Most PHQ-9 Responses Are Submitted During the Day, but Those Submitted Overnight Show Higher Depression Severity and Thoughts of Self-Harm Rates

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Key Findings:

- Most Patient Health Questionnaire-9 (PHQ-9) responses, which are primarily patient entered, were submitted during the day; submission volumes peaked mid-morning and were lowest overnight, with only about 2.5% of submissions between 11 p.m. and 5:59 a.m.
- The few surveys submitted overnight were frequently more severe: at the 2 a.m. hour, about 14.1% of surveys scored in the moderately severe or severe range; at the 6 a.m. hour, about 5.3% were.
- Positive responses to question 9 (thoughts of self-harm or being better off dead) were highest at the 2 a.m. hour (10.1% of responses). The positivity rate was lowest during the 6 a.m. hour (4.2%). Even so, nearly 97% of all positive responses to question 9 and 96% of severe-range responses were submitted during the day.

The Patient Health Questionnaire-9 (PHQ-9) is a nine-item questionnaire widely used to screen for and measure the severity of depression.[1] Patients are increasingly completing the questionnaires themselves through online patient portals like MyChart, which means responses can arrive at all hours rather than only during clinic visits. Previous research on mood and suicide has found that risk is not evenly distributed across the day. After accounting for how many people are awake at each hour, deaths by suicide are disproportionately concentrated overnight.[2] Being awake at night has been proposed as an independent risk factor for suicidal thoughts and behavior.[3] Patterns in PHQ-9 responses have not previously been well described. Understanding when patients disclose the most severe symptoms could help health systems time outreach, monitoring, and crisis-response resources.

We examined more than 600,000 PHQ-9 scores for U.S. patients aged 12 and older. Based on the questionnaire data assessed, we expect that the majority of surveys were completed by patients themselves in the patient portal, while some might have been entered by a clinician on their behalf. Each survey was assigned to the hour of day it was first submitted. Each PHQ-9 question is scored from 0 to 3, for a total of 0 to 27. A score of 15 or higher indicates moderately severe to severe depression, and question 9 asks specifically about thoughts of self-harm or being better off dead.

PHQ-9 surveys were overwhelmingly completed during the daytime. Submission volume climbed through the morning to a peak around the 9 a.m. hour and fell to its lowest overnight, with only about 2.5% of all surveys arriving overnight between 11 p.m. and 5:59 a.m., as seen in Figure 1. The small number of overnight surveys, however, skewed markedly toward higher severity. At the 2 a.m. hour, 14.1% of surveys reached the moderately severe to severe range (a score of 15 or higher), compared with 5.3% of surveys submitted at the 6 a.m. hour. While the data alone cannot account for the reasons for this, two possible explanations are that patients' symptoms might genuinely be worse at night, or that the small group who complete a questionnaire unprompted in the middle of the night might simply be more

distressed than the far-larger daytime population, many of whom are screened routinely during or prior to clinic visits.

Distribution of PHQ-9 Score Category by Hour of Submission

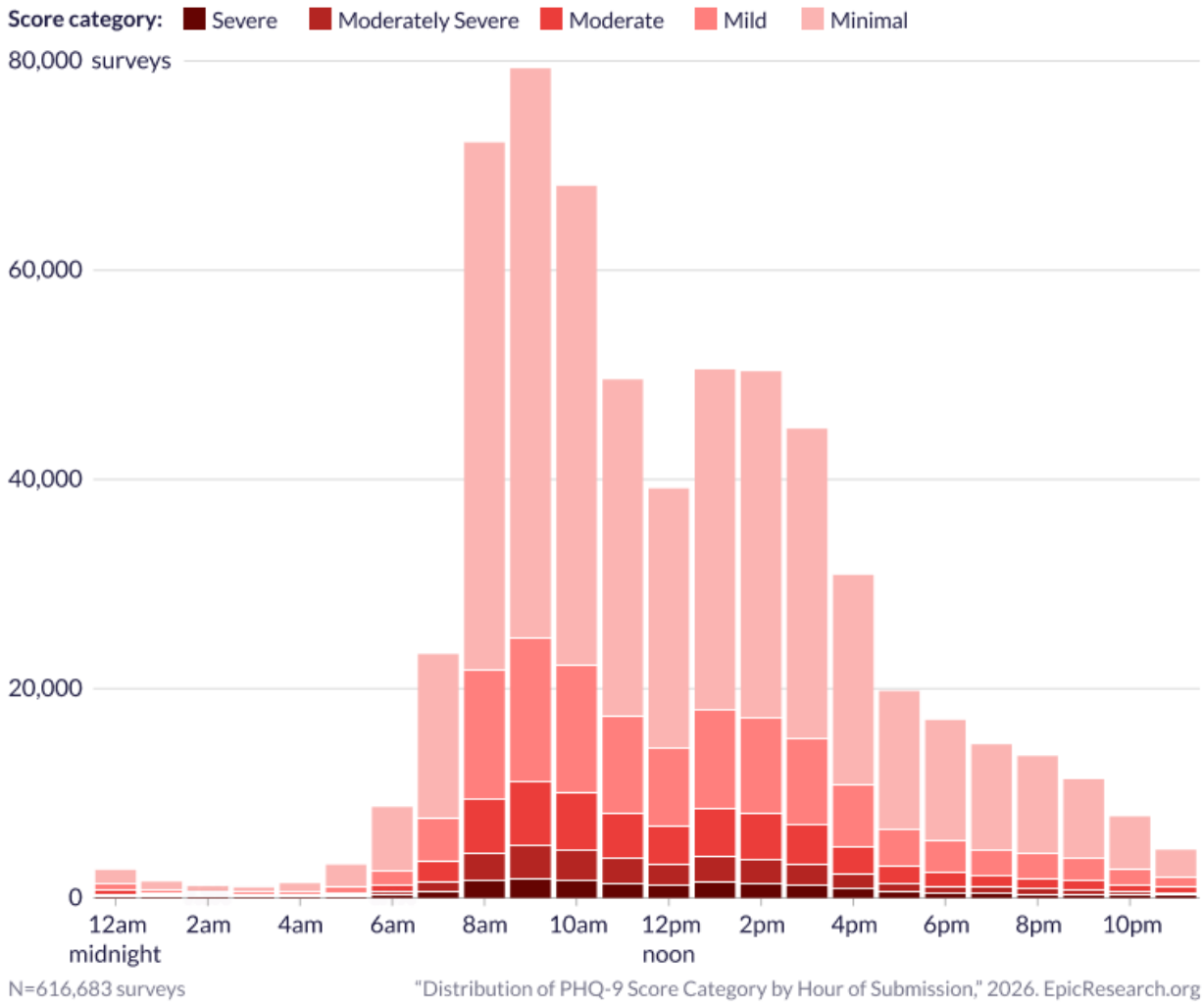

Figure 1a. The number of PHQ-9 responses by category and hour of submission.

Distribution of PHQ-9 Score Category by Hour of Submission

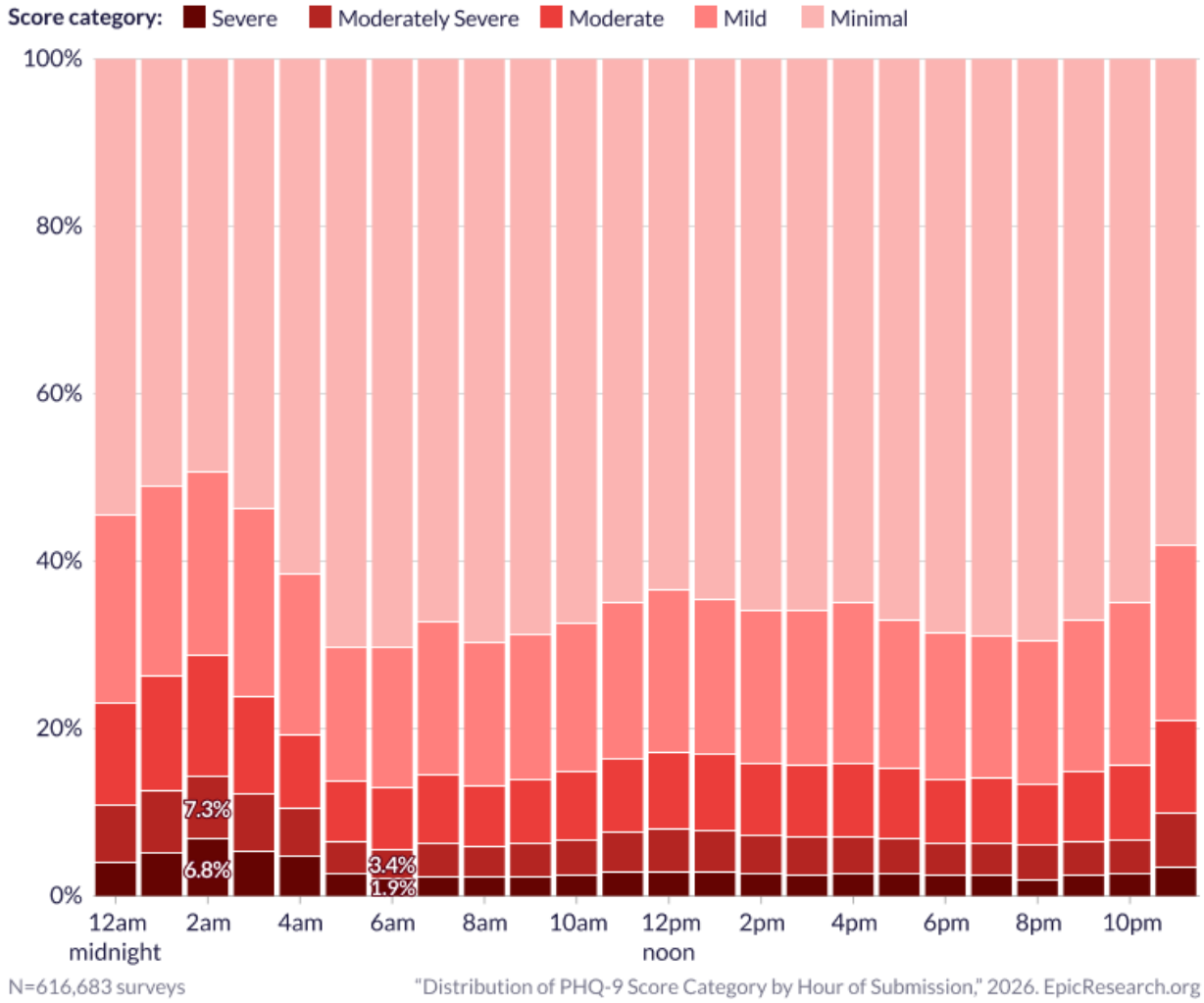

Figure 1b. The rate of PHQ-9 scores by category and hour of submission.

Question 9 of the PHQ-9 asks about thoughts of self-harm or being better off dead. Responses to this question followed the same daily pattern as severity above, with the share of surveys with a positive response more than twice as high at the 2 a.m. hour (10.1%) as at its lowest points around the 6 a.m. hour (about 4.2%), as seen in Figure 2. As with overall severity, the elevated overnight rate reflects only a small slice of the total: because so few surveys are submitted overnight, only about 3% of all positive question 9 responses arrived overnight (11 p.m. to 5:59 a.m.), while the remaining 97% came in during the day.

Surveys Indicating Thoughts of Self-Harm or Being Better Off Dead by Hour

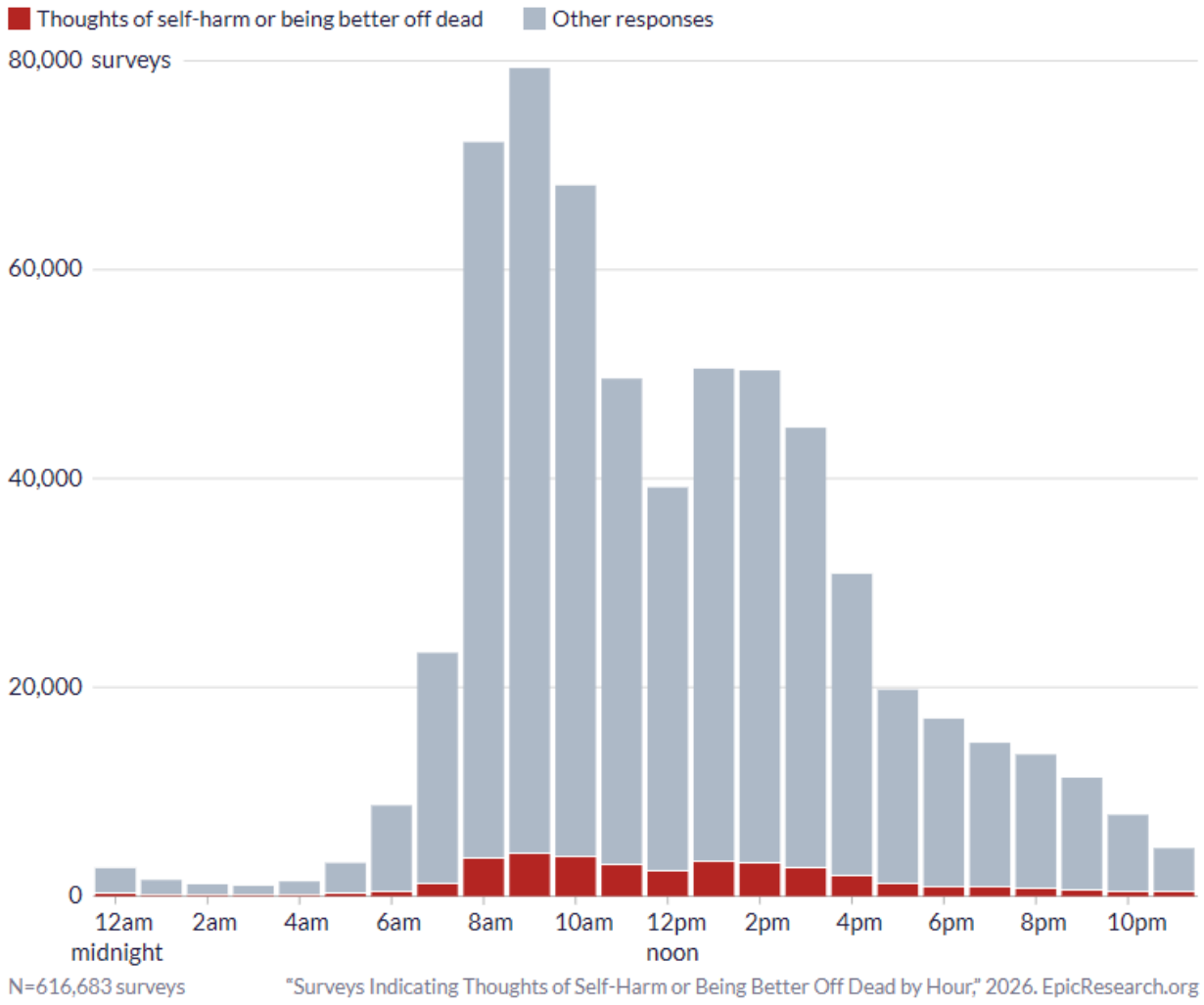

Figure 2a. The volume of PHQ-9s with a positive response to question 9 (thoughts of self-harm or being better off dead) by hour of submission.

Surveys Indicating Thoughts of Self-Harm or Being Better Off Dead by Hour

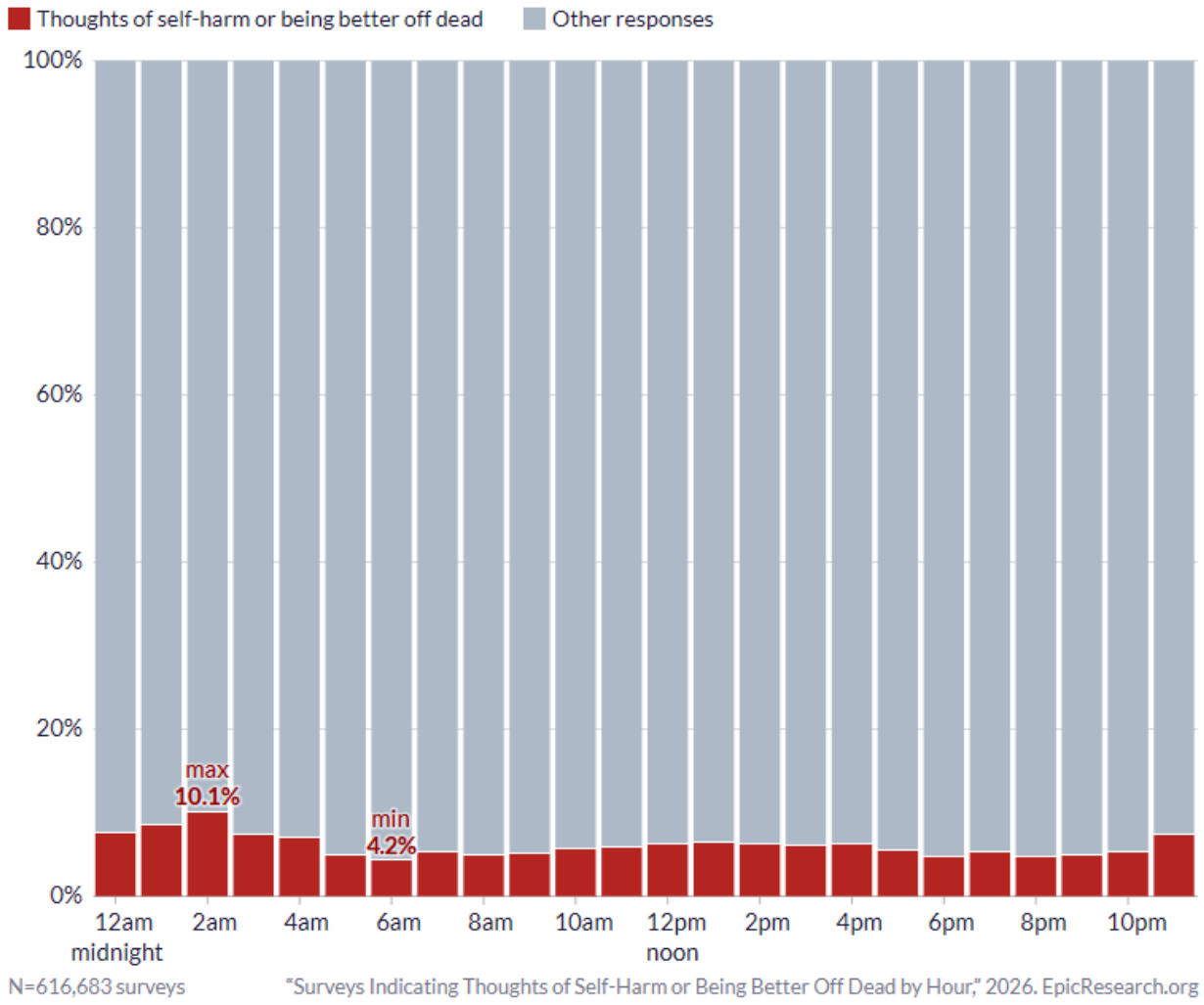

Figure 2b. The rate of PHQ-9s with a positive response to question 9 (thoughts of self-harm or being better off dead) by hour of submission.

These data come from Cosmos, a dataset created in collaboration with a community of Epic health systems representing more than 322 million patient records from 2,200 hospitals and more than 50,000 clinics from all 50 U.S. states, Canada, Lebanon, and Saudi Arabia. This study was completed by two teams that worked independently, each composed of a clinician and research scientist. The two teams came to similar conclusions. Graphics by Brian Olson.

References

1. Kroenke K, Spitzer RL, Williams JB. The PHQ-9: validity of a brief depression severity measure. J Gen Intern Med. 2001;16(9):606-613. doi:10.1046/j.1525-1497.2001.016009606.x
2. Perlis ML, Grandner MA, Brown GK, et al. Nocturnal Wakefulness as a Previously Unrecognized Risk Factor for Suicide. J Clin Psychiatry. 2016;77(6):e726-e733. doi:10.4088/JCP.15m10131
3. Tubbs AS, Perlis ML, Basner M, et al. Relationship of Nocturnal Wakefulness to Suicide Risk Across Months and Methods of Suicide. J Clin Psychiatry. 2020;81(2):19m12964. Published 2020 Feb 25. doi:10.4088/JCP.19m12964

Data Definitions

Term	Definition
Study period	1/1/2023 to 4/30/2026
Study population: inclusion	Patients: • Aged 12 or older at their first survey response • With the associated encounter department located in a U.S. state • With a completed PHQ-9 survey (either answers for all nine questions or answers of “Not at all” to the first two questions and no answers for the following seven)
Exposures	Local hour of survey submission (0–23), derived from the initial survey response in the department’s local time
Outcomes	Volume of PHQ-9 surveys entered by hour **PHQ-9 total score** by hour Rate of positive **PHQ-9 question 9** responses by hour
PHQ-9 question 9	A survey response to the item "Thoughts that you would be better off dead or of hurting yourself" indicating “Several days” or more
PHQ-9 total score	Sum of response values (0–3) for questions 1 through 9 on a single survey submission (range 0–27) or responses of 0 for questions 1 and 2 and the rest unanswered
Model specifications	Descriptive statistics Sensitivity analysis: We excluded surveys where only the first two questions were answered and found similar results. Additionally, those were a small proportion of the overall surveys in this study.
Limitations	Survey submissions were categorized by the associated encounter department’s time zone, which could differ from the patient’s time zone where they took the survey. The data cannot reliably distinguish surveys entered by patients through a portal from those documented by a clinician during a visit. PHQ-9 might be documented through other methods by a clinician during an encounter, such as flowsheet templates, within notes, or paper screenings that were not incorporated into this analysis.

Table 1. Population Characteristics

Survey Hour	0	1	2	3	4	5	6	7	8
Total	2,690	1,556	1,133	1,000	1,417	3,184	8,696	23,314	72,210
Sex Female	61%	63%	61%	61%	58%	59%	60%	61%	61%
Sex Male	34%	32%	33%	36%	39%	40%	39%	37%	37%
Sex Other	5%	5%	5%	3%	3%	2%	2%	2%	2%
Age 12 to 17	1%	1%	1%	1%	1%	2%	3%	6%	14%
Age 18 to 29	25%	29%	24%	20%	14%	11%	12%	15%	14%
Age 30 to 64	57%	56%	60%	61%	67%	69%	67%	62%	52%
Age 65 and Up	17%	14%	15%	18%	18%	18%	18%	18%	20%
Asian	7%	7%	5%	4%	4%	2%	3%	3%	3%
Black	10%	11%	10%	13%	9%	8%	6%	6%	7%
Hispanic	10%	9%	11%	9%	7%	5%	5%	6%	6%
SVI Q1	14%	12%	12%	16%	19%	22%	23%	21%	23%
SVI Q2	17%	17%	16%	14%	14%	16%	17%	19%	17%
SVI Q3	19%	18%	19%	18%	19%	19%	19%	19%	19%
SVI Q4	17%	17%	17%	16%	15%	14%	14%	15%	16%

SVI Q5	33%	35%	36%	35%	32%	28%	26%	25%	25%

Survey Hour	9	10	11	12	13	14	15	16
Total	79,304	68,065	49,567	39,146	50,518	50,350	44,863	30,873
Sex Female	59%	61%	61%	62%	60%	59%	58%	60%
Sex Male	38%	37%	36%	35%	37%	39%	39%	37%
Sex Other	3%	3%	3%	3%	3%	3%	3%	3%
Age 12 to 17	14%	13%	10%	6%	18%	25%	27%	12%
Age 18 to 29	15%	16%	18%	18%	18%	17%	16%	17%
Age 30 to 64	50%	48%	49%	53%	45%	41%	41%	50%
Age 65 and Up	21%	23%	24%	23%	19%	16%	16%	21%
Asian	3%	3%	3%	4%	3%	3%	3%	4%
Black	8%	8%	8%	7%	9%	9%	9%	7%
Hispanic	7%	7%	6%	7%	7%	7%	7%	7%
SVI Q1	21%	20%	20%	20%	21%	22%	23%	21%
SVI Q2	19%	19%	19%	18%	19%	19%	19%	19%
SVI Q3	18%	17%	18%	19%	18%	17%	17%	18%
SVI Q4	16%	17%	17%	16%	16%	16%	16%	16%
SVI Q5	26%	26%	25%	26%	26%	25%	25%	25%

Survey Hour	17	18	19	20	21	22	23
Total	19,788	17,003	14,692	13,575	11,347	7,791	4,601
Sex Female	60%	61%	62%	63%	64%	64%	63%
Sex Male	37%	36%	35%	34%	33%	33%	32%
Sex Other	3%	3%	2%	2%	3%	3%	5%
Age 12 to 17	6%	5%	4%	4%	3%	3%	2%
Age 18 to 29	15%	14%	14%	15%	18%	20%	24%
Age 30 to 64	54%	57%	58%	58%	59%	57%	55%
Age 65 and Up	24%	24%	24%	23%	20%	20%	19%
Asian	4%	3%	3%	4%	4%	6%	6%
Black	7%	7%	6%	5%	6%	7%	9%
Hispanic	6%	6%	6%	6%	7%	7%	9%
SVI Q1	21%	20%	23%	24%	22%	20%	16%
SVI Q2	18%	17%	18%	18%	18%	17%	18%
SVI Q3	19%	19%	19%	20%	19%	19%	20%
SVI Q4	16%	15%	15%	15%	15%	16%	16%
SVI Q5	25%	27%	24%	23%	24%	27%	29%

Table 2. Distribution of PHQ-9 Score Category by Hour of Submission Volumes

Survey Hour	Patient Surveys	PHQ-9 Minimal Risk	PHQ-9 Mild Risk	PHQ-9 Moderate Risk	PHQ-9 High Risk	PHQ-9 Severe Risk
0	2,690	1,467	608	325	186	104
1	1,556	795	352	215	116	78
2	1,133	560	248	165	83	77
3	1,000	538	224	118	68	52
4	1,417	873	272	124	83	65
5	3,184	2,240	513	230	120	81
6	8,696	6,116	1,456	655	300	169
7	23,314	15,715	4,244	1,892	948	515
8	72,210	50,424	12,341	5,213	2,685	1,547
9	79,304	54,585	13,728	6,076	3,118	1,797
10	68,065	45,918	12,095	5,549	2,914	1,589
11	49,567	32,266	9,254	4,359	2,347	1,341
12	39,146	24,855	7,586	3,626	1,965	1,114
13	50,518	32,662	9,341	4,656	2,424	1,435
14	50,350	33,207	9,195	4,350	2,270	1,328
15	44,863	29,636	8,291	3,830	2,006	1,100
16	30,873	20,099	5,931	2,676	1,344	823
17	19,788	13,277	3,519	1,647	826	519
18	17,003	11,660	2,984	1,301	666	392
19	14,692	10,157	2,472	1,145	574	344
20	13,575	9,457	2,323	989	551	255
21	11,347	7,619	2,055	943	463	267
22	7,791	5,073	1,506	701	315	196
23	4,601	2,680	957	517	293	154

Table 3. Distribution of PHQ-9 Score Category by Hour of Submission Percentages

Survey Hour	PHQ-9 Minimal Risk	PHQ-9 Mild Risk	PHQ-9 Moderate Risk	PHQ-9 High Risk	PHQ-9 Severe Risk
0	0.55	0.23	0.12	0.07	0.04
1	0.51	0.23	0.14	0.07	0.05
2	0.49	0.22	0.15	0.07	0.07
3	0.54	0.22	0.12	0.07	0.05
4	0.62	0.19	0.09	0.06	0.05
5	0.70	0.16	0.07	0.04	0.03
6	0.70	0.17	0.08	0.03	0.02
7	0.67	0.18	0.08	0.04	0.02
8	0.70	0.17	0.07	0.04	0.02
9	0.69	0.17	0.08	0.04	0.02
10	0.67	0.18	0.08	0.04	0.02
11	0.65	0.19	0.09	0.05	0.03
12	0.63	0.19	0.09	0.05	0.03
13	0.65	0.18	0.09	0.05	0.03
14	0.66	0.18	0.09	0.05	0.03
15	0.66	0.18	0.09	0.04	0.02
16	0.65	0.19	0.09	0.04	0.03
17	0.67	0.18	0.08	0.04	0.03

18	0.69	0.18	0.08	0.04	0.02
19	0.69	0.17	0.08	0.04	0.02
20	0.70	0.17	0.07	0.04	0.02
21	0.67	0.18	0.08	0.04	0.02
22	0.65	0.19	0.09	0.04	0.03
23	0.58	0.21	0.11	0.06	0.03

Table 4. Surveys Indicating Thoughts of Self-Harm or Being Better Off Dead by Hour

Survey Hour	Count	Thoughts of Self-harm or Being Better Off Dead
0	2,690	7.6%
1	1,556	8.5%
2	1,133	10.1%
3	1,000	7.4%
4	1,417	6.9%
5	3,184	4.8%
6	8,696	4.2%
7	23,314	5.2%
8	72,210	4.9%
9	79,304	5.1%
10	68,065	5.6%
11	49,567	5.9%
12	39,146	6.2%
13	50,518	6.4%
14	50,350	6.2%
15	44,863	6.0%
16	30,873	6.1%
17	19,788	5.4%
18	17,003	4.6%
19	14,692	5.3%
20	13,575	4.6%
21	11,347	4.9%
22	7,791	5.1%
23	4,601	7.3%