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Incidence of breakthrough infection after COVID vaccination and effect of post-covid-19 syndrome on medical students in a tertiary care hospital in Telangana

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ABSTRACT

Background: Even though many breakthrough infections have been reported in the Telangana region, adequate data regarding them are not available. In addition, there is evidence that SARS-CoV-2 infection can result in long-term physical and mental health consequences.

Aim: To estimate the incidence of breakthrough infections after COVID-19 vaccination and the effect of Post COVID 19 syndrome on staff and medical students in a tertiary care hospital in Telangana.

Objectives: 1. To detect the incidence of breakthrough infections in staff and students in our institute; 2. To measure the effect of post-COVID-19 syndrome on the staff, undergraduate, and postgraduate medical students in our institute

Materials and Methods: This study was carried out in a tertiary care medical college located near Hyderabad. This was a cross-sectional retrospective and prospective study where data was collected from individuals who were PCR-confirmed COVID-19-infected individuals diagnosed from December 2021 to July 2022. The cases were classified according to AIIMS clinical guidance for the management of adult COVID-19 patients. To assess the post-COVID syndrome in the staff and medical students, complaints of breathlessness, fatigue, difficulty in concentrating, and mood changes were further evaluated by using the modified dyspnea Medical Research Council scale, Fatigue Assessment scale (FAS), and Depression, Anxiety, Stress scale -21(DASS-21) respectively. Statistical analysis was performed using SPSS software version 23.

Result: The incidence of breakthrough infections was found to be 9.40%. The maximum number was observed in second-year medical undergraduates followed by medical post-graduates. A total of 40 participants (21.16%) reported suffering from post-COVID-19 syndrome. Fatigue was the most common symptom reported, followed by post-exertion malaise and headache.

Conclusion: The incidence of breakthrough infections shows that increased awareness and prompt management of post-COVID syndrome is crucial in the post pandemic era.

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1. Introduction

The COVID-19 pandemic caused by the novel SARS-CoV-2 has caused unprecedented mortality and morbidity in

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the global population. According to CDC, a breakthrough infection is a COVID case that occurs in someone who is fully vaccinated, meaning 14 or more days after completing the recommended doses of an authorized vaccine.¹

In addition, there is evidence that SARS-CoV-2 infection can result in long-term physical and mental health consequences. Such consequences lasting for longer than three months after infection are currently referred to as “post-COVID-19 syndrome”. Commonly reported symptoms in post-COVID syndrome include difficulty in breathing, fatigue, post-exertion malaise, and difficulty thinking or concentrating (brain fog). Other symptoms include cough, chest pain, headache, palpitations, diarrhea, sleep problems, dizziness, mood changes, and changes in menstrual period cycles.²

To control the COVID-19 pandemic, the Government of India introduced the world’s biggest vaccination drive since January 16, 2021. Two vaccines named BBV-152 (Covaxin®) and AZD1222 (Covishield™) were given in a phased manner to healthcare workers, front-line workers, and finally the general public with prioritized age groups more than 50 years who were vaccinated first followed by age groups less than 50 years with co-morbidities like diabetes, hypertension, cancer and lung diseases.³

ChAdOx1 nCoV -19 Corona Virus Vaccine (Recombinant) is Covishield™, and it is called ‘Recombinant’ because it contains a replication-deficient chimpanzee adenovirus vector encoding the SARS-CoV-2 Spike (S) glycoprotein and produced in genetically modified human embryonic kidney (HEK) 293 cells. Covaxin® is an inactivated vaccine using whole virion inactivated in Vero cells with each dose containing 6µg of whole-virion inactivated SARS-CoV-2 antigen (Strain: NIV-2020-770). Both vaccines are injectable with a dose of 0.5 ml, given intramuscularly in the deltoid muscle, two doses are recommended, the second dose 4 weeks after the first dose.^{4,5}

According to the operational guidelines for COVID-19 vaccines released by the Ministry of Health and Family Welfare, Government of India updated in December 2020; the healthcare workers were divided into nine categories in a tertiary care hospital. They included front-line health and ICDS (Integrated Child Development Services) workers, nurses and supervisors, medical officers, paramedical staff, support staff, students, scientists and research staff, clerical and administrative staff, and other health staff.⁶

Several studies have been conducted in various parts of the country to detect the COVID -19 breakthrough infections with their clinical presentations. Sachin Dhumal et al studied a cohort of healthcare workers and found that breakthrough infection were common among females in their medical center in Mumbai.⁷ Similar study was done by Dash et al in the general population in which they concluded that seropositivity in individuals receiving

Covishield was significantly higher than in individuals who received Covaxin.³ A study conducted in AIIMS, Patna, Bihar by Chandra Mani Singh et al displayed incidence of breakthrough infections was 10% with male predominance, more among health care workers and the mean age affected was less than or equal to 29 years.⁸

According to a review article published by Helena Maltezou et al, the post-COVID syndrome was defined as COVID-19 associated illness extending for more than three weeks after the onset of symptoms, and chronic COVID-19 as persistent symptoms extending beyond 12 weeks after the onset of symptoms.⁹ In our study, we have considered post-COVID syndrome as anyone who has persistent symptoms after three months of testing positive for COVID -19 by RT-PCR.

Menges D et al have concluded that commonly reported symptoms in post-COVID syndrome were difficulty in breathing, fatigue, post-exertion malaise, and difficulty thinking or concentrating (brain fog). Other symptoms were cough, chest pain, headache, palpitations, diarrhea, sleep problems, dizziness, mood changes, and changes in menstrual period cycles.² Hence we considered these symptoms as post-COVID-19 symptoms in our questionnaire.

The aim of this study was to estimate the incidence of breakthrough infections after COVID-19 vaccination and the effect of Post COVID 19 syndrome on staff and medical students in a tertiary care hospital in Telangana. While one of the objectives was to detect the incidence of breakthrough infections in staff and students in our institute, another objective intended to measure the effect of post-COVID-19 syndrome on the staff, undergraduate, and postgraduate medical students in our institute.

2. Materials and Methods

This study was carried out in a tertiary care medical college located near Hyderabad, Telangana. This was a cross-sectional retrospective and prospective study where data was collected from individuals who were PCR-confirmed COVID-19-infected individuals diagnosed from December 2021 to July 2022. Only staff and students from our tertiary care hospital were included in this study. The individuals who were excluded from the study were individuals who were not vaccinated, or who received only one dose of vaccine, in whom infection occurred before the completion of two weeks after administration of the second dose of the COVID-19 vaccine, and who did not consent for the study.³ Informed consent was obtained from all participants and approval from the institutional ethical committee was procured before starting the study. (Ref No. ETHICS COMMITTEE/KIMS/NKP/2022/04)

After enrollment, the participants completed a questionnaire with questions regarding socio-demographic

details, contact information, symptoms when diagnosed with SARS CoV2, name of vaccination received, vaccination status (two doses), medical comorbidities and risk factors, current health status, and present symptoms. The clinical disease of the diagnosed COVID-19 cases was classified as a mild, moderate, and severe according to AIIMS clinical guidance for the management of adult COVID-19 patients. Mild disease was cases with upper respiratory tract symptoms and or fever without shortness of breath or hypoxia. Moderate disease was defined as respiratory rate ≥ 24 /min, breathlessness, and SpO₂ of 90% to $\leq 93\%$ on room air. Severe disease was cases that had respiratory rate > 30 /min, breathlessness, and SpO₂ $< 90\%$ on room air.

To assess the post-COVID syndrome in the staff and medical students, questions regarding their recovery after infection, the duration they required to become symptom-free, any persistent symptoms, and other or new ongoing symptoms were recorded by personal interview. The staff and students with complaints of breathlessness, fatigue, difficulty in concentrating, and mood changes were further evaluated by using the modified dyspnea Medical Research Council scale, Fatigue Assessment scale (FAS), and Depression, Anxiety, Stress scale -21 (DASS-21) respectively. For the FAS scale, a score of 22 or more was considered the threshold. For the modified dyspnea Medical Research Council scale, Grade >1 dyspnea was considered significant. For DASS 21 scale, a score for depression > 9 , a score for anxiety > 7 , and a score for stress >14 were reported as significant.¹⁰⁻¹² Statistical analysis was performed using SPSS software version 23.

3. Results

A total of 2009 staff and students were working or studying in our tertiary care institute during the study period from December 2021 to July 2022. This number included medical undergraduate students, medical interns, medical postgraduate students, teaching staff in medical college and hospital, non-teaching staff in medical college and hospital, universal workers, drivers, and other miscellaneous workers. Among them, 189 were found to be RT-PCR positive for COVID-19, and hence the incidence of breakthrough COVID-19 infection in our institute during the study period was found to be 9.40%. Out of these cases, 181 (95.76%) had received at least two doses of Covishield vaccination, and the remaining 8 (4.23%) had received at least two doses of Covaxin vaccination during the vaccination drive and as represented in Figure 1.

Out of 189 participants who consented, 125 participants had also received a third dose of COVID-19 vaccination. Among the breakthrough cases, 120 were undergraduate students, 15 were interns, 36 were postgraduates and the

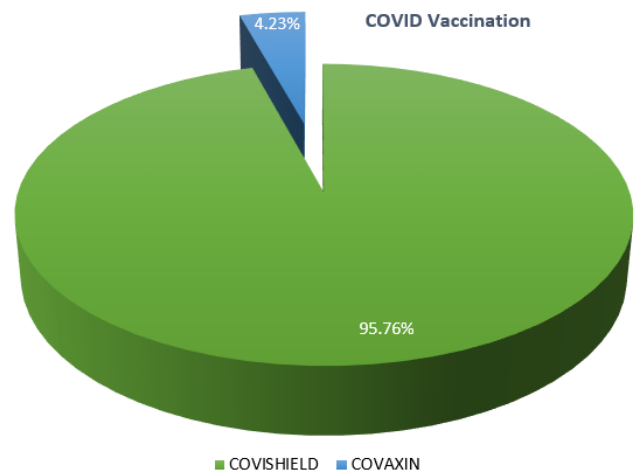


Figure 1: Distribution of COVID vaccination in study participants

remaining 18 were staff. The study participants were grouped under seven categories based on their student status and working status. The distribution of breakthrough infections among the various categories is displayed in Table 1.

The age of the participants ranged from 18 years to 70 years and hence they were divided into six age groups. The age distribution of breakthrough cases with mean ages is represented in Table 2.

There was a female predominance in the breakthrough cases with 129 females (68.25%) and 60 males (31.74%).

A chi-square test of independence was performed to examine the relationship between the study year of a medical undergraduate and the occurrence of breakthrough infections as represented in Table 3. It was found to be statistically significant. $\{\chi^2 (1, N=974) = 32.9017, p = < 0.00001\}$

The clinical disease of the diagnosed breakthrough COVID-19 cases was classified as a mild, moderate, and severe disease according to AIIMS clinical guidance for the management of adult COVID-19 patients. Out of 189 breakthrough infections, 24 (12.69%) were asymptomatic, 143 cases (75.66%) had mild disease, 21 cases (11.11%) had moderate disease and 1 case (0.52%) had severe disease and was hospitalized for treatment. Fever was the most common symptom reported, followed by cough. The various symptoms of the participants are listed in Table 4.

Significant history of any co-morbidity like asthma, diabetes, clinical depression, hypertension, malignancy, and any other diseases were taken. Out of 189 cases, 5 cases (2.64%) reported asthma, 3 cases (1.58%) had both diabetes and hypertension, and 1 case (0.52%) reported to have hypothyroidism. The participants were asked to describe their current health status as “recovered completely”, “better” or “worse” and out of 189 participants, 168

Table 1: Distribution of breakthrough infections among study participants

Category	Total number	Number of Breakthrough cases	Incidence (%)
First-year MBBS undergraduates	200	16	8
Second-year MBBS undergraduates	211	52	24.64
Third-year MBBS undergraduates	200	21	10.5
Fourth-year MBBS undergraduates	191	31	16.23
Medical Interns	172	15	8.72
Medical Post Graduates	216	36	16.66
Staff	819	18	2.19
Total	2009	189	9.40

Table 2: Age distribution of breakthrough cases in the study

Age Group	Number of breakthrough cases (n=189)	Percentage	Mean Age + SD (years)
18-27 years	160	84.65	21.93±0.79 years
28-37 years	22	11.64	30.63±1.04 years
38-47 years	1	0.52	47 years
48-57 years	1	0.52	53 years
58-67 years	3	1.58	64 years ±0.66 years
Above 68 years	2	1.05	69 years±0.5 years

Table 3: chi-square test of independence between the study year of medical undergraduate and the occurrence of breakthrough infections

Study year	Breakthrough COVID infections	Not infected by COVID Breakthrough infections	Total
MBBS 1	16 (27.72) [4.96]	184 (172.28) [0.80]	200
MBBS 2	52 (29.25) [17.70]	159 (181.75) [2.85]	211
MBBS 3	21 (27.72) [1.63]	179 (172.28) [0.26]	200
MBBS 4	31 (26.47) [0.77]	160 (164.53) [0.12]	191
Interns	15 (23.84) [3.28]	157 (148.16) [0.53]	172
Totals	135	839	974

Table 4: Symptoms list of breakthrough infections

Symptoms	Number of cases	Percentage (%)
Asymptomatic	24	12.69
Fever	143	75.66
Cold	49	25.92
Cough	124	65.60
Tiredness	123	65.07
Loss of taste/smell	66	34.92
Sore throat	98	51.85
Headache	114	60.31
Muscle pain	103	54.49
Rashes	4	2.11
Conjunctivitis	1	0.52
Diarrhea	10	5.29
Shortness of breath	22	11.64
Confusion	3	1.58
Chest pain	10	5.29

(88.88%) reported that they had "recovered completely", and the remaining 21 participants (11.11%) reported that they were "better". None of them reported any worsening of their current health status after the breakthrough infection. The 168 participants who had 'recovered completely' reported that they recovered within 30-45 days of the breakthrough infection and the 21 participants, who reported that they were 'better', took longer than 45-90 days to recover from the breakthrough infection.

A total of 40 participants (21.16%) reported suffering from various symptoms during the study period and hence were considered for post-COVID syndrome assessment. Out of the 40 post-COVID syndrome cases, three cases (7.5%) suffered from breakthrough infection 7 months before post-COVID assessment and 36 cases (90%) suffered from breakthrough infection 6 months prior. Only one case (2.5%) got infected with COVID -19, 40 days before the post-COVID assessment.

The post-COVID syndrome cases were also categorized into seven groups and the highest number of post-COVID syndrome cases were found in medical post-graduates (37.5%). The distribution of post-COVID syndrome cases among the various categories is displayed in Table 5.

The post-COVID syndrome cases were divided into five age groups. The age distribution of post-COVID syndrome cases with mean age is represented in Table 6.

There was a female predominance in the post-COVID syndrome cases with 31 females (77.5%) and 9 males (22.5%).

A chi-square test of independence was performed to examine the relationship between the student status and the occurrence of Post COVID syndrome as represented in Table 7. The relation between these two variables was significant. $\{\chi^2 (1, N=990) = 14.86, p = 0.005001\}$

Assessment of the post-COVID syndrome in the staff and medical students was performed by asking questions regarding their recovery after infection, the duration they required to become symptom-free, any persistent symptoms, and any other or new ongoing symptoms. The symptoms included difficulty in breathing, fatigue, post-exertion malaise, difficulty in thinking or concentrating, cough, chest pain, headache, palpitations, diarrhea, sleep issues, dizziness, mood changes, changes in menstrual cycles, and any other significant symptoms. Fatigue was the most common symptom reported, followed by post-exertion malaise. The various symptoms of participants in the post-COVID syndrome assessment are listed in Table 8.

Among the post-COVID syndrome cases, a total of 29 participants reported fatigue and were further evaluated using the Fatigue Assessment scale (FAS). Among the 29 individuals, 8 (27.58%) were medical undergraduate

students, 2 (6.89%) were medical interns, 14 (48.27%) were medical post-graduates and the remaining 5 (17.24%) were the staff. There were 22 (75.86%) females and 7 (24.13%) males among the participants who reported fatigue.

The FAS scale contains 10 statements that refer to how the individual feels and for each statement, they can choose five answer categories with scores varying from 'never' to 'always' with never=1, sometimes=2, regularly =3, often=4 and always=5. A score of 22 or more was considered significant fatigue in our study. Out of 29 participants who reported fatigue, 10 (34.48%) had a score of ≥ 22 and were found to have significant fatigue, 14 (48.27%) had a score of 20, and 5 (17.24%) had a score of less than 20.

5 post-COVID syndrome cases reported difficulty in breathing and were further evaluated by using the modified dyspnea Medical Research Council scale. Three members were post-graduates, 1 was an intern and 1 individual was a staff member. Four of the 5 cases were females.

The Dyspnea scale grades the breathlessness from Grade 0 to Grade 4, with Grade 0 = not troubled by breathlessness except on strenuous exercise, Grade 1 = Short of breath when hurrying or walking up a slight hill, Grade 2 = Walks slower than contemporaries on the level because of breathlessness or has to stop for breath when walking at own pace, Grade 3 = Stops for breath after walking 100 meters or after a few minutes on the level and Grade 4 = Too breathless to leave the house or breathless when dressing or undressing. A grade ≥ 1 was considered significant dyspnea in our study. Out of the 5 individuals with breathlessness, 1 (20%) had Grade 3 dyspnea, 1 (20%) had Grade 2 dyspnea, and the remaining 3 (60%) individuals had Grade 1 dyspnea.

A total of 8 participants in the post-COVID syndrome assessment reported difficulty in concentrating or thinking and mood changes. These individuals were further evaluated by using the Depression, Anxiety, and Stress Scale – 21 items (DASS-21). Out of the 8 individuals, 3 were medical undergraduates, 1 intern, 3 medical postgraduates, and 1 staff member. Seven were females and only one male participant was found among the 8 participants.

The DASS-21 scale is a set of three self-report scales designed to measure the emotional states of depression, anxiety, and stress. Each of the three DASS-21 scales contains 7 items, divided into subscales with similar content. Based on the scores, depression, anxiety, and stress are graded as normal, moderate, severe, or extremely severe. For DASS 21 scale, score for depression > 9 , score for anxiety > 7 and score for stress > 14 was considered as significant in our study.

The scores obtained by the 8 individuals were analyzed and 6 members had a depression score > 9 . Out of the 6 members, 2 members had a score of 14 to 20, 1 member scored 24 and 3 members scored more than 28. Anxiety score analysis of the 8 individuals displayed that 7 members had anxiety scores > 7 . Out of the 7 members, 1 member

Table 5: Distribution of post-COVID syndrome cases among study participants

Category	Number of post-COVID syndrome cases	Percentage (%)
First-year MBBS undergraduates	nil	0
Second-year MBBS undergraduates	9	22.5
Third-year MBBS undergraduates	4	10
Fourth-year MBBS undergraduates	2	5
Medical Interns	3	7.5
Medical Post Graduates	15	37.5
Staff	7	17.5
Total	40	

Table 6: The age distribution of post-COVID syndrome cases

Age Group	Number of post-COVID syndrome cases (n=40)	Percentage (%)	Mean Age + SD (years)
19-29 years	33	82.5	23.90±1.41 years
30-39 years	5	12.5	33.2±0.92 years
40-49 years	1	2.5	47 years
50-59 years	0	0	-
60-69 years	1	2.5	64 years

Table 7: Chi-square test of independence between the student status and occurrence of Post COVID syndrome.

Student status	Post-COVID syndrome present	Post-COVID syndrome absent	Total
MBBS 2	9 (7.03) [0.55]	202 (203.97) [0.02]	211
MBBS 3	4 (6.67) [1.07]	196 (193.33) [0.04]	200
MBBS 4	2 (6.37) [2.99]	189 (184.63) [0.10]	191
Interns	3 (5.73) [1.30]	169 (166.27) [0.04]	172
Post Graduates	15 (7.20) [8.45]	201 (208.80) [0.29]	216
Total	33	957	990

Table 8: Symptoms list of the post-COVID syndrome

Symptoms	Number of cases	Percentage (%)
Difficulty in breathing	5	12.5
Fatigue	29	72.5
Post-exertion malaise	9	22.5
Difficulty in thinking	8	20
Cough	7	17.5
Chest pain	3	7.5
Headache	9	22.5
Palpitations	8	20
Diarrhea	1	2.5
Sleep issues	5	12.5
Dizziness	7	17.5
Mood changes	3	7.5
Changes in menstrual cycles	8	20
Other symptoms	15	37.5

scored 8, 2 members had a score between 10 to 14, and the remaining 4 members had a score of 20 and above. Stress score analysis of the 8 individuals displayed that 5 members had a stress score > 14. Out of the 5 members, 4 members had a score between 19 to 25 and 1 member scored 26.

4. Discussion

Among the 2009 staff and students in our tertiary care institute, 189 were found to be RT-PCR positive for COVID-19. The incidence of breakthrough COVID-19 infection was found to be 9.40%. Similar incidence was reported by a study from AIIMS, Patna, Bihar by Chandra Mani Singh et al which displayed incidence of breakthrough infections at 10%.⁸ Bergwerk M et al reported an incidence of breakthrough infections of 13.1% in healthcare workers.¹ Sachin Dhumal et al studied a cohort of healthcare workers and found that the incidence of breakthrough infections after the second dose of vaccine was 5.6% in a medical institute in Mumbai.⁷

Out of 189 breakthrough cases of COVID-19, 181 (95.76%) had received at least two doses of Covishield vaccination, and the remaining 8 (4.23%) had received at least two doses of Covaxin vaccination. The AIIMS, Patna study claims that they had given only Covaxin to all individuals who participated in their study.⁸ The anti-spike antibody levels were tested by a COVAT study by Singh AK et al where they concluded that both vaccines elicited good immune response after two doses, although seropositivity rates and geometric mean titer of anti-spike antibody titer were significantly higher in Covishield compared to Covaxin recipients. This study also claims that it is not exactly known to what level of binding and neutralizing antibody protects humans from COVID-19.¹³ This explains the incidence of breakthrough infections even after the completion of two doses of vaccination. A pan India randomized controlled trial should be conducted to demonstrate if any real difference in inducing immunogenicity and corresponding efficacy exists between the two vaccines.

Among the 189 breakthrough cases, 84.65% of the cases were observed in the age group of 18 to 27 years followed by 11.64% of cases in the age group of 28 to 37 years. The commonest age of breakthrough infections in the AIIMS, Patna study was \leq 29 years, whereas Dash et al reported breakthrough infections in the age group of 47 years.^{3,8} But in our study as the majority of the study population were medical undergraduate students, the mean age of the breakthrough infected individuals was quite lower.

There was a female predominance in the breakthrough cases with 129 females (68.25%) affected. The infections were more among males in a study by Singh CM et al.⁸ But S. Dhumal et al claim that the incidence of vaccine breakthrough infections was significantly higher in females than males for unclear reasons.⁷ Similar findings have been

reported in studies done by Birhane M et al and Vaishya R et al.^{14,15} In our study, the reason for female predominance could be that the female ratio is higher than the male ratio in our overall student population.

Out of 189 breakthrough infections, 24 (12.69%) were asymptomatic and 143 cases (75.66%) had mild disease. These findings correlate with many studies which reported that the majority of the breakthrough infections were mild and without mortality.^{3,7,8,13} Fever was the most common symptom reported in the breakthrough infections, followed by cough. The most common symptoms found were fever (88.5%) followed by cough (77.6%) and sore throat (59.6%) in a study by Dash et al.³ Fever was the most common symptom in a study done by Singh CM et al.⁸

Out of 189 cases, 5 cases (2.64%) reported asthma, 3 cases (1.58%) had both diabetes and hypertension, and 1 case (0.52%) reported to have hypothyroidism. Comorbidities, such as diabetes, hypertension, hypothyroidism, and asthma were present in about 23.3% of individuals in a study by Dash et al, whereas 11% of the participants were reported to have diabetes mellitus while 12.3% had at least one chronic morbidity other than diabetes in a study done by Singh CM et al.^{3,8} In our study, as the majority of the population were young students, the occurrence of comorbidities like diabetes and hypertension was inconsequential.

A total of 40 participants (21.16%) reported suffering from Post COVID syndrome during the study period. The highest number of post-COVID syndrome cases were found in medical post-graduates (37.5%) followed by second-year medical undergraduates (22.5%). The age group most affected by post-COVID syndrome belonged to the age group of 19 to 29 years. Fatigue was the most common symptom reported in post-COVID syndrome assessment, followed by post-exertion malaise and headache. Similar findings have been reported by Uniyal N et al and Anjana NK et al.^{16,17}

A total of 29 participants reported fatigue and 5 post-COVID syndrome cases reported difficulty in breathing. A total of 8 participants in the post-COVID syndrome assessment reported difficulty in concentrating or thinking and mood changes.

A population-based cohort study by Menges D et al concludes that a wide range of patient-centered, integrative approaches will be required to support the recovery of individuals suffering from the post-COVID-19 syndrome.² A review by Kunal S et al on the emerging spectrum of post-COVID-19 syndrome implies that post-COVID-19 syndrome is associated with a significant social and economic burden for the family and the healthcare system. In addition, poor quality of life and absenteeism from work due to feeling unwell would further lead to loss of productive work hours.¹⁸

The maximum number of breakthrough infections was observed in second-year medical undergraduates followed by medical post-graduates. A chi-square test of independence was performed to examine the relationship between the study year of a medical undergraduate and the occurrence of breakthrough infections. It was found to be statistically significant. This could be attributed to the exposure of the students during clinical postings and hospital duties and a possible lack of adherence to standard infection control practices. A study conducted by Weldetinsae et al among 247 healthcare workers in Ethiopia, showed that 55 of the healthcare workers were compliant with infection control measures. This amounted to only 22.5% of the total study population.¹⁹ In another study carried out by Haas et al among 191 healthcare personnel, compliance to appropriate hand hygiene techniques was observed only 40 % of the time between visits to different patients of COVID-19.²⁰ The significance of COVID appropriate behavior and occurrence of breakthrough infections has been emphasized elaborately by a study done by Masthi R et al.²¹

5. Conclusion

The incidence of breakthrough infections has paved the way for further immunological studies on antibody levels and levels of protection offered by the present vaccines in future exposures if any. Increased awareness and prompt management of post –COVID syndrome by developing integrated approaches to support the recovery of these cases is crucial in the post pandemic era.

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7. Conflict of Interest


None.

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