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Detecting risk for depression and anxiety symptoms among older bereaved women using text-based analysis in the Nurses' Health Study II

Alexandra Hillcoat^{1,2}, Elaine D. Jeon¹, Maleeka Shrestha², Shaili C. Jha³, Jae H. Kang⁴, Janet W. Rich-Edwards⁵, Christy A. Denckla¹

¹Department of Epidemiology, Harvard T.H. Chan School of Public Health, Boston, USA

²Department of Social and Behavioral Sciences, Harvard T.H. Chan School of Public Health, Boston, MA, USA

³Channing Division of Network Medicine, Department of Medicine, Brigham and Women's Hospital and Harvard Medical School, Boston, MA, USA

⁴Division of Women's Health, Department of Medicine, Brigham and Women's Hospital and Harvard Medical School, Boston, MA, USA

⁵Psychiatric and Neurodevelopmental Genetics Unit, Department of Psychiatry, Massachusetts General Hospital, Boston, MA, USA

Abstract

We analyzed free-text narratives about recent bereavement experiences from 1,997 women aged 55–73 years ($M = 65.9$, $SD = 4.4$) enrolled in the Nurses' Health Study II to identify associations between text characteristics and post-bereavement mental health. We applied covariate-adjusted linear mixed effects models to assess the association between word count and expression of positive versus negative sentiment (emotional valence) in first-person bereavement narratives and standardized Patient Health Questionnaire-4 (PHQ-4) total, anxiety, and depression symptom scores over six months, stratified by loss of a partner or child versus a close other. Emotional valence was quantified using the VADER algorithm. Among women bereaved of a close other, word count was positively associated with log PHQ-4 total (0.06 SD, 95%CI [0.02, 0.09]), anxiety (0.05 SD, 95%CI [0.02, 0.09]), and depression (0.06 SD, 95% CI [0.03, 0.09]) symptom scores. Negatively scored emotional valence was associated with elevated log PHQ-4 total (−0.05 SD, 95%CI [−0.08, −0.01]), anxiety (−0.04 SD, 95%CI [−0.08, 0.00]), and depression (−0.04 SD, 95%CI [−0.07, −0.01]) symptom scores. Estimated associations among women bereaved of a partner or child were elevated but underpowered. Qualitative approaches in epidemiological cohorts offer promise in identifying novel characteristics associated with bereavement outcomes among older women.

Correspondence Address: Christy A. Denckla, 677 Huntington Avenue, Kresge Building, Room 706; Boston, MA, 02115 USA.

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Keywords

Qualitative; bereavement; anxiety; depression

The excess mortality observed worldwide during the COVID-19 pandemic¹ was disproportionately borne by older adults, leaving an estimated 9 million people bereaved of a close relative.² Bereavement is associated with acute grief in the immediate aftermath of loss, which typically recedes over time.^{3,4} However, for a significant number of older adults, bereavement is associated with prolonged grief disorder,⁵ late-life depression,⁶ post-traumatic stress disorder (PTSD),⁷ and/or physical health problems.^{8,9} Furthermore, previous research has identified a greater risk of post-bereavement distress among women relative to men and following the loss of a partner or child.¹⁰⁻¹² Given that older women experience numerous losses and a greater population-level burden of depression and anxiety than their male counterparts,^{13,14} early identification of those at greatest risk of enduring distress after bereavement is critical for the implementation of preventive interventions.¹⁵

Study designs that support generalizing results beyond research settings are well suited to population mental health questions regarding bereavement because they can more closely capture the lived context of grieving adults. Collecting qualitative data within large, epidemiologic cohorts enables examination of experiences that are not captured by traditional survey methods, which assess particular, pre-specified features of experiences.¹⁶ Leveraging such an approach is particularly attractive in bereavement research, in which the heterogeneity in bereavement experiences and individual grief responses necessitates study designs that facilitate more widely generalizable inferences.

Despite the advantages of analyzing qualitative data from large cohorts, few studies have used this approach.^{17,18} Written accounts of bereavement experiences have been shown to predict health outcomes.¹⁹⁻²¹ Pennebaker et al.¹⁹ found that increased use of insight-related words (e.g., realize, understand) and causation-related words (e.g., because, thus) in an experimental writing task was positively associated with later physical health and adaptive behaviors. Additionally, evidence suggests that writing about a negative event may be associated with greater emotional distress under particular circumstances.²²⁻²⁴ Sbarra et al. found that, among adults who had recently experienced marital separation, participating in an expressive versus control writing task was associated with greater subsequent emotional distress.²²

This study aimed to extend prior work by extracting characteristics of free-text narratives volunteered by bereaved older women to assess associations between linguistic characteristics and adverse mental health outcomes following bereavement. Existing research has demonstrated that emotional valence (expression of positive versus negative emotion) after bereavement is associated with psychological distress cross-sectionally and prospectively, suggesting that positive emotionality after bereavement is associated with lower subsequent symptoms of depression and anxiety.²⁵⁻²⁹ Thus, we anticipated that comments expressing more negative emotional valence would be associated with greater psychological distress at baseline and assessments 3- and 6-months later. Additionally, existing research suggests that higher word count in writing tasks may be associated with

psychological distress, including elevated anxiety, depression, and suicidality.³⁰⁻³³ This link may be partially explained by evidence that, by promoting rumination, self-disclosure may be associated with greater subsequent emotional distress.²²⁻²⁴ Thus, we additionally investigated an exploratory hypothesis that higher word count—hypothesized to reflect greater self-disclosure—would predict greater psychological distress at all time points. As the death of a partner or child has qualitatively different implications for one's daily life relative to the other forms of bereavement (e.g., role changes, loss of income) and is associated with increased risk of post-bereavement distress,³⁴ we investigated separate hypotheses for people bereaved of a partner or child versus other close relationships.

Methods

The Nurses' Health Study II (NHS2) is a prospective cohort study of 116,429 female registered nurses in the United States aged 25-42 at the time of enrollment in 1989. Cohort members complete biennial questionnaires assessing their health and health-related behaviors, and follow-up has been consistently very high (85%+). The NHS2 study design and procedures have previously been detailed.³⁵ The data are drawn from a substudy within the NHS2 conducted during the COVID-19 pandemic.³⁶ The study protocol was approved by the Institutional Review Boards of Brigham and Women's Hospital and the Harvard T.H. Chan School of Public Health.

Procedures

In April 2020, 55,925 NHS2 cohort members were invited to participate in the online COVID-19 substudy, which investigated individuals' experiences and health during the COVID-19 pandemic. 39,137 women (69.9%) completed the baseline survey, of which 30.3% were active healthcare workers. Participants completed three additional quarterly questionnaires between October 2020 and October 2021. Figure 1 presents the timeline of assessments and the number of respondents to each. A comparison of the sociodemographic characteristics of participants in the substudy relative to the complete NHS2 cohort found participants and non-participants to be largely similar,³⁶ with the exception that substudy participants were more likely to report a history of depression and antidepressant use prior to the COVID-19 pandemic.³⁶

In the Quarterly 1 survey conducted in Fall 2020, participants were asked if they had experienced the death of a loved one since March 1, 2020, and could voluntarily leave a comment in a free-text field ($N = 3,872$). A total of 6,901 participants (22.4% of respondents to the Fall 2020 survey) endorsed bereavement since March 1, 2020, 2,272 (32.9%) of whom provided a text comment. Commenters were largely similar to non-commenters at the Quarterly 1 survey with respect to covariates and patient health questionnaire-4 (PHQ-4) scores (see Table S1). Commenters were, however, slightly more likely to report being bereaved of a partner or child or a parent/sibling/grandparent and less likely to report being bereaved of a friend.

$N = 275$ observations were removed due to ineligibility (see Figure 2), resulting in an analytic sample of $N = 1,997$ with 5,778 PHQ-4 assessments. While individuals included versus removed from the analytic sample were largely similar, the latter were, on average,

less likely to identify as non-Hispanic White, more likely to have previously reported a depression diagnosis, less likely to live in the Northeast or Midwestern US at the Quarterly 1 survey, had a higher pre-pandemic score on the Center for Epidemiological Studies – Depression Scale (CES-D-10), and had a lower median geolocated household income in 2017 (see Table S2).

Measures

Bereavement: Bereavement was assessed at the Quarterly 1 survey with the following prompt: “Since March 1, 2020, has a loved one or someone important to you died?” Participants who responded affirmatively were asked to focus on the loss that they found most distressing and indicate their relationship to the deceased as well as the cause of death (confirmed or presumed COVID-19 infection versus other causes). The online survey did not allow for selection of multiple response options; participants could only respond with reference to one death.

Text characteristics: At the end of the bereavement section, participants were presented with an unlimited-length free-text field and the following prompt: “We recognize these questions may not capture your full experience. If you have additional information to provide, please use the comment box below”. Two linguistic characteristics of the narrative data were extracted for analysis.

1. **Emotional Valence.** To estimate positive versus negative emotionality in written text, we used the Valence Aware Dictionary and sEntiment Reasoner (VADER), an established lexicon and rule-based tool that has been found to outperform human raters³⁷ and other popular sentiment analysis algorithms³⁸ when classifying comment data as positive, negative, or neutral. VADER assigns each word a sentiment score ranging from -4 to 4, in which the sign represents polarity and the value represents intensity as determined by the word itself and its context (e.g., letter case, punctuation, surrounding negating words). It produces a compound score for each text, calculated as the sum of the component word scores scaled from -1 (negative emotional valence) to 1 (positive emotional valence).³⁷ The compound score, which has previously been applied in research on public health^{39,40} and mental health,⁴¹⁻⁴³ was used as the measure of emotional valence in our analyses. VADER was implemented in R Statistical Software (v4.2.0)⁴⁴ using the vader package (v0.2.1).⁴⁵ See Appendix S1 for further information on the VADER algorithm and considerations in selecting a tool for automated sentiment analysis.
2. **Word count.** The total word count was calculated as the raw number of words in a comment. Hyphenated words were counted separately, and numbers were included as words.

Depression and Anxiety Symptoms: Symptoms of depression and anxiety were assessed at all quarterly surveys using the PHQ-4, an established four-item measure of anxiety and depression symptoms experienced in the preceding seven days.⁴⁶ Respondents rate their agreement to each item on a 5-point Likert scale ranging from 0 (“Not at all”)

to 4 (“Nearly every day”). The total score ranges from 0-12, and the subscale scores range from 0-6. Internal consistency of the total score ($\alpha = 0.86$) and the subscale scores (Anxiety: range = 0.79-0.81; Depression: range = 0.83-0.84) was high at all three timepoints. When two or fewer PHQ-4 items were missing, the total score was imputed by multiplying the mean of the completed items by four. Subscale scores were not imputed.

PHQ-4 total, anxiety, and depression scores were calculated at the Quarterly 1 survey and averaged across the Quarterly 2 (Winter 2021) and 3 (Spring 2021) surveys. We elected to average across Quarterly 2 and 3 assessments for two reasons: (1) post-bereavement psychological distress is strongly associated with time since the loss, which was not measured in the quarterly surveys; and (2) psychological distress more generally was likely affected by location- and time-dependent changes in pandemic-related conditions. Due to the resulting complex association between time and PHQ-4 scores, averaging PHQ-4 scores across follow-up assessments allowed for a more robust examination of bereavement-related variation in psychological distress.

Controlling for pre-bereavement symptoms was critical to partial out the variance attributable to known risk factors for post-bereavement distress that may inflate its apparent association with the text characteristics. To adjust for pre-pandemic, and thus pre-bereavement, depression and anxiety, we included a binary indicator of lifetime clinician-diagnosed depression (assessed biennially from 2003-2019) and scores on two validated measures of depression and anxiety (CES-D-10⁴⁷ and the Generalized Anxiety Disorder-7⁴⁸ [GAD-7] scale) in 2017.

Covariates: To isolate the associations of interest from characteristics potentially associated with both text predictors and symptoms of anxiety and depression, we controlled for age as of March 2020, census region at each quarterly survey, race/ethnicity categorized as non-Hispanic White vs. non-White, and median geolocated census tract household income in 2017 based on the 2010 census. Analyses additionally controlled for previous depression diagnosis, pre-pandemic depression and anxiety symptoms, self-reported COVID-19 cause of death, and relationship to the deceased. Finally, relationship to the deceased, who had been identified as ‘a loved one or someone important to you,’ was further detailed as one of: “Spouse/partner”, “Child”, “Parent”, “Sibling”, “Grandparent”, “Other family member”, “Friend”, “Neighbor”, and “Other.” To stratify analyses, responses were grouped into two categories: 1) partner or child; 2) close other (i.e., parent, sibling, grandparent, other family member, friend, neighbor, and other). In analyses conducted within the close other group, relationship to the deceased was included as a categorical covariate with the following three groups: 1) parent, sibling, or grandparent; 2) friend; 3) another relationship.

Statistical Analysis

First, we conducted descriptive analyses of sample demographics, bereavement, and PHQ-4 symptoms. Then, we extracted the qualitative, text-based data and two independent reviewers screened the data to remove entries that met exclusion criteria (see Figure 2). Additionally, participants with missing covariate information were removed. Participants

in the final analytic sample are largely similar to those removed for missing data. Those missing covariate data were slightly more likely to identify as non-Hispanic White, more likely to report the loss of a parent, grandparent, or sibling, had a lower average CES-D-10 score in 2017, and had a higher median geolocated household income (see Table S3).

Since automated text analysis programs are sensitive to spelling errors and letter cases, two reviewers (AH and EDJ) manually reviewed text entries to correct spelling errors and expand acronyms (e.g., SIL to sister-in-law). Seven acronyms whose expanded forms are less frequently used were left as is (i.e., COVID-19, CT, MRI, PCR, RV, TV, DC). After each reviewer independently reviewed half of the text entries, they examined the revisions made by the other reviewer to ensure that all necessary corrections had been made and identify potential discrepancies. The reviewers then met to resolve any disagreements.

First, we fit linear regression models to evaluate the cross-sectional association between text characteristics and PHQ-4 total and subscale scores separately among women bereaved of a partner or child and those bereaved of a close other. As mentioned above, we elected to stratify analyses based on evidence that loss of a partner or child has qualitatively different implications for adjustment post-loss.³⁴ Then, to examine longitudinal associations among text comments and subsequent symptoms of depression and anxiety, linear mixed effects models were fit to estimate the association between text characteristics and three outcomes (PHQ-4 total, anxiety, and depression scores) at two timepoints: cross-sectionally at the Quarterly 1 survey and prospectively averaged over the Quarterly 2 and 3 surveys.

For each text characteristic and outcome variable combination, a minimally adjusted model controlling for age and a fully adjusted model including all covariates were fit to the entire sample to evaluate associations between relationship to the deceased (loss of a partner or child versus a close other) and PHQ-4 total and subscale scores. Subsequently, minimally and fully adjusted models were fit for each text characteristic and outcome combination to test our hypotheses separately for people bereaved of a partner or child versus a close other. Then, to evaluate if text characteristics are associated with change in PHQ-4 scores over time, we fit fully adjusted models including interaction terms between time (i.e., Quarterly 1 survey versus average of Quarterly 2 and 3 surveys) and each text characteristic.

In all longitudinal models among people who lost a close other, interactions between time and relationship to the deceased were included to capture differences in prolonged distress by relationship category.³⁴ Random intercepts were fit for each subject. A random slope of time was not included due to minimal variation in subject-specific slopes. Log transformations were applied to all PHQ-4 scores to address non-normality. The transformation was sufficient for total but not subscale scores, thus robust linear mixed effects models were fit for analyses of PHQ-4 subscale scores using *robustlmm* (v3.2.2).⁴⁹

Results

Participants were, on average, 65.9 years old (standard deviation [*SD*] = 4.4 years) and White (94.4%; see Table 1). The largest group of participants (43.7%) were bereaved of another relationship. Figures 3 and 4 display mean PHQ total, anxiety, and depression scores

by quartiles of word count and emotional valence across the study period among women bereaved of a partner or child and close other, respectively. Word count and emotional valence were weakly negatively correlated (Spearman's $r = -0.24$).

Association Between Text Characteristics and Baseline PHQ-4 Scores

Linear models among women bereaved of a partner or child found no statistically significant evidence of an association between word count or emotional valence and PHQ-4 scores at baseline (see Table 2).

Among women bereaved of a close other, higher word count was, on average, associated with 0.05 standard deviation (SD) higher log PHQ-4 total scores (95% confidence interval [CI] = [0.01, 0.09]), 0.05 SD higher log anxiety subscale scores (95% CI = [0.01, 0.09]), and 0.04 SD higher log depression subscale scores (95% CI = [0.00, 0.08]). Moreover, negative emotional valence (i.e., emotional valence scores with a negative value) was similarly associated with elevated log PHQ-4 scores (Total: 0.06 SD, 95% CI = [-0.10, -0.02]; Anxiety Subscale: 0.06 SD, 95% CI = [-0.10, -0.02]; Depression Subscale: 0.05 SD, 95% CI = [-0.09, -0.01]; see Table 2).

Association Between Relationship to the Deceased and PHQ-4 Scores

People bereaved of a partner or child had, on average, higher log PHQ-4 total (0.30 SD, 95% CI = [0.11, 0.48]) and depression subscale scores (0.52 SD, 95% CI = [0.34, 0.70]) relative to people who lost a close other. However, they also experienced, on average, a steeper decrease in log PHQ-4 total ($\beta = -0.19$, 95% CI = [-0.37, -0.01]) and depression subscale scores ($\beta = -0.37$, 95% CI = [-0.54, -0.19]) over follow-up (see Table S4).

Longitudinal Association Between Text Characteristics and PHQ-4 Scores

Among people bereaved of a partner or child ($N = 85$), linear mixed effects models revealed no statistically significant evidence for an association between word count or emotional valence and PHQ-4 total, anxiety, and depression scores at baseline and 3-6 months later (see Table 3).

Among people who lost a close other ($N = 1,912$), higher word count was associated with higher log PHQ-4 total ($\beta = 0.06$, 95% CI = [0.02, 0.09]), anxiety subscale ($\beta = 0.05$, 95% CI = [0.02, 0.09]), and depression subscale ($\beta = 0.06$, 95% CI = [0.03, 0.09]) scores. Similarly, negative emotional valence was associated with elevated log PHQ-4 total ($\beta = -0.05$, 95% CI = [-0.08, -0.01]), anxiety subscale ($\beta = -0.04$, 95% CI = [-0.08, 0.00]), and depression subscale ($\beta = -0.04$, 95% CI = [-0.07, -0.01]) scores at the Quarterly 1 survey and over follow-up (see Table 4). There was no evidence that the association between emotional valence or word count and PHQ-4 scores changed over follow-up, indicating that these associations held 3 to 6 months after the Quarterly 1 survey.

Note that, due to investigating numerous statistical comparisons, confidence intervals presented for all model results underestimate the true uncertainty in the findings they present.

Discussion

This investigation leveraged narrative data collected within a larger, longitudinal epidemiological cohort to identify text characteristics associated with emotional well-being after bereavement among older women. Our findings indicate that, among older women bereaved of a close other, higher word count and more negative relative to positive sentiment in free-text narratives is associated with higher symptoms of depression and anxiety across the 12-month period following the loss, supporting our hypotheses.

There is little research evaluating the association between word count in free-text narrative data and anxiety and depression, and results from extant research are mixed. While some studies report a positive association between word count and self-reported diagnosis of anxiety and/or depressive disorders or emotional distress,^{20,30,31,50} others report no association^{51,52} or a negative correlation⁵³ between word count and depression and anxiety symptoms.

These findings are consistent with results from a study on bereavement and rumination, which found that bereaved individuals with elevated depression symptoms were more likely to endorse a ruminative coping style (i.e., thinking repetitively and passively about emotional reactions to distressing events). While these participants tended to seek more social support, they were less likely to report satisfaction with the quality of their social support.⁵⁴ To our knowledge, only one study has reported testing an association between word count and a ruminative coping style, and found that lower spoken word count predicted greater trait rumination.⁵⁵ One potential explanation for our findings in the context of prior work is that word count serves as a proxy for rumination only when there is relatively little prompting for individuals to expand upon their negative experiences. If participants are instructed to spend a certain amount of time reflecting on an event, then word count may better reflect directed effort than rumination, which can occur outside of awareness. However, if participants are instead given the option to discuss their experience for as long as they wish, then voluntarily spending more time recounting their experience, presumably resulting in more words, may reflect the extent to which participants had already been dwelling on the event or to which they are seeking social support in the form of disclosing emotions. In support of this interpretation, all studies that analyzed social media posts, assumed to be unprompted, found a positive association between word count and emotional distress.^{20,31,50} Conversely, studies that employed an experimental paradigm with specific prompts reported conflicting findings.^{30,51-53,55}

Our results concerning emotional valence concur with previous evidence for a negative association between positive emotions after bereavement and later psychological distress.²⁵⁻²⁸ These findings are strengthened by our ability to robustly control for symptoms of anxiety and depression prior to both bereavement and the COVID-19 pandemic. Specifically, controlling for pre-existing symptoms of anxiety and depressions increases our confidence that the association between emotional valence in bereavement narratives and psychological distress post-bereavement cannot be fully explained by the continued experience of unrelated symptoms.⁵⁶

Finally, we did not find statistically significant evidence for an association between word count or emotional valence and symptoms of anxiety and depression among people bereaved of a partner or child. However, our analyses were likely underpowered due to the small number of participants who experienced these losses ($N = 85$), as suggested by elevated coefficients and wide confidence intervals (see Tables 2 and 3). Future research is necessary to investigate heterogeneity in associations between text characteristics and well-being post-bereavement by relationship to the deceased, particularly since the trajectories observed in this study suggest a complex association between post-bereavement symptoms of anxiety and depression and relationship to the deceased. The loss of a partner or child is often particularly disruptive to individuals' identities and daily routines, (for example, disrupting daily activities, changing the familial division of labor, reducing income, or altering social roles).⁵⁷ Thus, different factors may be more relevant to adaptation after partner or child bereavement relative to other losses.

Strengths and Limitations

These results must be interpreted considering several limitations. Due to power constraints, the categories for relationship to the deceased were defined broadly, potentially hiding important heterogeneity in adjustment after bereavement that should be evaluated in future investigations. We did not have information on how long ago the death occurred beyond that it occurred in the nine months prior to the first assessment. Since acute grief and distress generally decline with increasing time since the death,³ there may be an association between text characteristics and prospective symptoms of anxiety and depression that only exists or is strongest within a given time window after bereavement. There are also potential confounders for which we did not have data, including the nature of the loss (expected versus unexpected), other secondary stressors participants might experience, and participants' closeness to the deceased. Relatedly, grief symptoms were not assessed directly, restricting any conclusions that can be made with respect to grief-specific syndromes or symptoms. Additionally, there were three opportunities for selection bias: enrolling in the substudy, responding to the bereavement items, and providing a comment. A comparison of all eligible NHS2 participants and those enrolled in the substudy found few differences except for an increased risk of previous depression,³⁶ and our comparison of commenters versus non-commenters indicated that they were largely similar. Nevertheless, since the sample examined here may be more vulnerable to mental health sequelae,^{58,59} future research replicating these findings in more representative samples is necessary.

Moreover, the relatively small range of possible scores on the PHQ-4 (0-12 points) and subscales (0-6 points) may have reduced our power to detect small effects. Indeed, the PHQ-4 consistently exhibits floor effects, indicating it may be less sensitive to variability in subclinical depression and anxiety symptoms.^{60,61} Relatedly, previous research suggest the PHQ-4 items may perform differently across age groups,⁶² although other investigations found no evidence for differential item functioning.^{61,63-65} However, our ability to identify statistically significant associations despite this limitation supports the strength of our results. Finally, the generalizability of these results is limited by the study's basis in an occupational cohort of primarily White, older, female registered nurses in the US. Future

research is necessary to understand if these findings are consistent across other demographic groups.

Conclusion and Future Directions

The present findings suggest that word count and emotional valence in short bereavement narratives are associated with symptoms of anxiety and depression after bereavement of a parent, grandparent, sibling, friend, or another relationship. Pending further research, automated analysis of linguistic characteristics in short texts (e.g., social media posts, comments, e-mails) may present avenues for early identification of bereaved individuals who may benefit from targeted preventive interventions. Additionally, although we could not determine causality, the observed association between higher word count and more negative sentiment when writing about a loss event and elevated symptoms of anxiety and depression 3- to 6-months later is consistent with existing theories.^{22-25,28,30-33} Further investigation is necessary to confirm observed associations and establish directionality.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments2:

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Data Availability Statement:

The authors do not have permission to publicly share data from the Nurses' Health Study II or COVID-19 substudy. The data from the Nurses' Health Study II is owned and managed by the Channing Division of Network Medicine at Brigham and Women's Hospital and Harvard University School of Medicine. The procedure for requesting access to the Nurses' Health Study II data is described at <https://nurseshealthstudy.org/researchers>.

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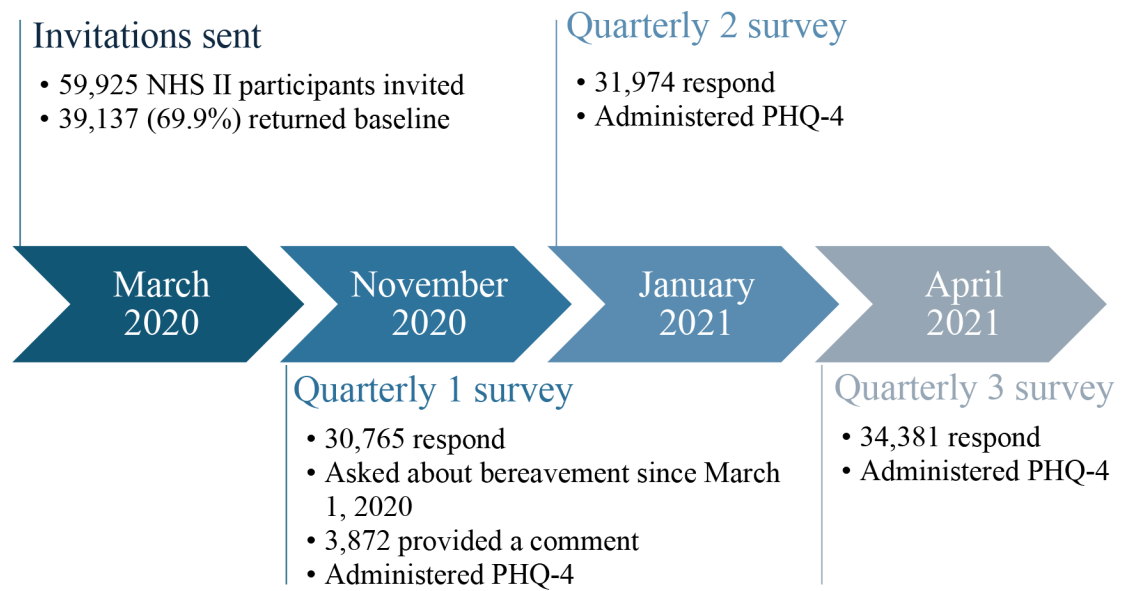


Figure 1.
Study Timeline

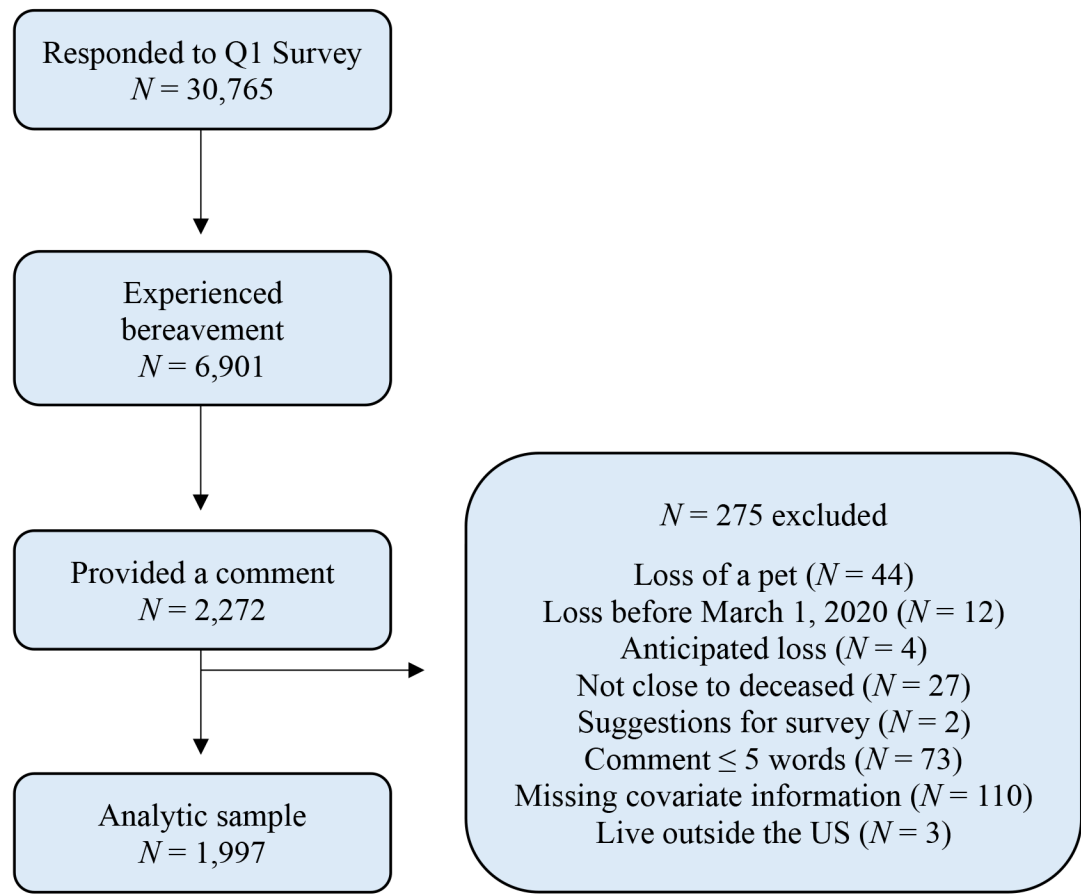


Figure 2.
Flowchart Illustrating Creation of Analytic Sample

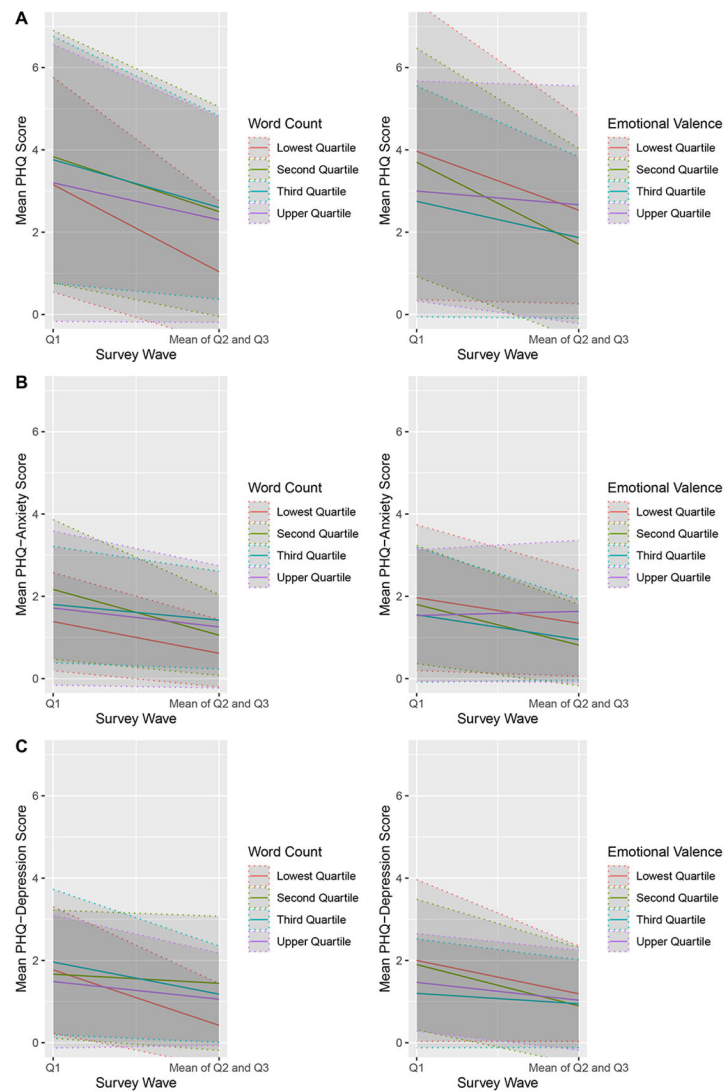


Figure 3.

Mean PHQ Total, Anxiety, and Depression Scores by Time and Textual Characteristics Among People Who Lost a Partner or Child ($N = 85$).

Women bereaved of a partner or child had, on average, higher PHQ-4 total and depression scores at the Quarterly 1 survey than women bereaved of a close other. Additionally, although a hypothesis test of the interaction term between continuous word count and time was non-significant among people bereaved of a partner or child, individuals in the lowest quartile of word count experienced, on average, a steeper decline in PHQ-4 total scores across follow-up relative to bereaved women in higher quartiles of word count.

A = PHQ-4 total score; B = PHQ-4 anxiety subscale score; C = PHQ-4 depression subscale score. For the emotional valence score, upper quartile refers to the most positive emotion and lowest quartile refers to the most negative emotion. Bands represent ± 1 standard deviation.

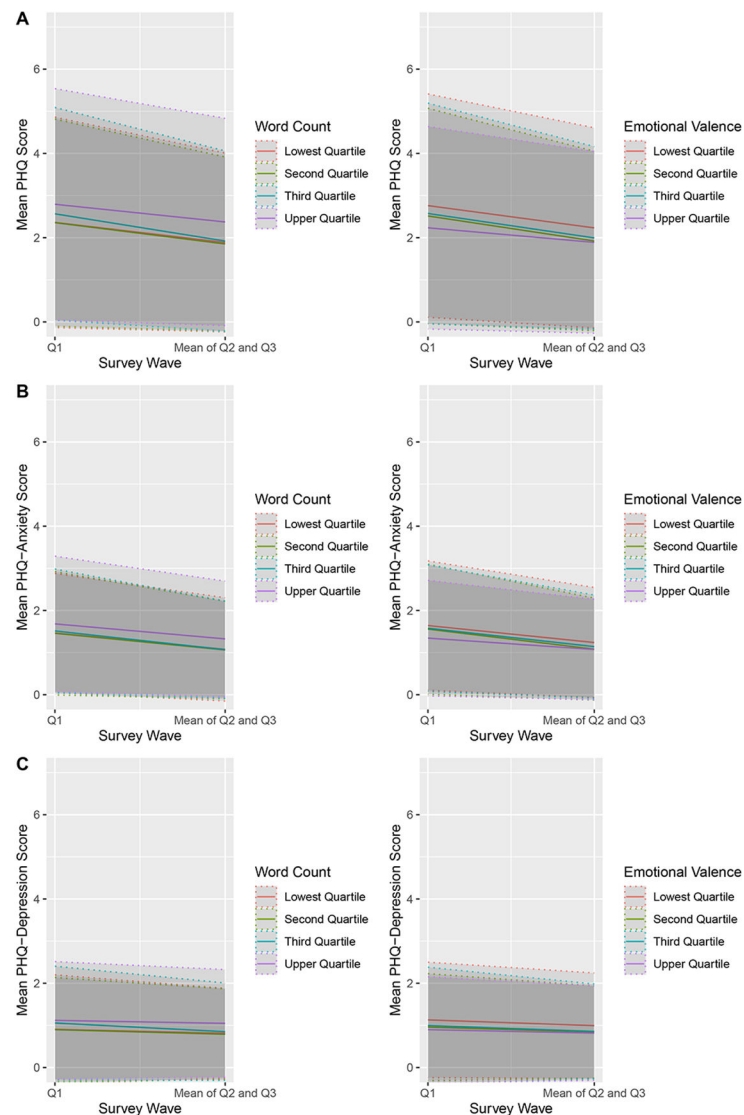


Figure 4. Mean PHQ Total, Anxiety, and Depression Scores by Time and Textual Characteristics Among People Who Lost a Parent, Grandparent, Sibling, Friend, or Another Relationship ($N = 1,912$).

Among women who lost a parent, grandparent, sibling, friend, neighbor, or another relationship, those in the highest quartile of word count reported higher PHQ-4 depression scores on the Quarterly 1 survey and 3- to 6-months later. Moreover, women whose writing expressed the most negative emotional valence (i.e., lowest quartile) reported higher PHQ-4 scores at the time of writing and 3- to 6-months later.

A = PHQ-4 total score; B = PHQ-4 anxiety subscale score; C = PHQ-4 depression subscale score. For the emotional valence score, upper quartile refers to the most positive emotion and lowest quartile refers to the most negative emotion. Bands represent ± 1 standard deviation.

Table 1.
Characteristics at First Quarterly Survey by Relationship to the Deceased

	Partner or Child (N = 85)	Parent, Sibling, or Grandparent (N = 585)	Friend (N = 454)	Another Relationship (N = 873)	Overall (N = 1997)
Age <i>M</i> (SD)	67.3 (4.3)	65.1 (4.4)	66.8 (4.4)	65.9 (4.3)	65.9 (4.4)
Non-Hispanic White <i>N</i> (%)	80 (94.1%)	556 (95.0%)	424 (93.4%)	826 (94.6%)	1886 (94.4%)
History of Diagnosed Depression <i>N</i> (%)	26 (30.6%)	176 (30.1%)	145 (31.9%)	261 (29.9%)	608 (30.4%)
Current Healthcare Worker <i>N</i> (%)	11 (12.9%)	156 (26.7%)	83 (18.3%)	194 (22.2%)	444 (22.2%)
COVID-19 Cause of Death <i>N</i> (%)	6 (7.1%)	73 (12.5%)	100 (22.0%)	187 (21.4%)	366 (18.3%)
Region of the US <i>N</i> (%)					
Northeast	30 (35.3%)	155 (26.5%)	131 (28.9%)	252 (28.9%)	568 (28.4%)
West	18 (21.2%)	95 (16.2%)	75 (16.5%)	160 (18.3%)	348 (17.4%)
South	18 (21.2%)	140 (23.9%)	118 (26.0%)	198 (22.7%)	474 (23.7%)
Midwest	19 (22.4%)	195 (33.3%)	130 (28.6%)	263 (30.1%)	607 (30.4%)
Median Household Income Median [Min, Max]	73,300 [30,900, 250,000]	76,200 [26,300, 250,000]	77,400 [8,080, 240,000]	78,600 [9,580, 250,000]	77,400 [8,080, 250,000]
2017 CES-D-10 Score <i>M</i> (SD)	5.92 (3.91)	6.01 (3.97)	6.08 (4.41)	5.99 (4.47)	6.01 (4.29)
2017 GAD-7 Score <i>M</i> (SD)	2.84 (3.25)	3.00 (3.25)	3.01 (3.34)	2.85 (3.20)	2.93 (3.25)
Q1 PHQ-4 Total Score <i>M</i> (SD)	3.45 (3.08)	2.65 (2.66)	2.59 (2.47)	2.39 (2.54)	2.56 (2.59)
Q1 PHQ-4 Anxiety Score <i>M</i> (SD)	1.75 (1.62)	1.57 (1.53)	1.57 (1.46)	1.48 (1.49)	1.54 (1.50)
Q1 PHQ-4 Depression Score <i>M</i> (SD)	1.69 (1.63)	1.08 (1.38)	1.02 (1.28)	0.92 (1.30)	1.02 (1.34)
Word Count Median [Min, Max]	46.0 [7.00, 266]	38.0 [6.00, 356]	24.0 [6.00, 567]	28.0 [6.00, 369]	30.0 [6.00, 567]
Emotional Valence <i>M</i> (SD)	-0.377 (0.558)	-0.282 (0.560)	-0.120 (0.555)	-0.349 (0.487)	-0.279 (0.535)

CES-D-10 = Center for Epidemiological Studies – Depression Scale; GAD-7 = Generalized Anxiety Disorder – 7; PHQ-4 = Patient Health Questionnaire – 4; Q1 = Quarterly 1 survey.

Table 2.

Results of Linear Models Evaluating Patient Health Questionnaire-4 Total and Subscale Scores at Baseline Stratified by Relationship to the Deceased

	ln(PHQ)		ln(PHQ-A)		ln(PHQ-D)	
	Minimally Adjusted	Fully Adjusted	Minimally Adjusted	Fully Adjusted	Minimally Adjusted	Fully Adjusted
	β [95% CI]		β [95% CI]		β [95% CI]	
Partner or Child (N = 85)						
Word Count	0.00 [-0.22, 0.21]	-0.06 [-0.27, 0.15]	0.01 [-0.21, 0.23]	-0.05 [-0.27, 0.17]	-0.03 [-0.24, 0.19]	-0.08 [-0.29, 0.12]
Semi-Partial R ²	0.000	0.004	0.000	0.002	0.001	0.009
Emotional Valence	-0.05 [-0.27, 0.16]	-0.07 [-0.29, 0.14]	-0.08 [-0.30, 0.13]	-0.14 [-0.36, 0.08]	-0.05 [-0.27, 0.16]	-0.05 [-0.26, 0.16]
Semi-Partial R ²	0.003	0.006	0.007	0.021	0.003	0.003
Close Other (N = 1,912)						
Word Count	0.08 [0.04, 0.13]	0.05 [0.01, 0.09]	0.07 [0.03, 0.12]	0.05 [0.01, 0.09]	0.07 [0.03, 0.12]	0.04 [0.00, 0.08]
Semi-Partial R ²	0.006	0.003	0.006	0.003	0.005	0.002
Emotional Valence	-0.08 [-0.13, -0.04]	-0.06 [-0.10, -0.02]	-0.08 [-0.12, -0.03]	-0.06 [-0.10, -0.02]	-0.07 [-0.12, -0.03]	-0.05 [-0.09, -0.01]
Semi-Partial R ²	0.007	0.004	0.006	0.004	0.005	0.003

Minimally adjusted models control for relationship to the deceased and age as of March 2020. Fully adjusted models additionally control for ever diagnosis of depression, pre-pandemic CES-D-10 and GAD-7 scores, White race, quartiles of median geolocated household income, region of the United States, binary indicator of COVID-19 cause of death, and binary indicator for being employed as a healthcare worker at the time of responding to the baseline survey. Note that, due to multiple comparisons, the confidence intervals presented here underrepresent the true uncertainty in conclusions drawn from these results.

PHQ = Patient Health Questionnaire-4; PHQ-A = Anxiety scale of Patient Health Questionnaire-4; PHQ-D = Depression scale of Patient Health Questionnaire-4; β = standardized regression coefficient; 95% CI = 95% confidence interval.

Table 3.

Results of Linear Mixed Effects Models Predicting Patient Health Questionnaire-4 Total Score and Subscale Scores Among People Who Lost a Spouse/Partner or Child ($N = 85$).

	ln(PHQ)			ln(PHQ-A)			ln(PHQ-D)		
	Minimally Adjusted	Fully Adjusted	Fully Adjusted + Time Interaction	Minimally Adjusted	Fully Adjusted	Fully Adjusted + Time Interaction	Minimally Adjusted	Fully Adjusted	Fully Adjusted + Time Interaction
	β [95% CI]			β [95% CI]			β [95% CI]		
Word Count	0.06 [-0.12, 0.24]	-0.02 [-0.17, 0.15]	-0.06 [-0.25, 0.13]	0.06 [-0.15, 0.28]	-0.01 [-0.19, 0.18]	-0.06 [-0.28, 0.15]	0.04 [-0.16, 0.25]	-0.04 [-0.19, 0.12]	-0.08 [-0.29, 0.12]
Semi-Partial R^2	0.004	0.000	0.002	0.004	0.000	0.002	0.001	0.002	0.004
Word Count x Time			0.11 [-0.10, 0.33]			0.12 [-0.10, 0.34]			0.09 [-0.19, 0.38]
Semi-Partial R^2			0.004			0.004			0.003
Emotional Valence	-0.03 [-0.21, 0.16]	-0.05 [-0.22, 0.11]	-0.09 [-0.28, 0.11]	-0.03 [-0.25, 0.18]	-0.05 [-0.24, 0.14]	-0.12 [-0.34, 0.10]	-0.03 [-0.23, 0.17]	-0.02 [-0.18, 0.14]	-0.06 [-0.27, 0.15]
Semi-Partial R^2	0.001	0.003	0.005	0.001	0.002	0.008	0.001	0.000	0.002
Emotional Valence x Time			0.06 [-0.15, 0.27]			0.14 [-0.09, 0.36]			0.06 [-0.22, 0.34]
Semi-Partial R^2			0.001			0.006			0.001

Minimally adjusted models control for age as of March 2020. Fully adjusted models additionally control for ever diagnosis of depression, pre-pandemic CES-D-10 and GAD-7 scores, White race, quartiles of median geolocated household income, region of the United States, binary indicator of COVID-19 cause of death, and binary indicator for being employed as a healthcare worker at the time of responding to the baseline survey. Note that, due to multiple comparisons, the confidence intervals presented here underrepresent the true uncertainty in conclusions drawn from these results.

PHQ = Patient Health Questionnaire-4; PHQ-A = Anxiety scale of Patient Health Questionnaire-4; PHQ-D = Depression scale of Patient Health Questionnaire-4; β = standardized regression coefficient; 95% CI = 95% confidence interval.

Table 4.

Results of Linear Mixed Effects Models Predicting Patient Health Questionnaire-4 Total Score and Subscale Scores Among People Who Lost a Parent, Grandparent, Sibling, Friend, or Close Other ($N = 1,912$)

	ln(PHQ)			ln(PHQ-A)			ln(PHQ-D)		
	Minimally Adjusted	Fully Adjusted	Fully Adjusted + Time Interaction	Minimally Adjusted	Fully Adjusted	Fully Adjusted + Time Interaction	Minimally Adjusted	Fully Adjusted	Fully Adjusted + Time Interaction
	β [95% CI]			β [95% CI]			β [95% CI]		
Word Count	0.09 [0.05, 0.13]	0.06 [0.02, 0.09]	0.05 [0.01, 0.09]	0.09 [0.04, 0.13]	0.05 [0.02, 0.09]	0.05 [0.01, 0.09]	0.09 [0.05, 0.14]	0.06 [0.03, 0.09]	0.06 [0.02, 0.10]
Semi-Partial R^2	0.011	0.005	0.002	0.009	0.004	0.002	0.012	0.007	0.003
Word Count x Time			0.02 [-0.02, 0.05]			0.01 [-0.03, 0.05]			0.00 [-0.04, 0.03]
Semi-Partial R^2			0.000			0.000			0.000
Emotional Valence	-0.07 [-0.11, -0.03]	-0.05 [-0.08, -0.01]	-0.06 [-0.10, -0.02]	-0.07 [-0.12, -0.02]	-0.04 [-0.08, 0.00]	-0.06 [-0.10, -0.02]	-0.07 [-0.12, -0.03]	-0.04 [-0.07, -0.01]	-0.05 [-0.09, -0.01]
Semi-Partial R^2	0.007	0.003	0.003	0.006	0.002	0.002	0.007	0.003	0.002
Emotional Valence x Time			0.02 [-0.01, 0.06]			0.03 [-0.01, 0.07]			0.02 [-0.02, 0.06]
Semi-Partial R^2			0.000			0.000			0.000

Minimally adjusted models control for relationship to the deceased and age as of March 2020. Fully adjusted models additionally control for ever diagnosis of depression, pre-pandemic CES-D-10 and GAD-7 scores, White race, quartiles of median geolocated household income, region of the United States, binary indicator of COVID-19 cause of death, and binary indicator for being employed as a healthcare worker at the time of responding to the baseline survey. Note that, due to multiple comparisons, the confidence intervals presented here underrepresent the true uncertainty in conclusions drawn from these results.

PHQ = Patient Health Questionnaire-4; PHQ-A = Anxiety scale of Patient Health Questionnaire-4; PHQ-D = Depression scale of Patient Health Questionnaire-4; β = standardized regression coefficient; 95% CI = 95% confidence interval.