

# Impact of COVID-19 Pandemic on Migraine in Migraine Buddy Users

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## Research article

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# Abstract

**Background:** The nature of COVID-19 pandemic measures has altered the clinical management of migraine, and has also created barriers to evaluate the impact of such measures of migraine patients. Using the Migraine Buddy smartphone application, we assessed the impact of the COVID-19 pandemic on migraine in users residing in the United States.

**Methods:** Migraine Buddy is a smartphone application by individuals to record their migraine headache episodes, characteristics, and coping mechanisms. For this study, anonymized self-reported data from 163,176 adult Migraine Buddy users in the United States between January 2020 and May 2020, were analyzed for migraines associated with stress. A stress-related migraine is defined as one in which stress or anxiety was reported as a trigger or symptom. A questionnaire on the impact of COVID-19 on migraine and its management was also completed by 1,322 users in the app between April 2020 and May 2020.

**Results:** 88% of the Migraine Buddy database extract and 83% of the respondents are female, with a mean age of 36.2 years. The proportion of stress-related migraine attacks peaked at 50% on March 17, although the number of migraine attacks decreased. This followed the declaration of the COVID-19 national emergency on March 13 and a spike in the number of COVID-19 cases in the United States. Questionnaire respondents felt that the following added more stress: social isolation (22.6%), information overdose (21.2%), access to essentials (food, medication, etc.) (18.7%), and financial concerns (17.8%). To help manage migraine during COVID-19, respondents suggested stress and diet coaching programs and resources (medical articles, etc.) (34.0%), having the option for home delivery of medication (30.6%) and tele-consulting (25.5%).

**Conclusion:** Here, we report the change in the proportion of self-reported stress-related migraine in relation to evolution of the COVID-19 pandemic, as well as its impact of migraine management. Our data will help increase the understanding of patients' needs and help with planning and execution of mitigating strategies.

## Introduction

The World Health Organization declared COVID-19 a global pandemic on March 11, 2020. At the time of writing (December 30), there have been 19,432,125 confirmed cases and 337,419 deaths in the United States [1]. New York City went into lockdown on March 22, requiring residents to stay home. As of May 30, New York has been the virus' epicenter in the United States with 23,780 deaths and 368,234 cases [2]. Under such conditions, it is difficult to assess the impact of COVID-19 for migraine patients without face-to-face consultations.

With the recent developments in information technology, real-world big data studies have attracted increasing attention in the field of medicine. Obtaining clinical insights is an important part of the wider scope of real-world medical data, and its standardized use is critical for the generation of high-quality

real-world evidence to improve the core functioning and competitiveness of clinical care data as well as provide high-quality medical services for patients.

Migraine Buddy is the most widely used smartphone application by individuals worldwide to record their patterns of migraine headaches, characteristics (triggers, pain intensity, symptoms) and coping mechanisms (medication intake, relief methods) [3]. By tracking the migraine headaches over time, users and their headache specialists are able to better understand and manage the condition. Through the app, Migraine Buddy users can also provide real-time insights for research purposes by responding to surveys and working with the Healint data analytics platform to extract key aggregated findings. Using the Migraine Buddy app, this study aimed to assess impact of the COVID-19 pandemic on migraine in Migraine Buddy users residing in the United States.

## Methods

The study is a non-interventional, retrospective analysis of data that is self-reported via the Migraine Buddy smartphone application. Participants provided authorization for their data to be used for research, and deidentified data were used and analyzed for this study. Participants have the option to refuse to this condition and are able to use the app without any restriction if they choose to do so. As such, study subjects were not placed at risk by being included in the study sample, and the study was approved by the Institutional Ethics Committee at the Saitama Neuropsychiatric Institute (approval number: SNI 20 – 006).

A retrospective analysis was conducted using data captured through the free smartphone application Migraine Buddy. When self-reporting a migraine headache episodes, users are prompted to provide the following: attack duration, attack type, pain intensity, location of pain onset, medication taken and its effectiveness, relief methods, symptoms, aura and prodrome, affected activities, location when the attack occurred, along with weather and prior sleep patterns collected by the app..

For this study, anonymized self-reported data from 163,176 adult Migraine Buddy users in the United States over the 5-month period from January 1, 2020 through May 31, 2020 were extracted from the Migraine Buddy database. The variables examined included the following: demographic characteristics (age, gender), migraine frequency and triggers. Each migraine record represents a single migraine attack. A stress-related migraine is defined as one in which stress or anxiety were self-reported as a trigger or symptom. The stress-related migraine group includes individuals who reported at least 1 stress-related migraine in each calendar month of the study period. The change of Dow Jones Industrial Average (DJIA) and the number of new COVID-19 cases in the United States were used as reference indexes [1].

In addition, a questionnaire survey was sent to Migraine Buddy users and completed in the app between April 2020 and May 2020. The survey was designed by authors to obtain responses of the impact of COVID-19 on migraine and migraine management during this period.

# Results

## Study population

The study sample included 1,116,605 migraine records from 163,176 users. 83% of users were female, with a mean age of 36.2 years. A summary of demographics and migraine characteristics of the study population is shown in Table 1, 2. The stress-related migraine group had a higher proportion of women than the migraine group that did not reported stress-related migraine ( $p < 0.0001$ ). Although there were no difference in pain intensity and monthly headache days between the two groups, the usage rate of acute and preventive treatment was higher in stress-related migraine group than non- stress-related migraine group ( $p < 0.0001$ ).

Table 1  
Demographics and migraine information of users included in the study

	Overall ( <i>N</i> = 163,176)	Stress-related migraine ( <i>N</i> = 84,740)	Non stress-related migraine ( <i>N</i> = 78,436)	<i>p</i>
<b>Demographics</b>				
Age (years), mean (SD)	36.2 (12.6)	36.2 (12.4)	36.2 (12.9)	
Gender: number (%)				< 0.0001
Male	13,009 (12%)	6,770 (10%)	6,239 (14%)	
Female	95,512 (88%)	57,815 (90%)	37,697 (86%)	
Unknown	54,655	20,155	34,500	
<b>Migraine characteristics</b>				
Pain intensity, mean (SD)	5.4 (2.1)	5.4 (2.1)	5.5 (2.1)	
Monthly headache days, mean (SD)	5.3 (5.7)	5.7 (5.7)	4.6 (5.5)	

Table 2  
Migraine treatment of users included in the study

	<b>Overall (N= 163,176)</b>	<b>Stress-related migraine (N= 84,740)</b>	<b>Non stress-related migraine (N= 78,436)</b>	<b><i>p</i></b>
<b>Medical characteristics</b>				
Acute treatment (OTC)				
Total, number (% of subjects)	102,676 (63%)	62,325 (74%)	40,351 (48%)	< 0.0001
Ibuprofen, number (% of reported)	57,032 (56%)	36,163 (58%)	20,869 (52%)	
Acetaminophen, number (% of reported)	56,704 (55%)	36,164 (58%)	20,540 (51%)	
Naproxen, number (% of reported)	15,656 (15%)	10,370 (17%)	5,286 (13%)	
Acetylsalicylic acid, number (% of reported)	4,074 (4%)	2,690 (4%)	1,384 (3%)	
Ketorolac, number (% of reported)	3,684 (4%)	2,538 (4%)	1,146 (3%)	
Acute treatment (prescription)				
Total, number (% of subjects)	65,846 (40%)	42,056 (50%)	23,790 (28%)	< 0.0001
Sumatriptan, number (% of reported)	27,390 (42%)	17,684 (42%)	9,706 (41%)	
Rizatriptan, number (% of reported)	17,347 (26%)	11,150 (27%)	6,197 (26%)	
Ondansetron, number (% of reported)	5,474 (8%)	3,914 (9%)	1,560 (7%)	
Eletriptan, number (% of reported)	4,364 (7%)	2,847 (7%)	1,517 (6%)	
Zolmitriptan, number (% of reported)	4,349 (7%)	2,827 (7%)	1,522 (6%)	
Preventive treatment				
Total, number (% of subjects)	27,029 (16.6%)	17,993 (21%)	9,036 (11%)	< 0.0001
Topiramate, number (% of reported)	7,950 (29%)	4,980 (28%)	2,970 (33%)	

	Overall (N=163,176)	Stress-related migraine (N= 84,740)	Non stress-related migraine (N= 78,436)	<i>p</i>
Erenumab, number (% of reported)	3,721 (14%)	2,489 (14%)	1,232 (14%)	
Botox, number (% of reported)	2,532 (9%)	1,803 (10%)	729 (8%)	
Galcanezumab, number (% of reported)	2,250 (8%)	1,594 (9%)	656 (7%)	
Propranolol, number (% of reported)	1,899 (7%)	1,310 (7%)	589 (7%)	

## Recorded migraine attacks

Figure 1 shows the number of recorded migraine attacks in the United States from January 1, 2020 to May 31, 2020. The number of recorded migraine attacks and proportion of stress-related migraine follow a consistent pattern when there is a sharp decrease on Saturday and Sunday, followed by an increase on Monday. On March 13, 2020, a “national emergency” was declared due to the COVID-19 pandemic followed by a spike in the number of new cases of COVID-19 in the United States. The proportion of stress-related migraine attacks recorded in Migraine Buddy reached the peak value of 50% on March 17, although the number of recorded migraine attacks decreased. During this time, DJIA index decreased by 37% from 29,551 points on February 12 to 18,591 points on March 23. The number of recorded migraine attacks gradually increased after April, but the number did not reach the figure recorded in March. On the other hand, the proportion of stress-related migraine gradually decreased.

## Questionnaire survey

A total of 1,322 respondents completed the questionnaire survey. Of the respondents, 83% were female; 12% were aged 35 to 44 years, 10% were aged 25 to 34 years, and 10% were aged 45 to 54 years (Fig. 2–1).

57.5% of respondents reported an increase in migraine days, with 26.0% describing a major increase and 31.5% as slight increase (Fig. <link rid="fig2">2</link>–2). The migraine severity was reported to worsen compared to before the pandemic by 41.8% of respondents, with 12.8% describing this as significant and 29.0% as claiming a slight worsening (Fig. 2–3). Sources of stress were reported as follows: social isolation (22.6%), information overdose (21.2%), access to essentials (food, medication etc.) (18.7%) and financial concerns (17.8%) (Fig. 2–4). In terms of migraine management, more than half of responders (58.1%) experienced an interruption of medication, health/emergency services, and doctor consultations, with a quarter of responders (26.3%) experiencing difficulty in maintaining migraine-friendly diet (Fig. 2–5). According to the respondents, the most helpful way in managing migraine was having a coaching

program (stress management, diet etc.) and resources (medical articles etc.) (34.0%), followed by medication home delivery (30.6%) and tele-consulting with a health specialist (25.5%) (Fig. 2–6).

## Discussion

In the present study, we reported a clear increase in the proportion of stress-related migraine as the COVID-19 crisis deteriorated. We chose this metric to illustrate the changing patterns in migraine, as the number of recorded migraine attacks is affected by the number of active users in Migraine Buddy. In our questionnaire survey, 57.5% of respondents reported an increase in migraine frequency and 41.8% indicated worse severity during pandemic period. Hence, we argue that the COVID-19 pandemic has not only increased the proportion of stress-related migraine but also the migraine frequency and severity. Similar to our findings, an online survey conducted in Kuwait demonstrated that the majority of respondents had reported increase in migraine frequency and severity during pandemic period [4].

Stress is known as the most common trigger of migraine attacks [5]. COVID-19 pandemic, as a global health crisis, is perceived as a major stressful event. In a recent study from Spain, 41% of participants reported feeling moderate to severe stress and depressive symptoms during the pandemic, and 25% experienced mild to severe levels of anxiety [6]. Young women, who consisted the majority of respondents in our study, felt the strongest negative impact [6]. COVID Stress Scales [7], which are scales measuring COVID-related stress and anxiety symptoms, may offer promise as tools for better understanding patients with COVID stress-related migraine.

Next, information overdose was reported as the second most common source of stress during pandemic in our questionnaire survey, with another study demonstrating that attention paid to COVID-19 media coverage as a risk factor for psychological distress in migraineurs [8]. This suggests that migraineurs could avoid paying too much attention on the media coverage of the pandemic.

Most respondents experienced significant life changes during a short period of time. In the light of questionnaire survey, respondents had difficulty maintaining migraine-friendly diets, scheduling doctor consultations, and accessing health/emergency services. A recent study reported that disturbance of eating habits was one of the factors affecting increase migraine frequency and severity [4]. A recent survey of 155 countries conducted by the World Health Organization found that nearly half of the patients with noncommunicable diseases failed to receive their regular medical care and medications since COVID-19 pandemic began [9]. With the various lockdown measures and shifts in healthcare systems towards COVID-19, it is plausible that this has resulted in a shift in patient behaviour towards self-management and may have exacerbated migraine.

From our questionnaire, 13.5% of respondents reported in migraine frequency and 11.2% of respondents reported improvement of migraine severity during pandemic period. This could be explained by the reduction in work-related pressure as workplaces shift towards a working from home arrangement, and echoed by our observation that migraine records tend to decrease over the weekend. This is similar to a recent study from Italy that reported fewer migraine attacks and lesser pain [10]. The authors attributed

the findings to a reduction of trigger as a result of less work. Another recent study of Italian working women revealed that most of the additional housework and childcare associated with the COVID-19 pandemic were managed on not their partners but women [11]. Therefore, less office work attributed to COVID-19 pandemic may also be another trigger of migraine for women.

Interestingly, the ratio of stress-related migraine showed inverse correlation with the DJIA index. Rising fears and global economic shutdown due to the COVID-19 pandemic are believed to be main causes of the stock market crash [12]. During the study observation period, we observed that the bottom of the DJIA index overlaps with the peak of the ration stress-related migraine, suggestive that the stock market performance has an impact on stress-related migraine.

The ongoing threat of COVID-19, or other future pandemics, will require strategies for patients to better manage their migraine. The solutions identified by the survey respondents include coaching programs, medication home delivery and telemedicine consultation. Thus, it is a positive sign that organisations such as the American Migraine Foundation remain dedicated to providing support, education and comfort to those with migraine [13]. These resources will be benefits for patients managing migraine during these difficult times. Headache specialists should also consider taking steps to rapidly develop remote teleconsultation services. There is an urgent need to identify clinicians who are trained in telemedicine, expand existing remote consultation technologies with community hospitals and emergency departments and offer medication home delivery.

There are known limitations inherent to these real-world studies that rely on self-reported data from a smartphone app. First, there is potential bias as the study analyzed data reported by users, and no physician diagnosis is available to confirm a migraine diagnosis. However, the majority of respondents have reported the use of common migraine medication within the Migraine Buddy app.

Secondly, selection bias may arise owing to the requirement to have access to a mobile smartphone and comfort level in operating digital apps and, therefore, the population may not be entirely representative of the migraine population. Our respondents were unbalanced for sex and age, as the population to be young females. However, migraine is known to be more common in females, with the highest prevalence in the 20–50 age groups. Also, younger population usually constitutes the majority of smartphone app users.

Thirdly, being an observational study conducted via a smartphone app, the establishment of a direct causal relationship between migraine and COVID-19 pandemic can be difficult. Our goal is to present findings that can be representative of the real-world impact of COVID-19 on patients with migraine, given the rather large sample size. This will help increase the understanding of patients' needs, and help with the planning and executive of mitigating strategies.

During COVID-19 pandemic, the clinical management of migraine as well as mental health should not be neglected. The stress-related psychosocial impact of the pandemic is evident and complex. Migraine attacks can be associated with a decline in perceived stress [14]. It is plausible to experience an increase

in migraine cases once the COVID-19 pandemic situation has stabilized. Long-term follow-up data are necessary and smartphone apps like the Migraine Buddy can play a big role in monitoring changes in migraine management. In future, the analysis of information about the body, collected via wearables, together with self-reported data entered into the migraine diary, can be performed by artificial intelligence to provide migraine patients with feedback to optimize their migraine management.

## **Conclusion**

Here, we leveraged the Migraine Buddy smartphone app to query and report the change in the proportion of self-reported stress-related migraine as the COVID-19 pandemic evolves, as well as its impact of migraine management. From these responses, we propose that headache specialists continue to develop appropriate strategies to help patients manage migraine and mental health. Our data will help increase the understanding of patients' needs and help in the planning and execution of such mitigating strategies.

## **Abbreviations**

DJIA, Dow Jones Industrial Average

## **Declarations**

### **Authors' contribution**

WP had the original idea for the study, and planned the overall design. YK wrote the initial draft. WP and ZH were responsible for data acquisition. YK, WP and TS were responsible for analysis of the result. WP, ZH, FC, TS and YM critically reviewed the initial manuscript. The authors have read, revised and approved the final manuscript.

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This study received no funds.

### **Availability of data and materials**

The data generated for this study are available on request to the corresponding author.

### **Ethics approval and consent to participate**

This study was approved by the Institutional Ethics Committee at the Saitama Neuropsychiatric Institute (approval number: SNI 20-006).

## Consent of publication

Not applicable.

## Competing interests

The authors declare that they have no conflicts of interest.

## Conflict of interest

None

## References

1. Centers for Disease Control and Prevention. [online]. Available at: [https://covid.cdc.gov/covid-data-tracker/#trends\\_dailytrendscases](https://covid.cdc.gov/covid-data-tracker/#trends_dailytrendscases)
2. Pix11. [online]. Available at: <https://www.pix11.com/news/coronavirus/latest-coronavirus-updates-in-new-york-saturday-may-30-2020>
3. Vo P, Paris N, Bilitou A, Valena T, Fang J, Naujoks C, Cameron A, de Reydet de Vulpillieres F, Cadiou F. Burden of migraine in Europe using self-reported digital diary data from the Migraine Buddy© application. *Neurol Ther* 2018; 7: 321-332.
4. Al-Hashel JY, Ismail II. Impact of coronavirus disease 2019 (COVID-19) pandemic on patients with migraine: a web-based survey study. *J Headache Pain* 2020;21:115.
5. Sauro KM, Becker WJ. The stress and migraine interaction. *Headache* 2009;49:1378-86.
6. Rodríguez-Rey R, Garrido-Hernansaiz H, Collado S. Psychological Impact and Associated Factors During the Initial Stage of the Coronavirus (COVID-19) Pandemic Among the General Population in Spain. *Front Psychol* 2020;11:1540.
7. Taylor S, Landry CA, Paluszczek MM, Fergus TA, McKay D, Asmundson GJG. Development and initial validation of the COVID Stress Scales. *J Anxiety Disord* 2020;72:102232.
8. Ma M, Fang J, Li C, Bao J, Zhang Y, Chen N, Guo J, He L. The status and high risk factors of severe psychological distress in migraine patients during nCOV-2019 outbreak in Southwest China: a cross-sectional study. *J Headache Pain* 2020;21:100.
9. World Health Organization (2020) Preliminary results: rapid assessment of service delivery for noncommunicable diseases during the COVID-19 pandemic <https://www.who.int/who-documents-detail/rapid-assessment-of-service-delivery-for-ncds-during-the-covid-19-pandemic>
10. Parodi IC, Poeta MG, Assini A, Schirinzi E, Del Sette P. Impact of quarantine due to COVID infection on migraine: a survey in Genova, Italy. *Neurol Sci* 2020;41:2025-2027.
11. Del Boca D, Oggero N, Profeta P, Rossi M. Women's and men's work, housework and childcare, before and during COVID-19. *Rev Econ Househ* 2020;18:1001-1017.

12. Time. A Market Crash Was Coming, Coronavirus Was Just the Spark [online]. Available at: <https://time.com/5793506/a-stock-market-crash-was-coming-coronavirus-was-just-the-spark>
13. American Migraine Foundation. Managing Migraine During COVID-19. Available at: <https://americanmigrainefoundation.org/covid-19-resources/>
14. Lipton RB, Buse DC, Hall CB, Tennen H, Defreitas TA, Borkowski TM, Grosberg BM, Haut SR. Reduction in perceived stress as a migraine trigger: testing the "let-down headache" hypothesis. *Neurology* 2014;82:1395-1401.

## Figures

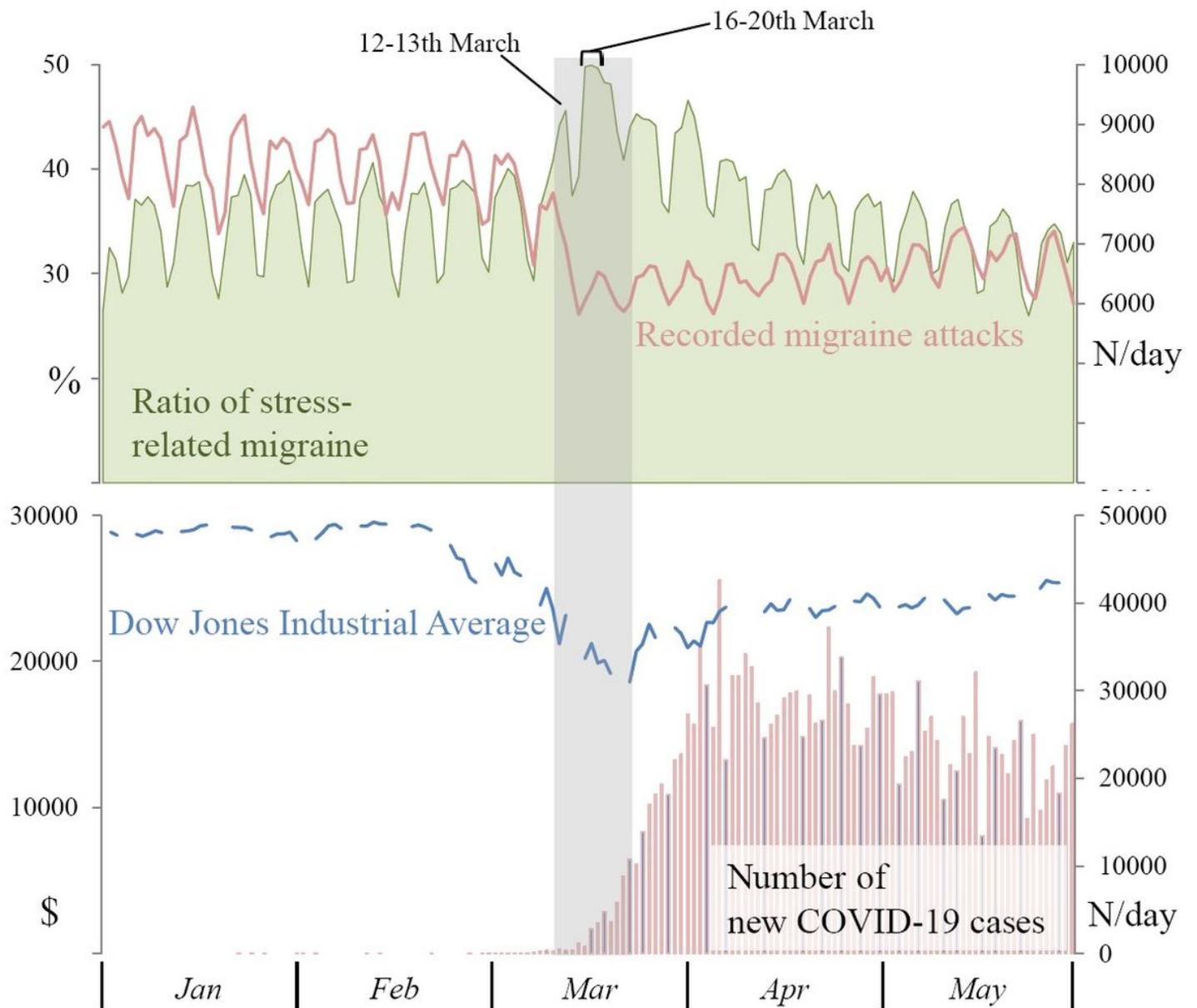
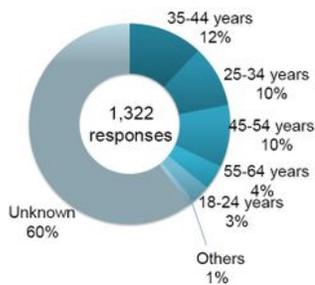


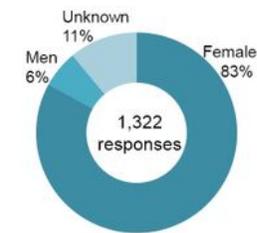
Figure 1

The graph shows trend about number of recorded migraine attacks, the ratio of stress-related migraine, Dow Jones Industrial Average and the number of new COVID-19 cases over time. The ratio of stress-related migraine reached the peak value of 50% on March 17, though the number of recorded migraine attacks decreased. During this time, Dow Jones Industrial Average index decreased sharply.

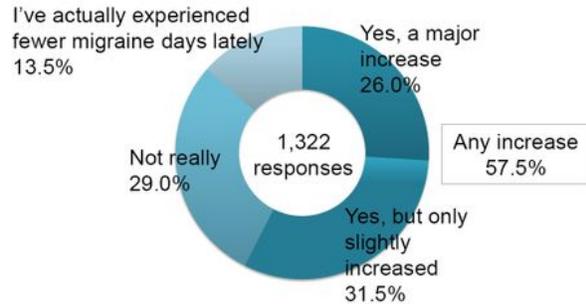
Age distribution of respondents



Gender distribution of respondents



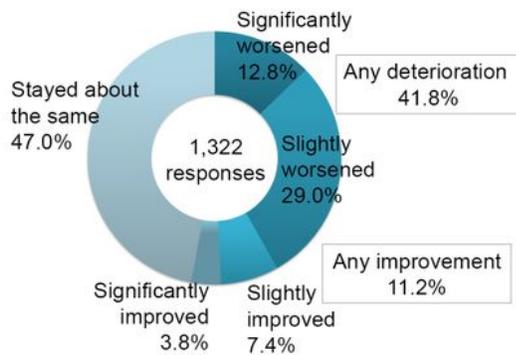
Have you noticed an increase in migraine days during the ongoing situation?



2-1

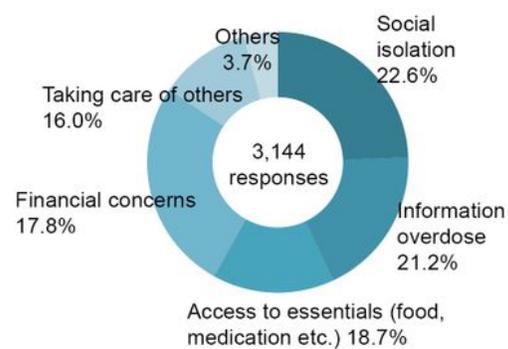
2-2

Do you feel like your migraines have worsened in severity during the COVID-19 situation compared to before?



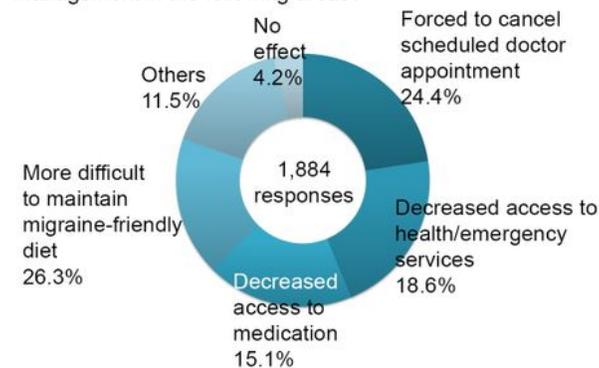
2-3

Which of the following have been an added source of stress during the ongoing situation?



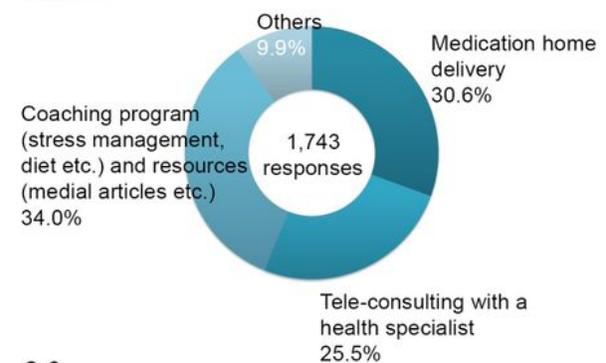
2-4

Has the ongoing COVID-19 situation affected your migraine management in the following areas?



2-5

Which of the following would be the most helpful to you in terms of dealing with your migraine during the ongoing situation?



2-6

Figure 2

Results of questionnaire survey