244.80 (−453.38 to −36.22)	−5.48 (−10.14 to −0.81)

SARIMA=seasonal autoregressive integrated moving average; SE=standard error.
Data pre-7 April 2017 (1 January 2010 to 6 April 2017) were checked for additive and innovative outliers and level shifts, which were integrated when necessary. A SARIMA(1,0,3)(1,0,1) model (see supplementary text S1 for an explanation of these parameters), stationary R^2=0.45, Box-Ljung Q=13.37, degrees of freedom=13, P=0.43, was fitted to the pre-7 April 2017 data. This model was subsequently used for analysis of the whole time series (see supplementary appendix for detailed descriptions of the model, all model parameters, and further adjusted analyses).

The effectiveness of the song on calls to a helpline is a novel finding. The results show that it is possible to promote help seeking for suicidal crises in the absence of negative news, and indicate that suicides could potentially be reduced with prevention focused campaigning, such as Logic's song. Although the reduction in suicides was small, this finding shows that the song did not result in harmful effects on suicide occurrence, which would have been indicated by an increase in suicides. This is important because some prevention messaging that aimed to reduce suicides was ultimately associated with increases in suicides.[12] These narratives, however, typically focus on suicide deaths and attempts, not on hope and recovery from suicidal thoughts and feelings.

The amount of exposure generated by prevention messages about hope and recovery seems to be crucial in efforts to yield positive effects on behaviours including help seeking and potentially suicides. In accordance with the most sustained and strongest public attention to Logic's song, as indicated by tweet volume, the uptick seen for Lifeline calls was strongest after his performance of the song at the MTV Video Music Awards in 2017 followed by his performance at the Grammy Awards in 2018, and then the song's release. This pattern underscores the importance of reaching large proportions of the target population to achieve behavioural effects. Compared with other prevention events, public attention for Logic's song, as reflected in tweet volume, was more sustainable, but the event did not necessarily result in more tweets overall. Based on query terms used for World Suicide Prevention Day 2020[16] in the US, for example, the day resulted in a total of approximately 94 000 tweets from 58 000 users, including more than 30 000 on 10 September 2020 alone. Overall social media attention was comparable in total magnitude to Logic's song (82 000 tweets from 55 000 users), but the attention was concentrated on a single day, whereas Logic's song was highlighted repeatedly over several specific and diverse media events. This amount of attention was, however, still considerably smaller than for some harmful media events in the recent past—for example, in the three months after the release of *13 Reasons Why*, a TV show that violated key recommendations for safe portrayals of suicide[12-14] and was associated with an increase in teenage suicides,[12] there were tweets from 870 056 individual users about the show.[12] This is more than 15 times larger than for Logic's song. Although Logic's song sets an important, extraordinary example for widely disseminated and quite sustainable suicide prevention messaging, exposure is still considerably stronger for some conceivably harmful media events.

Different pathways and mechanisms might be at play in any reduction in suicides associated with Logic's song. The present analysis indicates that periods that were strongly associated with an uptick in calls showed a simultaneous decrease in suicides. We have not established whether calling behaviour affected people who did (or did not) die by suicide after the song's release. People who are at risk of suicide are often socially withdrawn, and some might not consistently use helplines. The proportion of socially isolated, suicidal callers, however, has been found to be particularly high among frequent callers of crisis lines,[21] indicating that the threshold for calling a telephone crisis centre is lower than for accessing help services that require on-site visits. The song, however, might have triggered other or additional routes of action beside calling Lifeline. Finding romantic love and positive communication with his family, for example, are major contributors to the improvement in suicidal thoughts and feelings of the protagonist seen in Logic's music video, and some people might have felt inspired to reach out for help from other sources. In-depth qualitative research might help shed light on the question of whether and how precisely people with suicidal thoughts and feelings were influenced by the song.

Strengths and limitations of this study

A strength of this study is the length of the time series, with daily data from 2010 to 2017 available to model the expected pre-intervention suicide counts. The model controlled and adjusted for several exogenous variables (namely, concurrent side events, such as suicides of well known celebrities, and National Suicide Prevention Week). Trends, temporal fluctuations, and seasonality were adjusted for in the SARIMA models. A further strength of this study is the use of daily data, resulting in precise modelling in accordance with periods when social media attention to Logic's song was strong, as indicated by the volume of tweets about it. Estimating exposure based on social media data is more objective than merely estimating exposure times in the absence of any supporting data. This refined

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approach is consistent with studies indicating that public attention to social media discourse in terms of tweets is short lived, with lifespans of a tweet normally not extending beyond a few hours.[22]

The main limitation of the study is that it was based on ecological data, so it was not possible to ascertain whether the people calling Lifeline or not dying by suicide had been exposed to Logic's song and related media events, or what their motivations might have been for calling or not dying from suicide. The observational nature of this research does not allow us to establish causality. Furthermore, only total daily call and suicide data were available, without any stratified data for various demographic factors, such as gender, age, or location of residence. Specifically for suicides, data stratified by age or gender would have resulted in small numbers on some days. This is a limitation because adolescents and young adults are over-represented among the viewership of the MTV Video Music Awards.[23] Although this age discrepancy does not equally apply to the other events related to the song—the Grammy Awards 2018 was watched by 17% of Americans aged 50 or older[24]—or to the music preferences for rap or hip hop music in the US,[25] a somewhat stronger exposure of young people seems plausible. Notably, the demographic profile (as well as primary presenting problems) of callers in September 2017, the month with strongest attention to the song, did not grossly deviate from other months in the observation period after the song's release, thus indicating that possible age effects, if present at all, might have been limited (see supplementary appendix).

Other limitations of our approach include the inability to assess longer term associations beyond the periods of strong public interest. As previously noted, 56.3% of tweets about Logic's song between March 2017 and April 2018 were posted in the 34 day high impact period defined in this study, indicating that the bulk of attention was covered by the selected period. This is consistent with the generally short lived public attention to media events and related public discourse, which requires constant repetition to become sustainable.[22 26] Furthermore, the different peaks identified were dissimilar not only in duration but also in the maximum number of tweets on a given day. The present impact periods have been modelled as discrete pulses, consistent with the assumption that visible, large changes in attention (rather than overall number of tweets) might most likely affect behavioural outcomes, such as help seeking and suicide. This is consistent with related evidence that other media data, such as those from Google Trends, generally struggle to predict general suicide trends,[27] whereas sudden strong changes in Google search behaviours, as seen during major events such as the release of *13 Reasons Why* or the covid-19 pandemic, do seem to be useful in estimating suicide trends.[28 29] Studies are needed to assess how long the effects of suicide prevention messaging generally last and what absolute amount and duration of attention, as reflected in social media, is necessary to yield any observable effects. Social media data, such as tweets, are only a proxy of public attention, however, and might not always reliably reflect actual exposure. Finally, the determination of suicide deaths is a challenging task, and suicide deaths are sometimes under-reported.[30] Even though a certain degree of misclassification is possible, rapid fluctuations in classification accuracy of national suicide data, which could impact the present analysis, seem unlikely.

Conclusions

This analysis suggests that Logic's song "1-800-273-8255" was associated with a noticeable increase in calls to Lifeline and a simultaneous small reduction in suicides during peak social media discourse about the song. The latter outcome is worth underscoring—the occurrence of a widely disseminated song and video was associated with more than 200 fewer suicides than expected. These findings emphasise the potential population health benefits of working creatively and innovatively with other sectors, such as the music and entertainment industries, to promote new impactful stories of help seeking that resonate with broad audiences, leave a visible footprint on social media, and are safe in terms of not featuring potentially lethal actions but rather coping and mastery of crises.[13] Interventions that follow these principles could help create behavioural change to increase help seeking and prevent suicide.

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Contributors: TN, UST, and SS had full access to all data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. TN and UST conceived and designed the study, drafted the manuscript, and performed the statistical analysis. All authors acquired, analysed, or interpreted the data and critically revised the manuscript for important intellectual content. MJStrauss was responsible for conceptualising and making the figures. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criterial have been omitted. TN and UST are guarantors.

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role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

Competing interests: All authors have completed the ICMJE uniform disclosure form at http://www.icmje.org/disclosure-of-interest/ and declare: MG, TN, and BT had financial support from Vibrant Emotional Health for not directly related work in the same area, which was the basis for development of this research project; MS reports a grant from the American Foundation for Suicide Prevention (grant No SRG-0-153-19) for not directly related work in the same area in the past three years; SM, FG, and JD have been employees of Vibrant Emotional Health, the non-profit organisation that administers the National Suicide Prevention Lifeline and is funded by the Substance Abuse and Mental Health Services Administration, USA, in the past three years; BT reports consulting fees in the past three years from Suicide Awareness Voices of Education (SAVE) for not directly related work in the same area; MG reports membership in the Steering and Standards, Training and Practices committees of the National Suicide Prevention Lifeline; TN reports being a current board member of the International Association for Suicide Prevention as vice president.

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Dissemination to participants and related patient and public communities: The study findings will be broadly disseminated via public media, conference presentations, press releases, and social media. We will work with the communications team of Vibrant Emotional Health (specifically, the National Suicide Prevention Lifeline) to achieve this goal. The authors will also disseminate findings to media organizations and press councils, as well as to national and international health organizations that have been instrumental in the development of media recommendations for suicide reporting. How the findings will be used to the benefit of the community will be discussed in interdisciplinary groups involved in media portrayals of suicides, which includes media professionals, the interested public, individuals with personal experience of suicidal thoughts and feelings, suicide attempts, and bereavement from suicide, as well as mental health professionals.

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Supplementary information: Supplementary texts S1-3. Supplementary tables S1-7. Supplementary figure S1.

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