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## ORIGINAL ARTICLE

# Impact of the COVID-19 pandemic on medical genetics and genomics training: Perspective from clinical trainees

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**Abstract**

We sought to understand how the coronavirus disease 2019 (COVID-19) pandemic has affected the well-being, clinical training, and medical education for clinical trainees in medical genetics and genomics residency and fellowship programs. All clinical genetics trainees in the Accreditation Council for Graduate Medical Education (ACGME)-accredited training programs were invited to complete a survey. 31 out of 174 trainees completed the survey. With regards to well-being, 18 trainees reported increased anxiety, 10 had increased depression, 3 increased financial strain, 13 worsening work-life balance, and 13 worsening physical health. There was increased telehealth utilization in both outpatient (3% before the pandemic vs. 67% during the pandemic) and inpatient clinical encounters (0% vs. 29%). The most commonly reported challenges in telehealth use were inadequate physical examination and technical problems during visits. Twenty trainees believed that the pandemic has negatively impacted overall clinical training while none reported a positive impact. We concluded that the COVID-19 pandemic has negatively impacted most clinical genetics trainees in ACGME-accredited training programs. Telehealth has been increasingly used with some challenges. Further studies are needed on how to optimally integrate what we have learned into the training of medical genetics and genomics in the post-pandemic era.

**KEYWORDS**

COVID-19, genetic education, medical genetics and genomics residency, well-being

## 1 | INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic has had an abrupt and unprecedented impact on healthcare systems and graduate medical education. Residency and fellowship training programs have faced unique challenges pertaining to ensuring the safety and well-being of trainee physicians, while optimizing learning as conventional educational approaches were confronted with disruptions to clinical service and canceled in-person activities. Several surveys of medical trainees have demonstrated that the pandemic has adversely affected training; findings include worsened quality of life and work-

life balance (Li et al., 2020; Pivert et al., 2021), an increase in reported stress, anxiety, burnout, and/or depression (Alhasan et al., 2021; Cravero et al., 2020; Khan et al., 2021; Khusid et al., 2020; Rana et al., 2020; Sanghavi et al., 2020; Zoorob et al., 2021), a decline in operative and procedural volume (Khan et al., 2021; Khusid et al., 2020; Rana et al., 2020; Zoia et al., 2020), increased work hours (Cravero et al., 2020), growing concerns over professional development and career goals (Cravero et al., 2020), and an overall negative impact on clinical education (Alhasan et al., 2021; Li et al., 2020; Rana et al., 2020).

The field of medical genetics and genomics has also been impacted. Many of our patients are at risk for significant illness as a result of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)

Anne Slavotinek and Allison Tam contributed equally to this work.

infection. Globally, clinical services and research for patients with genetic disorders have decreased (Chowdhury et al., 2021; Elmonem et al., 2020). It also has changed how patient care is delivered, as demonstrated by reported experiences from two institutions on the rapid implementation of a division-wide telehealth care model, for both inpatient and outpatient services (Pereira et al., 2020; Shur et al., 2021). This model has proved to be sustainable, effective, and increased patient's access to medical genetics professionals. Given different challenges and related adaptations due to the pandemic in the field of medical genetics and genomics, it can also be assumed that medical genetics training would be impacted. To better understand the perspectives of medical genetics clinical trainees on their well-being, clinical training and medical education during the COVID-19 pandemic, we surveyed clinical trainees in the medical genetics and genomics residency and fellowship programs.

## 2 | METHODS

### 2.1 | Study design

The study obtained exempt status from the University of California, San Francisco Institutional Review Board. All 174 clinical trainees in the Accreditation Council for Graduate Medical Education (ACGME)-accredited medical genetics and genomics residencies, and medical biochemical genetic subspecialty fellowship programs were invited to complete an anonymous, voluntary, 30-question online survey via the HIPAA-compliant Research Electronic Data Capture (REDCap) system. We contacted the American Board of Medical Genetics and Genomics who agreed to send the link to the survey to all current clinical trainees, including 159 medical genetics and genomics residents and 15 medical biochemical genetics fellows. The survey link was sent twice via e-mail, 1 month apart, and was available from March 22, 2021 to April 30, 2021. Implied informed consent was obtained from participants who voluntarily completed the survey and submitted their responses.

The survey inquired about the following aspects (see Text in Supporting Information): participant's demographic information; personal history and risk of COVID-19; institution's response to the pandemic; personal well-being; clinical training, including telehealth use; and education and research. It utilized a range of question types that comprised single-answer, multiple-answer, rating scales for percentage of time spent on telehealth in both inpatient and outpatient settings, and Likert scales graded on a 1–5 scale, ranging from “strongly agree” to “strongly disagree.” There were five Likert scale questions regarding well-being and four Likert scale questions regarding education and research. Participants were also asked to provide free text describing the impact of the COVID-19 pandemic on their medical genetics training.

### 2.2 | Data analysis

Descriptive statistics, including percentages for categorical variables and means with standard deviations for continuous variables, were used to present all responses. We then assessed whether participant's

characteristics, personal history and risk of COVID-19, and/or perceived institution's response to the pandemic had impacted their well-being. Given that there were few responses for each item in Likert scale questions on well-being, we categorized the responses into Yes (top 2 box, if the responses were “strongly agree” and “agree”) and No (bottom 2 box, if the responses were “strongly disagree” or “disagree”) answers, and calculated a Fisher's exact test (for categorical variables) and unpaired *t*-test (for age) to evaluate differences of the top 2 box percentages between two groups. Paired *t*-test was used to compare percentages of telehealth utilization before and during the pandemic. The analyses were performed by the IBM SPSS Statistical Software Package (version 20). A *p*-value of 0.05 or less was considered statistically significant and all tests were bidirectional. Qualitative free text responses were analyzed thematically by previously described methods (Braun & Clarke, 2006). We generated initial codes relevant to the impact of the pandemic on trainees. Themes then were developed from the codes with codes separated, combined, and refined to form overarching themes.

## 3 | RESULTS

### 3.1 | Cohort characteristics

A total of 31 out of 174 clinical trainees returned the survey, corresponding to a response rate of 18%. Table 1 outlines participants' characteristics, personal history and risk of COVID-19, and institution's response to the pandemic. The mean age of survey participants was  $33.5 \pm 4.8$  years and 17 participants (55%) were female. Among all trainees who received the survey but did not necessarily complete it, the mean age was 33.9 years and 90 (52%) were female. Three trainees had been diagnosed with COVID-19 and eight trainees had evaluated SARS-CoV-2-positive patients in-person during their genetics rotations. None was redeployed to another service to work with COVID-19 patients. When inquiring whether trainees have appropriate access to COVID-19 testing if necessary, one trainee answered “strongly disagree.” There were three trainees who disagreed with the statement “There is additional help and support for trainees in need (e.g., medical and mental health, housing, travel, food) from your hospital and training program during the pandemic.”

### 3.2 | Impact on well-being and potential associated factors

Figure 1a illustrates trainees' answers from five 5-point Likert scale questions regarding well-being. By combining the answers “strongly agree” and “agree,” 18/31 (58%), trainees reported increased anxiety, 10/31 (32%) had increased depression, 3/31 (10%) described increased financial strain, 13/31 (42%) noted worsening work-life balance, and 13/31 (42%) perceived worsening physical health. Assessment of the potential factors associated with unfavorable well-being outcomes (see Table S1) demonstrated that trainees with children suffered more financial strain (3/7 [43%] in with-children group vs. 0/14

**TABLE 1** Participants' characteristics, personal history and risk of COVID-19, and perception of the pandemic at the participant's institution ( $n = 31$ )

Participants' characteristics	
Median age (years $\pm$ standard deviation)	33.5 $\pm$ 4.8
Male	14 (45.2%)
Training program <sup>a</sup>	
Categorical medical genetics	13 (41.9%)
Internal medicine/medical genetics	2 (6.5%)
Maternal fetal medicine/medical genetics	3 (9.7%)
Pediatrics/medical genetics	10 (32.3%)
Medical biochemical genetics	3 (9.7%)
Post-graduate year (PGY) <sup>a</sup>	
PGY-1	3 (9.7%)
PGY-2	4 (12.9%)
PGY-3	7 (22.6%)
PGY-4	4 (12.9%)
PGY-5	7 (22.6%)
Higher than PGY-5	6 (19.4%)
International medical graduate <sup>a</sup>	6 (19.4%)
Have children	
Live alone	10 (32.3%)
Personal history and risk of COVID-19	
Had a personal history of COVID-19	3 (9.7%)
Was redeployed to treat COVID-19 patients	0
Evaluated COVID-19 patients in-person during genetic rotation	8/29 (27.6%)
Perception and response to the pandemic at the participant's institution <sup>b</sup>	
The local severity is more severe than national average	8 (25.8%)
Personal protective equipment (PPE) is adequate	30 (96.8%)
COVID-19 testing is adequate	30 (96.8%)
There is additional help and support from the training program	22 (71.0%)

<sup>a</sup>The total numbers of surveyed participants in each training programs, each post-graduate year, and that of international medical graduate are not available.

<sup>b</sup>The numbers represent the top-2-box percentage scores from the 5-point Likert scale.

[0%] in without-children group,  $p = 0.026$ ) but less depression (1/9 [11%] in with-children group vs. 9/16 [52%] in without-children group,  $p = 0.040$ ). Junior residents (Post-Graduate Year, PGY1-3) reported a greater increase in depression than senior residents (PGY  $\geq 4$ ; 7/11 [64%] vs. 3/14 [21%], respectively,  $p = 0.049$ ).

### 3.3 | Impact on clinical training, education, and research

There was an increase in telehealth utilization in outpatient encounters from a mean of 3% (range 0%–25%) pre-pandemic to 67% (range

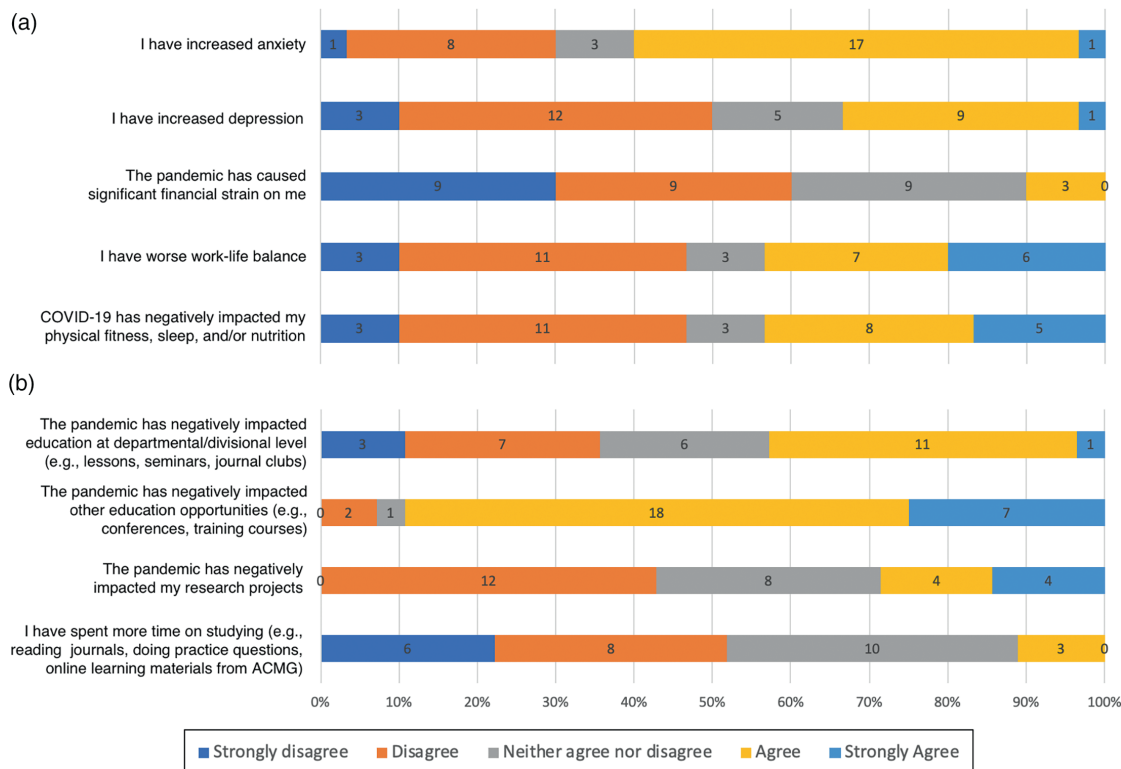
15%–100%) during the pandemic ( $p < 0.001$ ). An increase in telehealth utilization in inpatient encounters from 0% pre-pandemic to 29% during the pandemic (range 0%–90%) was independently noted ( $p < 0.001$ ). Reported challenges in telehealth are shown in Figure 2. The most commonly reported challenges included an inability to do an adequate physical examination ( $n = 26$ ), technical problems during visits ( $n = 25$ ), and limited availability to only patients with internet access ( $n = 20$ ). Despite these drawbacks, eight trainees wanted to continue the same amount of telehealth as part of clinical training after the pandemic (Figure 3a). Fifteen trainees believed that the COVID-19 pandemic has negatively impacted overall clinical training but the experience could be made up in the future, whereas five trainees answered that the experience could not be made up. None of the trainees reported a positive impact of the pandemic (Figure 3b). Figure 1b illustrates trainees' answers regarding education and research. Twelve and 25 trainees agreed that the pandemic had negatively impacted their education at the departmental/divisional level, and other education opportunities (such as conferences), respectively.

### 3.4 | Thematic analysis of free text

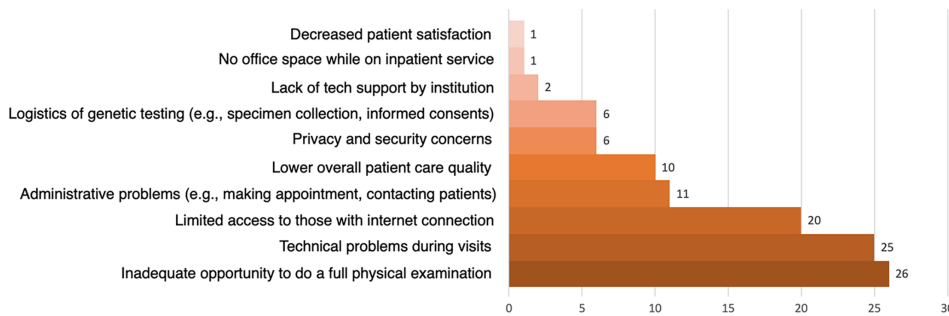
Thirteen trainees responded to a free text question at the end of the survey. The results of the thematic analysis are provided in Table 2. The most frequent theme identified was trainees' description of how the pandemic has negatively impacted their education and research activity ( $n = 5$ ).

## 4 | DISCUSSION

To our knowledge, this is the first formal evaluation of the COVID-19 pandemic's impact on medical genetics residency and fellowship programs. Additionally, our study provides insights on telehealth utilization and well-being of medical genetics trainees, topics that have not been explored. The results of this study highlight that clinical genetics trainees perceived an overall negative impact of the pandemic on every domain surveyed, and that there was a significant increase in telehealth utilization in both inpatient and outpatient settings. Our results indicated three factors associated with poorer well-being outcomes. First, having children was associated with higher financial strain ( $p = 0.026$ ). This has previously been suggested to be related to an increased burden and anxiety regarding finding childcare (Bayham & Fenichel, 2020; Rana et al., 2020). Second, not having children, on the other hand, was associated with increased depression ( $p = 0.040$ ). Together with the observation that those who lived alone were more depressed ( $p = 0.075$ ), we hypothesize that social isolation could have negatively impacted trainees' mental health. A survey conducted prior to the pandemic revealed that loneliness, which correlated with depression, burnout, and fatigue, was common among physicians (Ofei-Dodoo et al., 2021). The thematic analysis additionally identified the negative impact the pandemic has had on socializing and networking. Even though social distancing is a crucial measure for dampening the spread of the virus, its profound impact on trainee's



**FIGURE 1** Perspectives of trainees on the impact of COVID-19 pandemic on their well-being (a) and education and research (b) ranked on a 5-point scale. Participants were asked to choose one of the following: Strongly agree, agree, neither agree nor disagree, disagree, or strongly disagree



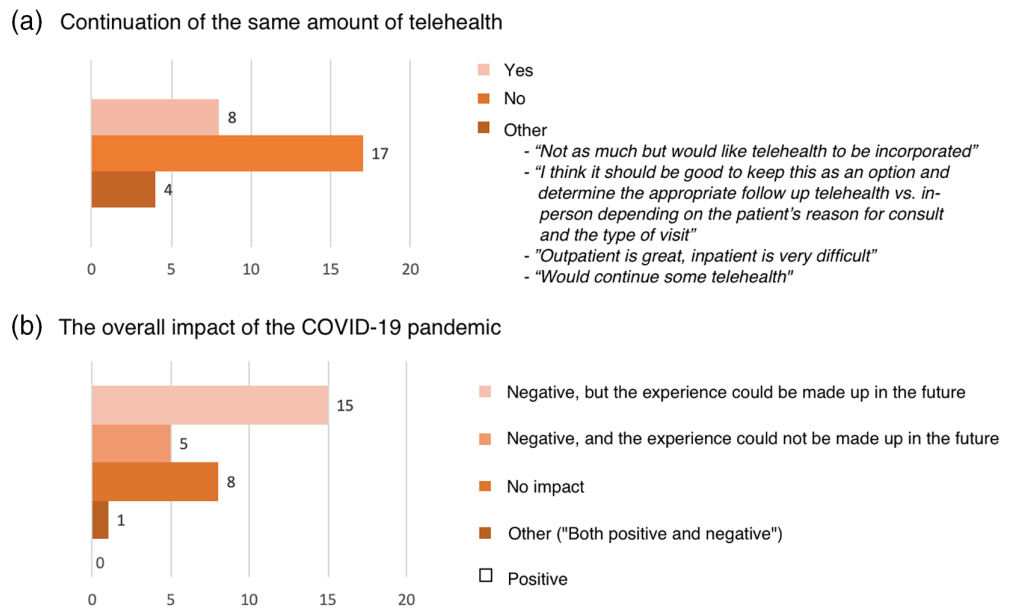
**FIGURE 2** Reported challenges with telehealth by trainees ( $n = 29$ )

well-being has been well described (Raj, 2016; Sanghavi et al., 2020). Third, senior residents (PGY  $\geq 4$ ) reported less depression than junior residents ( $p = 0.049$ ). This finding corroborates with previous publications which showed that senior residents experienced a lesser degree of anxiety (Rana et al., 2020), and that the majority of interns (PGY1) reported disrupted social connectedness and educational experiences during the pandemic, particularly those with health concerns and children (Winn et al., 2021).

Almost all trainees (30/31) agreed that they had adequate personal protective equipment (PPE) when needed, and one trainee did not agree or disagree. This is reassuring since PPE unavailability has been identified as a source of worsened well-being (Khusid et al., 2020; Rana et al., 2020). While 30 trainees felt that access to COVID-19 testing was appropriate, one trainee strongly disagreed. As lack of access to testing will result in poor infection control and

negative mental health outcomes, the availability of COVID-19 testing is critical (Khusid et al., 2020; Sanghavi et al., 2020). Twenty-two trainees agreed that there was additional institutional support, whereas three trainees disagreed. Support from training programs has been correlated with residents' favorable well-being and resilience (Khusid et al., 2020; Zoorob et al., 2021). Although none of the trainees was redeployed to nongenetic departments, three trainees were diagnosed with COVID-19 and eight trainees reported that they had treated COVID-19 positive patients in person during clinical genetics rotation. Studies have associated fear of contracting the virus as well as caring for patients with COVID-19 with negative well-being outcomes (Alhasan et al., 2021; Cravero et al., 2020; Sanghavi et al., 2020; Zoorob et al., 2021). With ubiquitous use of telehealth and the risk of COVID-19 transmission, it seems reasonable and feasible to limit medical genetics trainees' in-person exposure to patients

**FIGURE 3** Trainees' opinions on (a) whether they would like to continue the same amount of telehealth as part of their clinical training after the pandemic and (b) the overall impact of the COVID-19 pandemic on their clinical training



**TABLE 2** Core themes identified from qualitative analysis of free text responses (n = 13)

Theme	Subtheme	Examples of free test response
Education and research activity	More access to various virtual learning platforms (2)	<ul style="list-style-type: none"> <li>Increased access to conferences or other lectures available via zoom, e.g., University of Colorado's excellent seminar series</li> </ul>
	Trainees described negative impact (5)	<ul style="list-style-type: none"> <li>The volume [of patients] was significantly reduced</li> <li>Overall lack of desire among members of the division to teach trainees when not in-person, many of our virtual didactic sessions go unfilled due to Zoom burnout</li> <li>I get better learning in person because I am able to learn from other people's cases in clinic</li> <li>Significant negative impact on research projects requiring enrollment of patients.</li> </ul>
Social interaction and networking	Negative impact on social interaction and networking (3)	<ul style="list-style-type: none"> <li>I feel that I have not developed relationships with my co-fellows and attendings</li> <li>Increased telemedicine burden from home has caused feelings of isolation personally</li> <li>There are no known networking opportunities among trainees at national conferences and training courses</li> </ul>
Telehealth utilization	Trainees appreciate some aspects of telehealth (3)	<ul style="list-style-type: none"> <li>Telehealth has been great for cancer and prenatal visits, as I was able to see significantly more patients each day.</li> <li>Some companies made genetic testing via mail easier</li> </ul>
	Difficulties of inpatient consultation (2)	<ul style="list-style-type: none"> <li>Inpatient newborn exams really need to be in person and was way too difficult to do over Zoom</li> </ul>
	More administrative works related to testing arrangement (2)	<ul style="list-style-type: none"> <li>Everyone seems overworked from new COVID-related work/logistics not previously needed</li> </ul>

Note: Numbers in parentheses represent numbers of trainees who mentioned this theme.

with active COVID-19. A modified schedule, which minimizes direct patient contact, has been described as an effective way to handle education amid the outbreak (Rana et al., 2020).

Telehealth has been widely adopted in the training of many specialties (Khusid et al., 2020; Li et al., 2020; Pivert et al., 2021; Zoia

et al., 2020). We observed significantly increased telehealth utilization during the pandemic in medical genetics residency and fellowship programs, with average time spent on telehealth of 67% (range 15%–100%) for outpatient service, and 29% (range 0%–90%) for inpatient service. Inadequate opportunity to do a full physical examination and



technical issues were the most common challenges. Pre-pandemic publications of telehealth in medical genetics revealed that it resulted in increased access to care, high levels of patient satisfaction, and clinical efficacy (Hilgart et al., 2012). Concerns surrounding inadequate physical examination were however infrequently raised (Hopper et al., 2011; Tise, 2021; Wenger et al., 2014). During the pandemic, nongenetics residents who attended a virtual genetics clinic identified dysmorphology as a weak area of education via telehealth (Pritchard et al., 2021). Cohen et al. (2021) has suggested three steps on how to use telehealth as an effective educational tool in medical genetics: (1) create telemedicine milestones to measure a trainee's progress toward competency; (2) teach trainees novel clinical and technical telemedicine skills to perform a remote physical examination; and (3) provide tools for families to help obtain complementary components of the examination. Other specialties also reported employing a "telemedicine curriculum" during the pandemic (Sanghavi et al., 2020). The thematic analysis, and a recently published opinion by a medical genetics resident (Tise, 2021), has identified inpatient consultations as difficult to cover by telehealth. In order to successfully implement telehealth in inpatient encounters, a step-wise strategy may be required, ranging from chart review to contact with the team and then with the patient (Griebeler et al., 2021).

The pandemic has had a significant toll on education and research activities, as identified as the most recurrent theme from free text analysis. In addition to the lack of engagement with face-to-face learning, the cancellation of conferences and transition to virtual lectures has caused missed networking opportunities, Zoom fatigue, and worsening well-being (Sanghavi et al., 2020). However, the positive aspects of this situation should not be overlooked: more than ever, trainees are utilizing online resources for medical genetics education, such as those shared by Regier et al. (2020).

Overall, the COVID-19 pandemic unarguably has had a negative impact on medical genetics training, a sentiment reflected by the 20 trainees who agreed with this statement. Five believed that the lost experience cannot be made up in the future. This is in contrast to the study conducted in nongenetic residents, most of whom reported a neutral or positive impact of the pandemic on their elective rotations in Genetics (Pritchard et al., 2021). We speculate that this is due to the difference in clinical responsibilities and expectations between medical genetics trainees and rotating residents.

The major limitation of our study is the low response rate (18%). While there is no agreed standard for an acceptable minimal response rate to a survey, response rate of higher than 70% is considered good; it is however not uncommon that physician surveys have a response rate lower than 30% (Bonevski et al., 2011). Potential explanations include lack of time, perceived salience of the study, concerns about confidentiality, and the sensitive nature of the topic (Cunningham et al., 2015; VanGeest et al., 2007). Offering a survey incentive may help increase the response rate in future studies. We did not include state, region, and institution in our survey due to privacy concern, which might further lower the response rate. While nonrespondent bias potentially exists and may impact the generalizability of our

results, studies have identified smaller-than-expected differences between physician respondents and nonrespondents, suggesting low rates of nonrespondent bias and reflecting a homogenous population of the surveyed physicians (VanGeest et al., 2007). In our study, the average age and gender proportion of our cohort are also similar to those of all trainees who received the survey.

There are other limitations. First, a small sample size causes inherently low statistical power to detect differences between two groups, and the need to categorize answers to top-2-box and bottom-2-box scores. While this approach may simplify the interpretation of results, some information is lost when "strongly agree" and "agree" are grouped together (MacCallum et al., 2002). Although the top-box score analysis is more commonly applied to the 5-point Likert scale, the top-2-box score analysis has been utilized in several studies (Halaska et al., 2019; Joslin et al., 2020; Mortezaei et al., 2021). Second, we did not use a validated questionnaire, such as the Patient Health Questionnaire-9, when assessing well-being. A validated questionnaire would have provided more insights into the studied population. Lastly, the cross-sectional nature of this survey, which was distributed when case numbers in the United States had dropped after a peak in January 2021, could not capture the dynamic impact of the pandemic. A follow-up study to reassess trainee's perspective may be considered in the future.

In conclusion, the COVID-19 pandemic has negatively impacted most trainees' well-being, clinical training, and education. To promote the well-being of medical genetics trainees, maintaining or increasing institutional help and support is critical. This may include modifying schedules to reduce the risk of COVID-19 exposure, childcare assistance, program mentorship and personal contact with program directors, mental health services, providing adequate PPE and COVID-19 testing when needed, and creating social gathering opportunities (even virtually) to reduce social isolation. These are particularly important for junior trainees, who might be more vulnerable due to need to adapt to new environment and new training program. As telehealth has been increasingly used in both inpatient and outpatient encounters, we have identified some potential factors that may help maximize trainees' learning experience, including creation of a telemedicine curriculum and a systematic plan to establish an inpatient telehealth service. Further studies, which could also include laboratory trainees and genetic counseling students, are needed on how to optimally integrate what we have learned during the pandemic into the training of medical genetics and genomics in the post-pandemic era.

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#### CONFLICT OF INTEREST

The authors declare no competing interests.

## AUTHOR CONTRIBUTIONS

Conceptualization and methodology: Jirat Chenbhanich, Allison Tam, and Anne Slavotinek. Data collection: Jirat Chenbhanich and Allison Tam. Data analysis: Jirat Chenbhanich. Supervision: Allison Tam and Anne Slavotinek. Writing—original draft: Jirat Chenbhanich. Writing—review & editing: Allison Tam and Anne Slavotinek.

## DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article due to their containing health information that could compromise the privacy of research participants.

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## SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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