ORIGINAL ARTICLE

# COVID-19 Breakthrough Infections among Medical Students under the SLICE and CLARO Programs: Ateneo School of Medicine and Public Health Experience

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## ABSTRACT

**Objective.** This study aims to report the incidence and characteristics of breakthrough infections among medical students in the first Philippine private medical school that resumed limited face-to-face classes and clinical rotations from July to December 2021.

**Methods.** This is a descriptive study using secondary worksheet from multiple-source records review of breakthrough infections among medical students from July to December 2021.

**Results.** Among the 837 vaccinated medical students, 23 (2.7%) experienced COVID-19 breakthrough infections. Of these, 9 were male and 14 were female. Four were asymptomatic and 19 were symptomatic. Of the 19 symptomatic, 18 had mild and 1 had severe disease. Mild infections presented with upper respiratory tract symptoms. Duration of symptoms ranged from 4 to 27 days with an average of 10 days. Timing of breakthrough infections ranged from 35 to 212 days after the second dose of COVID-19 vaccine with a mean of 86 days. Contact with confirmed cases was reported in 14 of 23 cases, 13 were from household members and none within the SLICE and CLARO programs.

**Conclusion.** Our study showed that even in the midst of the Delta surge, low breakthrough infection rate with mostly mildly symptomatic cases and no case transmissions within the SLICE and CLARO programs are possible with vaccination, regular health surveillance, and strict adherence to minimum health protocols.

*Keywords: breakthrough infection, COVID-19, Philippines, medical students, vaccination*



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## INTRODUCTION

Since the declaration of the COVID-19 global pandemic by the WHO on March 11, 2020,[1] medical schools have adopted different teaching strategies to keep up with the challenges posed by the face-to-face restrictions and the threat of SARS-CoV-2 transmission. To address these challenges, the Ateneo School of Medicine and Public Health (ASMPH), in consultation with and upon approval of the COVID-19 Inter-Agency Task Force for the Management of Emerging Infectious Diseases (IATF) and the Pasig City government unit, developed and implemented two programs namely, the Clinical Limited-Access Rotations (CLARO) for clerkship and internship in February 2021, and the Sequential Limited Class Exposure (SLICE) for the first three preclinical year levels in July 2021. As the names of the programs imply, these allow medical students to participate in on-site clinical work and classroom activities. These two programs involved the Health Services Office's (HSO) regular health surveillance,

deputization of student safety officers, infection control and basic skills training, health insurance coverage, monthly supply of personal protective equipment (i.e., KN95 masks, face shields, gowns, and gloves), provision of shuttle services, and the subsequent vaccination of the medical students beginning March 2021.

The Health Services Office with the help of student safety officers enforce regular health surveillance by the accomplishment of daily health checklist to monitor for COVID-19 related symptoms and exposures. All reported cases undergo risk assessment, contact-tracing, and appropriate course of action are recommended based on the existing national guidelines.

In October 2020 when COVID-19 vaccines were not yet available, results of a Danish observational cohort study conducted in the University of Copenhagen showed that medical students had a high seroprevalence of antibodies against SARS-CoV-2 compared with the general Danish population and other healthcare workers.[2]

The development of safe and effective COVID-19 vaccines is probably one of the greatest achievements in the battle against this global pandemic. The subsequent vaccination of the population, which started with health care workers in March 1, 2021, was a welcome development in the medical education field. This allowed for the safer resumption of limited face-to-face teaching both in the classroom and clinical settings.

Despite the relatively high efficacy of COVID-19 vaccines administered in the Philippines, there have been reports of breakthrough infections among fully vaccinated adults. The Center for Disease Control and Prevention defines breakthrough infection as, "detection of the SARS-CoV-2 RNA or antigen in a respiratory specimen collected from a person more than 14 days after having completed recommended doses of an EUA-authorized COVID-19 vaccine."[3]

In October 2021, FDA made initial reports of 516 breakthrough infections or 0.0025% of the 20.3 million adults vaccinated in the Philippines.[4] In a study by Velasco et al. in March to July 2021 in a Philippine tertiary military hospital, 129 out of 192 COVID-19 infections were classified as breakthrough.[5] National breakthrough infection rates have increased since then.

Breakthrough infections (BTI) were likewise reported in countries worldwide where the vaccination started a few months before the Philippines. In the United States, CDC COVID-19 Vaccine Breakthrough Case Investigations Team reported a total of 10,262 BTI in 46 states as of April 2021 where a total of 101 million individuals have already been fully vaccinated. Of these cases, 63% were female, with a median age of 58. The asymptomatic individuals comprised 27% of the cases, while those hospitalized were 10%, and 2% died. Among the hospitalized, 29% were admitted for non-COVID-19 related reasons.[3] In the largest medical center in Israel, only 39 cases of breakthrough infections were reported out of the 11,453 fully vaccinated health care workers in Sheba Medical Center. The number of BTI reported was from the 1,497 individuals who had RT-PCR results available with a positivity rate of 2.6%.[6]

Some studies in 2021 have shown varied rates of breakthrough infections among student populations, particularly during gatherings and events. Among student athletes in the US, they identified 22.4% of positive cases were BTI while 77.6% were unvaccinated.[7] While strict adherence to preventive protocols limited the BTI cases among fully vaccinated students in a school in India to only 37 out of more than 500 students.[8]

Certain risk factors were correlated with the development of BTI by Butt et al. Their study concluded that increasing age and presence of anemia increase the risk of BTI.[9] In another study, presence of symptoms and contact with a confirmed case were major risk factors for BTI.[10]

Aside from the above identified factors, findings reported from Israel indicated that there is waning immunity in all age groups a few months after completing the primary vaccine series.[11] The same was mentioned in other studies where protection offered by the vaccines were expected to decline over the months which can bring about increase in likelihood of breakthrough infections.[12]

This study aims to report incidence and characteristics of breakthrough infections among ASMPH medical students using pertinent medical information from the Health Services Office during the initial implementation of the SLICE and CLARO programs. Information from this study will be beneficial to understanding the characteristics and possible risk factors that may affect breakthrough infections in student populations especially when full face-to-face classes are about to start nationwide. Furthermore, this study hopes to contribute data to the currently very limited information about medical students and COVID-19 incidence, characteristics, transmission, exposures, and risk factors.

## METHODS

### Study Design

This is a descriptive study that reports the incidence rate of COVID-19 breakthrough infections among ASMPH medical students and describes the characteristics and frequency of risk factors related to the cases.

### Study Setting and Population

Ateneo School of Medicine and Public Health is a medical school located in Pasig City, Philippines with a 100% fully vaccinated student population of 837. The first three-year levels (YL5, YL6 and YL7), also considered preclinical years, under the SLICE program have a total of 502 students. Students under the SLICE program attend face-to-face classes in sequential order. Only one year level holds face-to-face classes at a time in the ASMPH campus. The classrooms, laboratories, tables, and seating arrangements

have been modified to allow for proper ventilation and physical distancing.

The two clinical year levels (YL8 and YL9) under the CLARO program have a total of 335 clerks and interns. Students in the CLARO program rotate in partner hospitals and clinics in small groups and under limited work hours (12 to 24 hours) per shift. They are provided with all the personal protective equipment required in their areas of rotation.

#### *Inclusion criteria*

All ASMPH medical students from all year levels with evidence of COVID-19 infection through a positive SARS-CoV-2 RT-PCR or rapid antigen test result from July to December 2021.

#### *Exclusion criteria*

None.

### Data Collection

Students with COVID-19 symptoms or exposure with subsequent confirmed positive results by Nasopharyngeal RT-PCR or rapid antigen test for the first semester (July to December) of school year 2021-2022 were included in this study. A BTI worksheet was provided to HSO for the collection of pertinent information related to this research.

Students' health records collected and managed by the Health Services Office include medical history, vaccination history, consultation records and health declaration reports from the daily health checklist.

### Data Analysis

#### *To determine the rate of breakthrough infections*

Incidence was calculated by determining the number of breakthrough infections divided by the number of vaccinated students within the first semester of school year 2021-2022. Our data showed that 23 medical students were infected with SARS-CoV-2 from July to December 2021. This represents 2.7% of the 837 total population of fully-vaccinated medical students.

#### *To describe the characteristics and possible factors that may affect breakthrough infections among medical students*

Baseline characteristics of the 23 medical students who experienced breakthrough infections are shown in Table 1 and are reported as frequencies and percentage of BTI. Table 2 lists characteristics of BTI symptoms using frequency and percentage of the 19 symptomatic cases.

## RESULTS

### Breakthrough Infections

Among the 837 fully vaccinated medical students, 23 (2.7%) experienced breakthrough infections. Of these 23 cases, 9 were male (2.6% of the 343 male student population) and 14 were female (2.8% of the 494 female students). Four were asymptomatic and 19 were symptomatic. Of the 19 symptomatic, 18 (94.7%) had mild symptoms and 1 (5.3%) had severe disease.

### Characteristics of medical students who experienced breakthrough infections

Table 1 illustrates the characteristics of medical students with BTI. Age range of the 23 medical students is 22 to 28 with an average age of 24. Among these 20 cases in whom data are available regarding body mass index, 12 are within normal, 7 are overweight and 1 obese. Only one of the 23 breakthrough cases has a comorbidity which is chronic heart disease (mitral valve prolapse with moderate mitral valve regurgitation). Two of the 23 cases are current smokers and 2 were previous smokers.

### Exposure of medical students who experienced breakthrough infections

Of the 502 students from the first three-year levels enrolled in the SLICE program, 14 (2.8%) had breakthrough infections. In the clinical years, 9 (2.7%) of the 335 students enrolled in the CLARO program had breakthrough infections. Contact with a confirmed case was reported in 14 out of 23 cases where 13 were from household members and 1 from a community outside the SLICE or CLARO programs. There was no report of a breakthrough infection from exposure to a COVID-19 patient, classmate, or co-worker.

### Characteristics of breakthrough infections among medical students

Most breakthrough infections presented with upper respiratory tract symptoms. Nasal symptoms (stuffy, runny nose or sneezing) were noted in 17 (89.5%) of the 19 symptomatic cases. This is followed by 15 (79%) with cough and 14 (73.7%) with throat pain, itch, or discomfort. Body aches, malaise, fatigue, and myalgia were noted in 11 (57.9%), headache in 11 (57.9%), fever in 8 (42.1%), loss of smell and taste in 7 (36.8%), diarrhea in 4 (21.1%), chills in 3 (15.8%), chest pain and dyspnea in 2 (10.5%), nausea in 2 (10.5%) and conjunctivitis in 1 (5.3%).

Four of the 23 breakthrough infections were asymptomatic while 18 students had mild symptoms. Duration of symptoms ranged from 4 to 27 days with an average of 10 days. Only 1 (1.35%) had severe symptoms and required hospitalization for a chronic heart disease.

### Vaccine and breakthrough infections

Vaccines were administered to medical students from March to July 2021 prior to entry to academic year 2021-2022. Of the 23 breakthrough cases, 13 received Coronavac (Sinovac), 8 Astra-Zeneca, 1 Moderna, and 1 Pfizer. Timing of breakthrough infections ranged from 35 to 212 days after

**Table 1.** Characteristics of Medical Students who Experienced Breakthrough Infections (n=frequency, total BTI cases=23)

| | | Frequency (n) | Percent of BTI (%) total cases=23 |
|---|---|---|---|
| ***Age*** | 20-29 years old | 23 | 100.0 |
| | 30-39 years old | 0 | 0.0 |
| | ≥40 years old | 0 | 0.0 |
| ***Gender*** | Male | 9 | 39.1 |
| | Female | 14 | 60.9 |
| ***Body Mass Index*** | ≤25 | 12 | 52.2 |
| | 25-30 | 7 | 30.4 |
| | >30 | 1 | 4.3 |
| | Data not available | 3 | 13.0 |
| ***Comorbidity count*** | None | 22 | 95.7 |
| | 1-2 | 1 | 4.4 |
| | ≥3 | 0 | 0.0 |
| ***Smoker*** | Current smoker | 2 | 8.7 |
| | Previous smoker | 2 | 8.7 |
| ***Comorbidities*** | Asthma | 0 | 0.0 |
| | Diabetes | 0 | 0.0 |
| | Hypertension | 0 | 0.0 |
| | Chronic Heart Disease | 1 | 4.4 |
| | Chronic Kidney Disease | 0 | 0.0 |
| | Chronic Lung Disease | 0 | 0.0 |
| | Chronic Liver Disease | 0 | 0.0 |
| | Neurologic Disease | 0 | 0.0 |
| | Immune Disease | 0 | 0.0 |
| ***Symptomatic/Asymptomatic*** | Symptomatic | 19 | 82.6 |
| | Asymptomatic | 4 | 17.4 |
| ***Type of program*** | CLARO | 9 | 39.1 |
| | SLICE | 14 | 60.9 |
| ***Contact with confirmed case*** | Household member | 13 | 56.5 |
| | Co-worker/Classmate | 0 | 0.0 |
| | Patient | 0 | 0.0 |
| | Community (outside SLICE/CLARO) | 1 | 4.4 |
| | Unknown | 9 | 39.1 |

the second dose of COVID-19 vaccine with a mean of 86 days. Nine (39.1%) of 23 cases tested positive for the disease 29-60 days from the second dose of vaccine, 7 (30.4%) within 61-90 days and 7 (30.4%) after more than 90 days. Only 1 case received a booster vaccine and developed symptoms with confirmed positive results 14 days after having received the booster dose or 212 days after second dose was administered.

## DISCUSSION

This study reported 23 cases of breakthrough infections among 837 medical students in the first private medical school in the country that resumed limited face-to-face clinical and classroom exposure from July to December 2021. This paper described the characteristics of medical students with breakthrough infections and noted that the number of male and female cases is proportional to the male and female student population noted to be 2.6% (9 of the 343 male student population) and 2.8% (14 of the 494 female student population), respectively. Similar proportion was observed for cases under SLICE and CLARO programs where incidence rates were noted at 2.7% and 2.8%, respectively.

Our findings showed that neither gender nor being in the program with clinical exposure differed in frequency of COVID-19 breakthrough infections. This is contrary to the results of a study on incidence of COVID-19 among medical students in the University of Jordan where clinical students showed significantly higher incidence recorded at 15.2% versus 11.2% in preclinical students. They attributed the difference to the likelihood of clinical students being exposed to patients with COVID-19 in the clinic or hospital setting.[13] A similar study among Danish medical students showed that increase in hours spent in the clinically-based education is associated with higher seropositivity.[2]

An important finding from this study is that no case was attributed to the students' contact with a COVID-positive classmate, co-worker or patient within the SLICE or CLARO program. This may be due to strict adherence to

health standards such as use of personal protective equipment, limited time and capacity of classes and clinical rotations within the said programs, and compliance to guidelines set by the ASMPH Health Services Office as approved by the CHED-IATF.

In a medical education institute in Western Maharashtra in India where all medical students were required to reside in the campus, a clustering of COVID-19 cases was observed after a series of indoor and outdoor student-organized activities that took place in August 2021. They reported 37 cases out of more than 500 vaccinated medical students. They attributed the cases to possible breaches of COVID-appropriate behavior among those in attendance during the five-day school events.[8]

Our contact-tracing report showed that majority of case transmissions took place within the household. Adherence to minimum health standards may be easy to monitor within the SLICE and CLARO programs but difficult inside the homes wherein wearing of face masks and maintaining a safe distance can be a challenge. In the Philippine setting, medical students are almost always considered community medical frontliners. They are the first to be consulted within a household or community where there is no available health care worker. They are likewise expected to be personally taking care of a sick household member, relative or neighbor. These conditions may explain the higher frequency of contact with COVID-positive household members than with confirmed cases in the hospital, clinic, or classroom setting.

In Table 2, 56.5% of breakthrough cases received Coronavac (Sinovac) versus 34.8% who received Astra-Zeneca as their primary vaccine. However, this study cannot attribute the risk of developing BTI in relation to the vaccine

**Table 2.** Characteristics of Breakthrough Infections among Medical Students (n=frequency, symptomatic BTI=19)

| | | Frequency (n) | Percent of symptomatic BTI (n/19*100) |
|---|---|---|---|
| ***Symptoms*** | Stuffy, runny nose, sneezing | 17 | 89.5 |
| | Cough | 15 | 79.0 |
| | Throat pain, itch, or discomfort | 14 | 73.7 |
| | Body pain, malaise, myalgia, fatigue | 11 | 57.9 |
| | Headache | 11 | 57.9 |
| | Fever | 8 | 42.1 |
| | Loss of smell, taste | 7 | 36.8 |
| | Diarrhea | 4 | 21.1 |
| | Chills | 3 | 15.8 |
| | Dyspnea, chest pain | 2 | 10.5 |
| | Nausea | 2 | 10.5 |
| | Conjunctivitis | 1 | 5.3 |
| | | **Frequency (n)** | **Percent of BTI (n/23*100)** |
| ***Timing of breakthrough infection after 2nd dose of COVID-19 vaccine*** | <14 days | 0 | 0.0 |
| | 14-28 days | 0 | 0.0 |
| | 29-60 days | 9 | 39.1 |
| | 61-90 days | 7 | 30.4 |
| | >90 days | 7 | 30.4 |
| ***Severity*** | Asymptomatic | 4 | 17.4 |
| | Mild | 18 | 78.3 |
| | Moderate | 0 | 0.0 |
| | Severe | 1 | 4.4 |
| ***Duration of symptoms*** | 1-7 days | 2 | 10.5 |
| | 8-14 days | 13 | 68.4 |
| | 15-21 days | 3 | 15.8 |
| | 22-28 days | 1 | 5.3 |
| ***Vaccine administered*** | AstraZeneca | 8 | 34.8 |
| | Moderna | 1 | 4.4 |
| | Pfizer BioNtech | 1 | 4.4 |
| | Janssen | 0 | 0.0 |
| | Sinovac | 13 | 56.5 |
| | Sputnik | 0 | 0.0 |
| ***Booster Vaccination*** | AstraZeneca | 0 | 0.0 |
| | Moderna | 1 | 4.4 |
| | Pfizer BioNtech | 0 | 0.0 |
| | Janssen | 0 | 0.0 |

received because the proportion of cases is almost the same for both vaccines. They account for 2.9% or 13 of the 446 Coronavac and 2.7% or 8 of the 293 Astra-Zeneca vaccinated population.

This study described the characteristics of breakthrough infections in terms of symptoms. Nasal and throat problems were the most common manifestations. This is consistent with the highest viral load being in the nasopharyngeal and oropharyngeal areas. Most cases experienced nasal symptoms ranging from congestion, rhinorrhea and sneezing usually presenting within day 1 of the disease. This is followed by cough and throat symptoms described as either throat pain, discomfort, or itchiness. Onset of loss of smell or taste was between day 4 to day 6 of the course of the infection.

Findings of breakthrough cases being mostly mild (18 out of 19 symptomatic) and with short duration (mean and median of 10 days) are consistent with several observations including those cited in similar press release from Centers for Disease Control and Prevention and from World Health Organization regarding benefits of being fully vaccinated.[14,15]

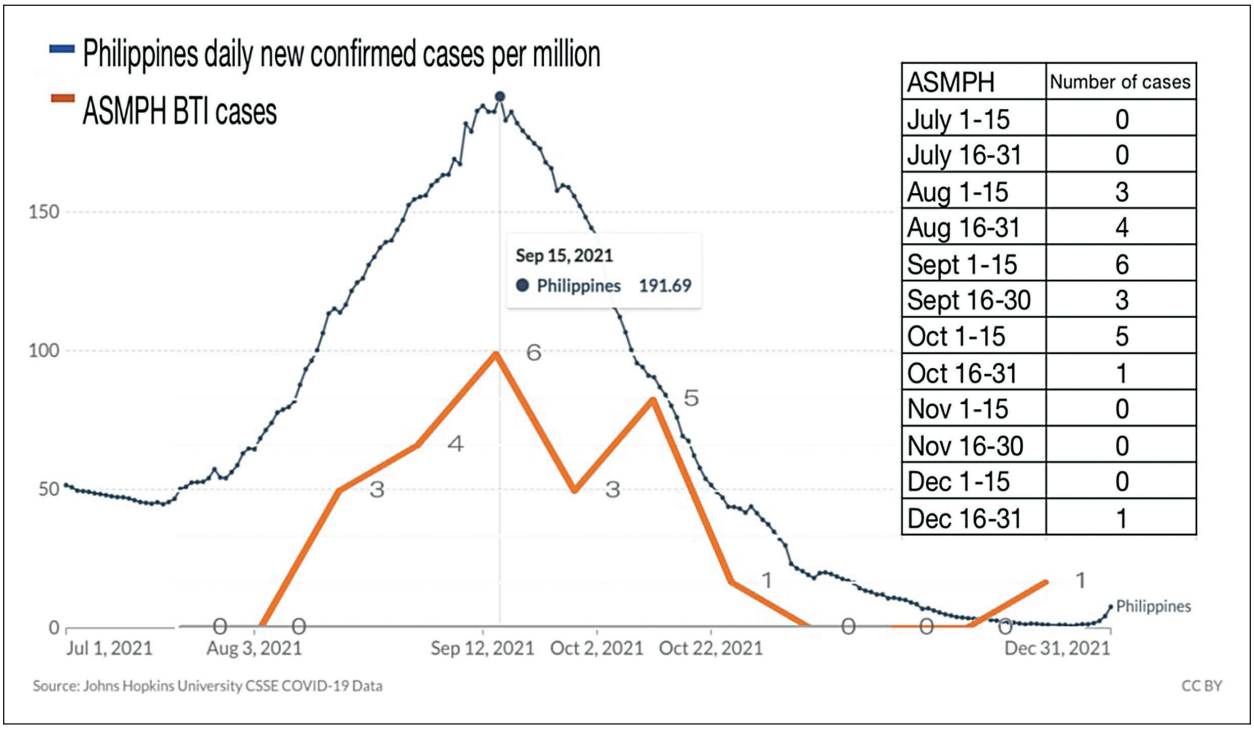
A number of studies have shown increases in cases within public gatherings and school activities, but similar to the study of Prasad et al. in India, the ASMPH had an advantage of a 100% student vaccination coverage. They likewise held strict preventive measures, robust contact tracing, early identification, and isolation of cases.[8] All these contribute to the lower rates of COVID-19 cases. This may not be the case in a student festive event in Germany where a study reported that increased time spent, conversation with an index person, shared drinks and person-to-person direct contact at the event contributed to increased infection despite having been fully vaccinated.[16]

The increase in number of breakthrough cases observed in the months of August to October 2021 coincided with the Philippines' uphill trend of cases as seen in Figure 1 due to the Delta variant surge.[17] A similar trend in the increase in cases was observed in a study done among fully vaccinated and unvaccinated university athletes belonging to the U.S.-based National Collegiate Athletic Association in August to September 2021 which coincided with the start of school semester and possibly due to the higher transmissibility and breakthrough infections caused by the Delta variant.[7]

Alpha and Beta were the dominant variants in June to mid-July 2021 but the Delta variant gradually took over in late July and dominated over the other strains by 90% on August 23 and 97% in September 6 as illustrated in Figure 2.[18] The characteristic greater transmissibility and higher infectivity of the Delta variant compared with earlier Alpha and Beta variants triggered the spike and uphill trend in breakthrough cases among medical students in the months of August, September, and October 2021.

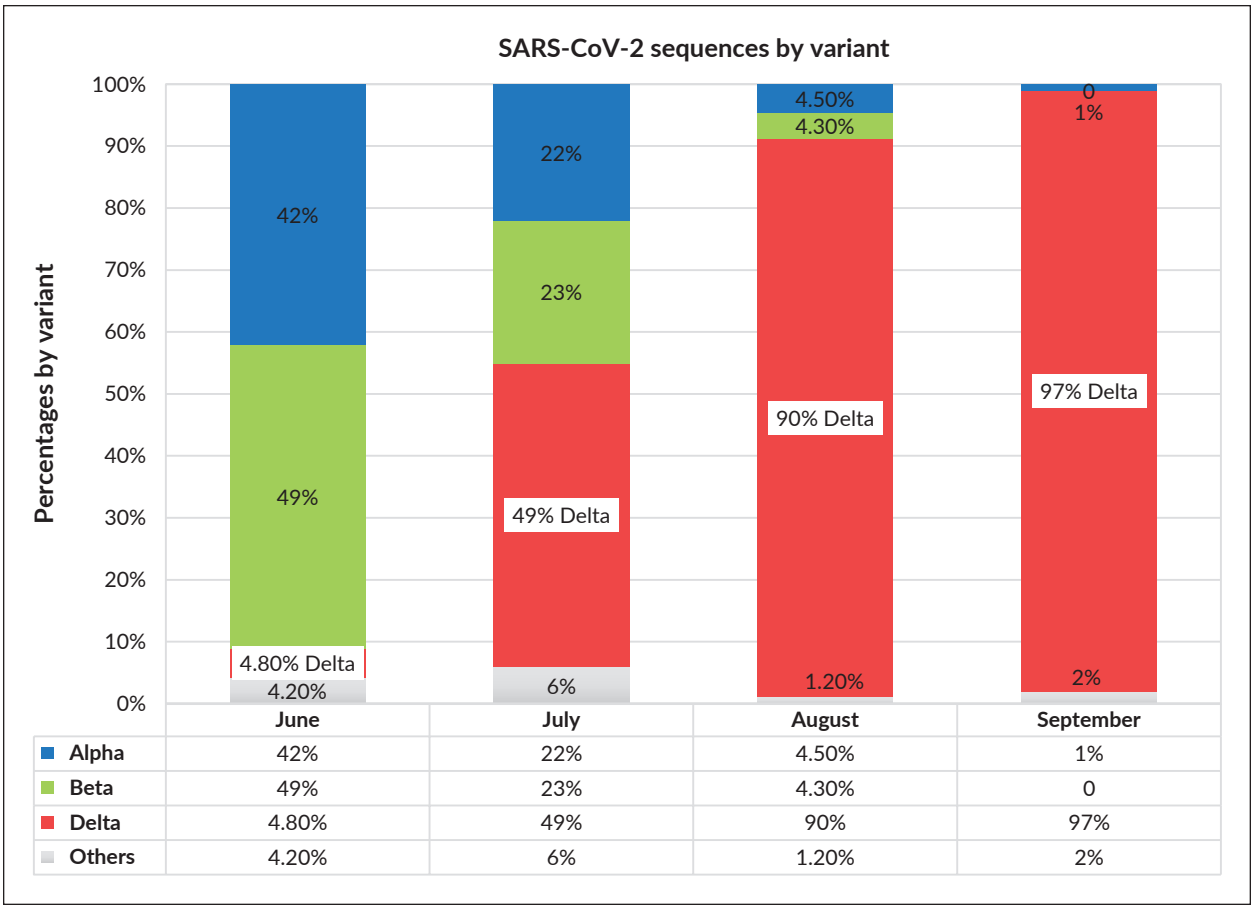
## CONCLUSION

Breakthrough infections occurred in 2.7% of a fully vaccinated medical student population but were mostly mildly




| ASMPH | Number of cases |
|---|---|
| July 1-15 | 0 |
| July 16-31 | 0 |
| Aug 1-15 | 3 |
| Aug 16-31 | 4 |
| Sept 1-15 | 6 |
| Sept 16-30 | 3 |
| Oct 1-15 | 5 |
| Oct 16-31 | 1 |
| Nov 1-15 | 0 |
| Nov 16-30 | 0 |
| Dec 1-15 | 0 |
| Dec 16-31 | 1 |

**Figure 1.** Timeline of ASMPH breakthrough infections from July to December 2021 versus Philippines daily new COVID-19 cases per million. *Source: Our World in Data. [Online report]. Johns Hopkins University CSSE COVID-19 Data.*[17]




| | June | July | August | September |
|---|---|---|---|---|
| Alpha | 42% | 22% | 4.50% | 1% |
| Beta | 49% | 23% | 4.30% | 0 |
| Delta | 4.80% | 49% | 90% | 97% |
| Others | 4.20% | 6% | 1.20% | 2% |

**Figure 2.** SARS-CoV-2 sequences by variant (Philippines, June to September 2021). *Source: Our World in Data.*[18]

symptomatic and some asymptomatic. Severe COVID-19 was reported in a single case with chronic heart disease as a comorbidity. Most cases of transmission were within the household and none within the SLICE and CLARO programs. Our findings showed that neither gender nor being in the program with clinical exposure differed in frequency of COVID-19 breakthrough infections. The cases were mostly observed during the Philippine Delta surge. The study suggests that in the resumption of classes, vaccination alone does not protect against spread of infection but strategies should include regular health surveillance and strict adherence to minimum health protocols.

The period of the COVID-19 spread continues, particularly with breakthrough infections even with vaccination. Academic institutions will continue to face this significant challenge as more face-to-face classes are adapted by the different institutions. The efforts implemented within the academic communities can have a significant impact in the reduction of the spread of infection within the classroom and school-setting.

This report contributes to understanding the characteristics and possible risk factors that may affect breakthrough infections in student populations, particularly medical students. It provides an opportunity to further investigate the nature of preclinical and clinical rotations and effective efforts to mitigate the transmission of infection within the school and its partner hospitals and communities. These data can be used to make recommendations in the crafting and updating of guidelines and policies relevant not only to the current SLICE and CLARO programs within ASMPH but also in the resumption of face-to-face classes nationwide.

## Limitations

This study has some limitations. First, it only covered breakthrough infections reported within the 6-month post-vaccination period from July to December 2021. Second, the data was limited to available medical records collected and managed by the Health Services Office which include medical history, vaccination history, consultation records and responses to online questionnaires of the 23 reported breakthrough infections. Third, the study did not intend to prove or compare the effectiveness of COVID-19 vaccines and boosters administered.

The results described the breakthrough infections in ASMPH and may not represent the situation in other communities and academic institutions.

## Ethics Approval

This paper underwent ethics review under the Ateneo de Manila University Research Ethics Committee and was granted approval on February 15, 2022.

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## Statement of Authorship

PDCD contributed in the conceptualization, literature search, project administration, supervision, data curation, data analysis, drafting, writing, and revising of manuscript, and final approval of the version to be published. ABCD contributed in the conceptualization, data analysis, investigation, methodology, drafting, writing, and revising of manuscript. JJJC contributed in the conceptualization, methodology, data collection, data curation, and investigation.

## Author Disclosure

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