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Case Study

A Study on School Health Regarding the management and Practices during the Covid-19 Pandemic at Hisar School in the 2021-2022 Academic Period

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PREAMBLE AND PURPOSE

When COVID-19 hit the world, it took millions of lives and had an impact on the health of many people, making a name for itself as the most severe viral infection of this century. Awareness was raised by the World Health Organization which declared an "International Public Health Emergency" on January 30, 2020 and this prompted many measures to be taken to help prevent the infection with the declaration of "Pandemic" on March 11, 2020. Since the first confirmed case in Turkey, protective and restrictive measures were introduced for the whole nation as per the National Guide published by the Turkey Ministry of Health (1).

Restrictive measures pertained to all aspects of life, including - first and foremost - travel and education. Steps were taken towards normalization in a controlled fashion when knowledge about the disease expanded, more successful diagnoses and treatments were carried out and vaccines were introduced. A milestone for efforts towards normalization was the start of face-to-face education with protective measures for the academic period of 2021 - 2022, which covered September 1, 2021 - June 15, 2022. One great concern, however, was the potential role that preschool and primary school students who were yet to be vaccinated and in close contact with one another would play in spreading the disease and the extent to which they would be impacted by the virus.

This study examined an educational institution with 1521 students aged 4-18 and 330 employees that continuously maintained protective measures against COVID-19. How the total number of cases changed, the breakdown of cases by age groups, variants and the presence of vaccination, corelation between such data and overall data for Turkey, and how it changed over time were also analyzed in a retrospective manner.

MATERIALS AND METHOD

Study design

The study was carried out at a private school in Istanbul, Turkey's largest province with a population of 20 million people, and involved a retrospective evaluation of data collected and recorded subject to measures taken against COVID-19. An older age group of students, teachers and school staff was also included in the study. The study began on September 1, 2021, which was the start of the academic year of 2021 - 2022 in Turkey and ended on June 15, 2022. Periods were named the Delta Variant Period and Omicron Variant Period when these variants were considered to be dominant as per the data of the Turkey Ministry of Health when the study was being conducted. Omicron variant was identified on December 10, 2021 for the first time in Turkey (2) and became the dominant variant as of January 1, 2022 (Tuyji Tok Y, 2022). Therefore, September 1, 2021 - January 1, 2022 was the period of Delta Variant, and January 1 - June 15, 2022 was the period of Omicron when our study was being conducted.

The Ministry of National Education strongly recommended

minimum two doses of Covid-19 vaccinations for all teachers and school staff in the academic year of 2021-2022. It was mandatory for unvaccinated individuals to have PCR tests two times a week (as per the statement of the Ministry of National Education on August, 21, 2021).

Forming of study groups

Among students, preschool students (aged 4-5) were named (Group 1), primary school students (aged 6-9) were named (Group 2); middle school students (aged 10-13) were named (Group 3) and high school students (aged 14-18) were named Group 4. Teachers and school staff at older ages were named Group 5.

Protective measures: Once face-to-face education started during the academic year, universal measures were introduced as suggested by the Ministry of Health and the Guide for the COVID-19 Pandemic prepared by Hisar School (1). Measures included the obligation to wear a mask at school and on shuttle buses, take care of hand hygiene, distance at classrooms, offices and shuttles, plexi-glass barriers between rows, and cancellation of sports and shows which normally take place in crowded settings. In addition, primary and middle school students ate lunch at their classrooms, while high school students used the refectory only in a controlled fashion and by taking distance. Individuals other than students and school staff were not allowed to enter or exit the premises. All ventilation systems were supported with natural ventilation or HEPA filters, and regular maintenance was conducted. Communication channels for students and parents to easily contact with the administration were made fully accessible. This enabled prompt access to information regarding suspected contacts and new infections. Meetings and seminars were held online. A hybrid program was put in place for students reported to have chronic illness or be in isolation due to Covid-19 infection/close contact who were enabled to attend classes online.

Contact tracing and assessment of patients and close contacts

A database was created for students and staff who either had close contact with an infected individual or showed active symptom of the virus (Hisarnet-Infirmary). All cases entered into the database were made easily traceable on Hisarnet. Rapid antigen testing was provided to employees who showed symptoms of COVID-19 including fever, fatigue, sore throat, coughing, muscle and joint pain, and headache. Additional PCR testing (COBAS, SARS-CoV-2 Roche Diagnostic, UK) was provided to those whose antigen tests came out positive. People who had close contact were re-tested 5 to 7 days after their first rapid antigen testing was negative. Students and staff, who had close contact or were confirmed to have been infected as per serological and PCR tests, were enabled to rest at home for a period of 7 - 14 days after first diagnosis. Students or school staff who had close contact with infected individuals was examined in the same manner. Demographics, symptoms, contact history and vaccination status of confirmed cases were recorded. Cases who isolated and received treatment due to Covid-19 were identified as "Active Cases" (1). COVID-19 patients with mild to medium pneumonia despite treatment as well as those patients who had severe pneumonia were hospitalized as per the COVID-19 (SARS-CoV-2 Infection) Adult Patient Treatment Guide (4) and COVID-19 (SARS-CoV-2 Infection) Pediatric Patient Management and Treatment Guide (5) released by the Turkish Ministry of Health's Public Health General Directorate. Aside from school staff, testing was not made mandatory for students to come back to school after their isolation period ended. Risky behavior of all students and staff confirmed to be infected was analyzed and protective measures implemented were revised in light of this information.

Vaccination

Students and employees were registered for the COVID-19 vaccination program as suggested by the Turkish Ministry of Health. Minimum age for vaccination was reviewed in line with the recommendations of WHO and the Turkish Ministry of Health (6). The study also kept a record of those who reacted to vaccines sensitively or were unable to tolerate vaccines. Inactive virus vaccines (Coronavac-Sinovac, China) and vaccines prepared via genetic mRNA technology (Biontech, Germany) were used during the vaccination program. All data related with vaccination was entered into the automation system.

Statistics

Values showing the ratio of COVID-19 patients to those who were not infected are shown in percentage. Furthermore, incidence densities of 1000 school days for each group were also identified in this study. Incidence densities were calculated as infection frequency per 1000 school days [(Covid-19 Cases / Number of school days) x 1000]. There were 181 school days in the 2021-2022 academic periods.

Graphics were created as per the "absence due to Covid-19 report" provided by the Turkish Ministry of Health, while each case between reports start and end days was considered to be "active case". For active cases in Turkey, daily active cases were calculated on the basis of daily new cases and daily recoveries as announced by the Turkish Ministry of Health. Chi-square tests were used in vaccinated-unvaccinated / covid-19 (+) – covid-19 (-) assessments and statistical relevance was identified to be 5% (Alpha).

FINDINGS

Covid-19 conclusions

1851 people were included, 1521 of them students and 330 school staff, in the study for the academic year of 2021-2022. 50% of the students and 36% of staff were male. The largest student population was in Group 4 (Table 1). 144 students

(8%) were in Group 1, 440 (24%) in Group 2, 445 (24%) in Group 3 and 492 (26%) in Group 4. Group 5 consisted of 239 teachers (72%) and 91 (28%) school staff. With the exception of one (0.06%) student, all students continued with their schooling except when they were infected or under quarantine.

The total number of students who were confirmed cases of COVID-19 was 520 (34%), and the number of students and staff with confirmed infection was 138 (42%). COVID-19 incidence density was 2873 / 1000 school days for students and 762/1000 school days for teachers and staff. When we assessed by group, the highest COVID-19 ratio and incidence density was in Group 3 (45% and 1116 cases / 1000 school days) (Table 1). Covid-19 infection ratios among teachers were 45%, while incidence density was 591/1000. All teachers and school staff (all Group 5) had at least two doses of vaccines when instruction began **(Table 1)**.

An assessment of variant strains shows that Delta variant infection ratio was 9%, and Omicron variant infection ratio was 25% among students. Incidence density for the Delta variant was 1734/1000 school days when it was 3755/1000 for Omicron among students. Similarly, Covid-19 cases of Delta for school staff were 13% and 28% for Omicron variant. Incidence density for the Delta variant was 557/1000 school days when it was 922/1000 for Omicron among staff. 28% of Covid-19 cases at the school co-incided with the wave of the Delta variant, and 72% coincided with the Omicron variant. During the study, one student (0.06%) and one member of the staff (0.3%) were hospitalized for treatment as they had severe infection. No confirmed case of Covid-19 resulted in death.

Rapid test results provided on days 5 and 7 for staff who had close contact and comparative results with PCR tests. Rapid Test and PCR Comparative Results: When compared with PCR, rapid test sensitivity was 93.8%, specificity was 99.3%, positive predictive value was 76.9% and negative predictive value was 99.8%. When all cases were assessed, overall accuracy 99.1% **(Table 2)**.

Table 1. Covid-19 ratios and incidence densities by group.

Groups	Group Numbers (%)	Disease Ratio (%)	Incidence Density of the Disease (/1000 school days)
Group 1	144 (8%)	17	133
Group 2	440 (24%)	32	785
Group 3	445 (24%)	45	1116
Group 4	492 (26%)	31	840
Group 5	330 (18%)	42	762
TOTAL	1851 (100%)		

Table 2. Rapid test / PCR comparison.

Results	PCR(+)	PCR(-)	Total
Rapid test (+)	30	9	39
Rapid test (-)	2	1208	1210
Total	32	1217	1249

For all cases involved in the study, time-bound COVID-19 Active Case Curve and its comparison with Turkey's Active Case curve is provided in Figure 1. For our cases, time-bound curve of Covid-19 is similar with Turkey's Active Case curve. However, it was January 2022 when Covid-19 peaked for our cases, while this peaking was on the first days of March 2022 for Turkey's Active Case Curve (**Figure 1)**.

For the cases in Group 1, change curve over time and Turkey's Active Case curve is provided in Figure 2. Although cases in Group 1 peaked in mid-January 2022, it was the early days of March 2022 for overall Turkey when the disease peaked **(Figure 2)**.

For the cases in Group 2, change curve over time and Turkey's Active Case curve is provided in Figure 3. Times when cases in Group 2 peaked and the period when cases peaked across Turkey was similar, meaning the initial days of March 2022 (**Figure 3)**.

For the cases in Group 3, change curve over time and Turkey's Active Case curve is provided in Figure 4. Although cases in Group 3 peaked in mid-January 2022, it was the early days of March 2022 for overall Turkey when the disease peaked **(Figure 4)**.

For the cases in Group 4, change curve over time and Turkey's Active Case curve is provided in Figure 5. Although cases in Group 4 peaked in mid-January 2022, it was the early days of March 2022 for overall Turkey when the disease peaked **(Figure 5)**.

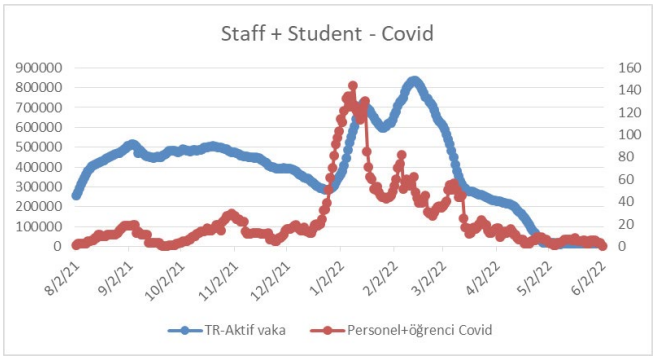

Figure 1. Comparison of all active cases with Turkey's active cases.

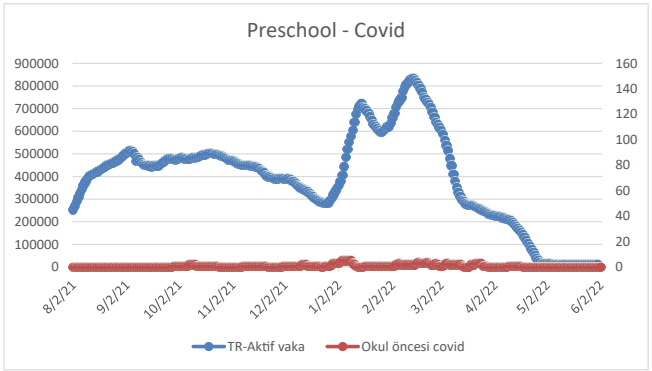

Figure 2. Comparison of number of cases in group 1 with the number of active cases in Turkey.

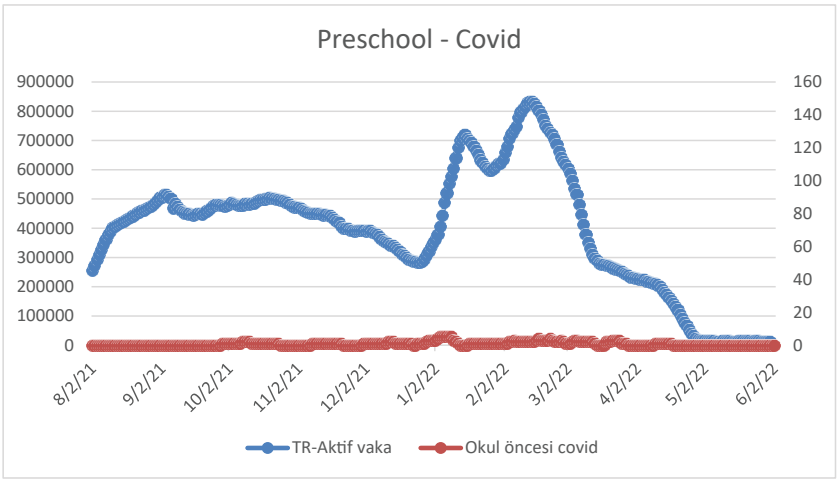

Figure 3. Comparison of number of cases in group 2 with the number of active cases in Turkey.

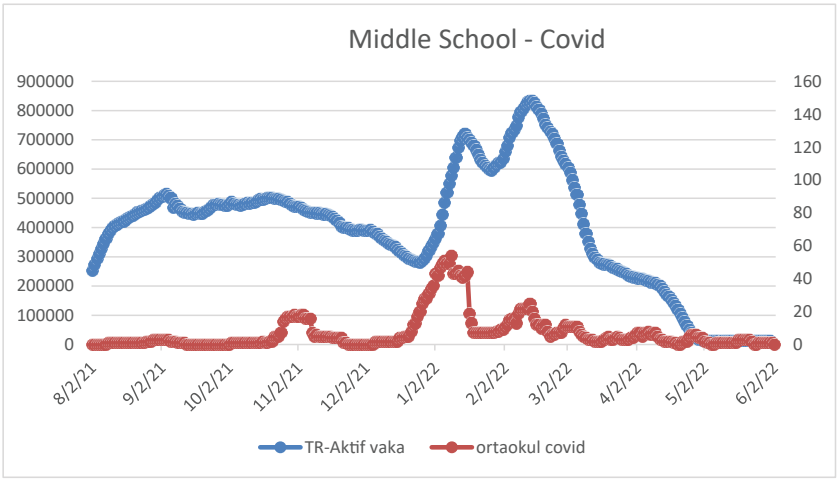

Figure 4. Comparison of number of cases in group 3 with the number of active cases in Turkey.

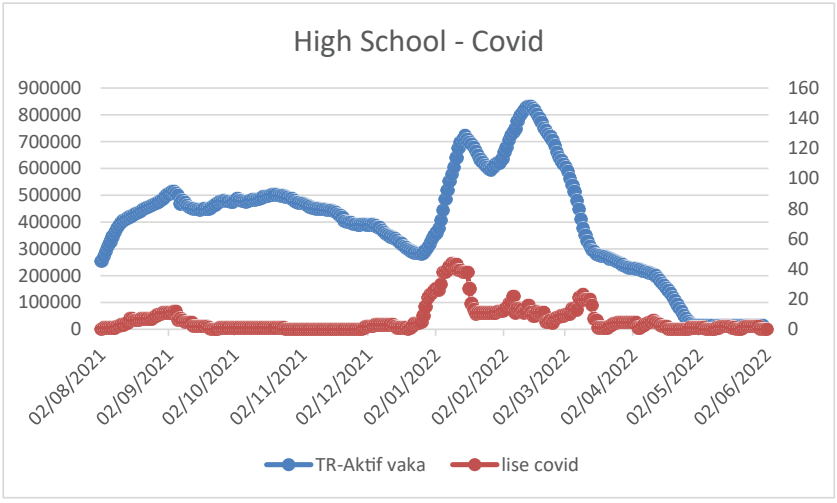

Figure 5. Comparison of number of cases in group 4 with the number of active cases in Turkey.

For the cases in Group 5, change curve over time and Turkey's Active Case curve is provided in Figure 6. Although cases in Group 5 peaked in January and early February 2022, it was the early days of March 2022 for overall Turkey when the disease peaked **(Figure 6)**.

Covid-19 conclusions by vaccination status

COVID-19 prevalence was 30% and incidence density was

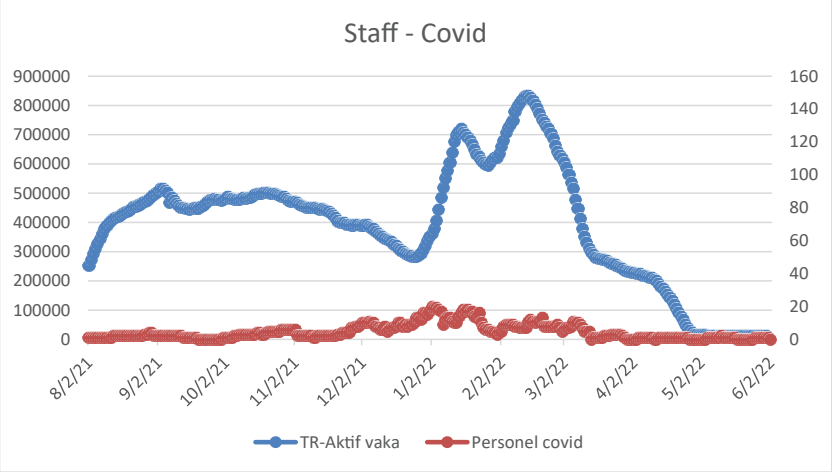

Figure 6. Comparison of number of cases in group 5 with the number of active cases in Turkey.

Table 3. Comparison of groups by COVID-19 diagnosis.

GROUPS	Group 1		Group 2		Group 3		Group 4		Group 5	
	Vaccinated	Unvaccinated	Vaccinated	Unvaccinated	Vaccinated	Unvaccinated	Vaccinated	Unvaccinated	Vaccinated	Unvaccinated
	-0.07%	-99.30%	-0.09%	-99.10%	-26%	-74%	-73%	-27%	-100%	0%
COVID-19 Positive	0 (0)	24	2 (0.45%)	140 (32%)	33 (7.4%)	169 (38%)	109 (22%)	43 (9%)	138 (42%)	0
		-17%								
COVID-19 Negative	1	119 (83%)	2 (0.45%)	296 (67%)	82 (18.4%)	161 (36%)	251 (51%)	89 (18%)	192 (58%)	0
	-0.07%									
P	0.653		0.446		0.000001		0.625		-	
TOTAL	1	143	4	436	115	330	360	132	330	0

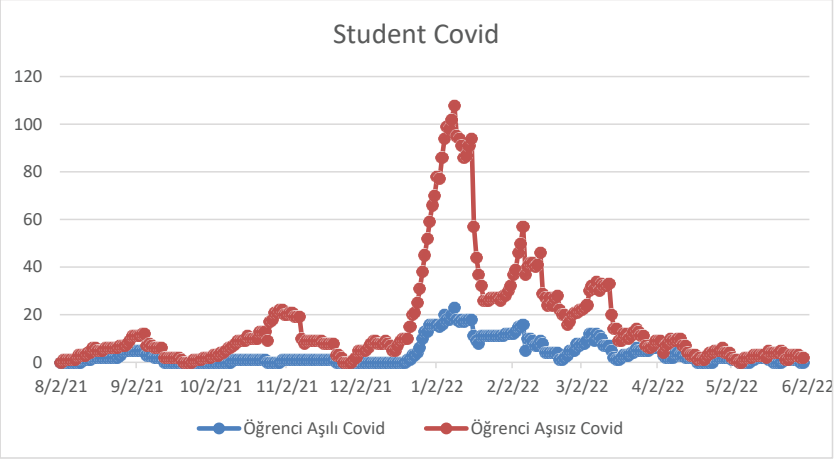

Figure 7. Time-bound change of COVID-19 seen in vaccinated and unvaccinated students.

795 per 1000 school days among vaccinated students. COVID-19 prevalence was 42% and incidence density was 762 per 1000 school days among vaccinated staf. When unvaccinated individuals were assessed, its ratio was 36% among students and incidence density was 2077/1000 school days. All teachers and school staff were vaccinated.

When cases with COVID-19 diagnosis are assessed by groups, the highest number of cases was seen in Group 5 among vaccinated individuals and the highest number of cases was seen in Group 3 among unvaccinated individuals **(Table 3)**.

Time-bound experience of COVID-19 by students' vaccination status is shown in Figure 6. There is a remarkable difference in the number of cases between Covid-19 positive cases among unvaccinated students and vaccinated students although confirmed cases peak in the same period. However, positive cases of Covid-19 are lower in number among vaccinated people **(Figure 7)**.

DISCUSION

This study shows the time-bound evolution of COVID-19 in real time for a wide range of age groups including pre-school, primary school, middle school and high school students as well as teachers and staff. This study is a cohort study since it relates to the surveillance data of a school where vaccination was provided and all necessary measures were taken against COVID-19 in line with universal guidelines. Furthermore, this data is compared with the time-bound pandemic data across the country.

When all cases are taken into consideration, school time-bound active case disease curve is similar with the graphs of cases across the country. However, the prevalence is at its highest in mid-January 2022, while the peaking level of active cases coincides with the early days of March 2022 in Turkey. When compared with Turkey's data, the disease curve has a similar rising curve when compared to the increase in the number of cases. However, it is seen that the school's curve dropped in a shorter amount of time. This may be linked with preventive measures being more effective and helping the school take control of the disease for a smaller population at the school. It may also be related with continued surveillance of confirmed cases depending on who contacted with them and implementation of a monitoring system required for close contacts.

When active case curves related with COVID-19 are assessed, the disease is seen to have risen in number in several time periods. This rise, however, is associated with the time when new variants emerged rather than a seasonal fluctuation. A study by Di Domenico L et al. discusses that, although seasonal fluctuations for Covid-19 are expected like in influenza, this has not been the case. In Turkey, we have also seen fluctuations caused by successive CoV2 variants. This study has also shown that when all conventional measures are combined with patient isolations, vaccinations and regular testing procedures in the face of growing number of cases during the academic period, the process can be managed without having to shut down schools (Di Domenico L, 2021).

When we compare the results of our study with data in Turkey, no remarkable rise is observed when restrictions are lifted and face-to-face education is started at school. In addition, the active case curve is no different from society at large. According to a study conducted in Brazil, when the data of 8,764 schools conducting face-to-face education is compared with 9,997 schools continuing with remote instruction, cumulative COVID-19 incidences at open schools is 20 cases per 1,000 individuals and 0.5 deaths per 1,000 individuals. Meanwhile, the incidence is 18 cases per 1,000 individuals and 0.45 deaths per 1,000 individuals at closed schools. Study findings show that keeping schools open during the COVID-19 pandemic does not have an adverse contribution to total disease activity (Lichand G, 2022).

Another point that raised our attention was the gradual drop in the number of cases starting from mid-January 2022 despite the Omicron variant which posed a higher risk of contraction. This trend was seen across Turkey only as of the initial days of March 2022, and lower levels continued in the months that followed. A drop in the number of cases across the country may be linked with the effectiveness of vaccination and herd immunity turning into a norm. Indeed, m-RNA vaccines are reported to reach 60 to 70% after the third dose, while providing effective protection against severe illness (Tseng HF, 2022).

When we look at the number of cases per school day (incidence density), the highest numbers are observed in the unvaccinated student population, and education continued in hybrid format for a period of 7-14 days so as to prevent any interruption in instruction. A study by Jahan FA et al. clearly showed the necessity of hybrid instruction models to prevent interruption due to numerous natural disasters in the US, the most recent being the COVID-19 pandemic (Jahan FA, 2022). One striking impact of COVID-19 has, without a doubt, been the rapid spread of remote communication and education models and their successful implementation. This has also enabled remote education, which became widespread after COVID-19, to turn into a lasting alternative across the world. Aside from education, this trend has brought along several opportunities in business.

The number of COVID-19 cases among students and school staff was higher at the initial stage of our study, which coincided with the time period when Omicron was a more prevalent offshoot compared to Delta. The curve of positive cases over time started to drop gradually during the Omicron variant period and reached the levels of Delta variant after four months. It was found that curves dropped drastically starting from March 2022, when the disease was at its peak during the Omicron period, and it was taken under control after May. However, the curve of the disease is seen to plateau in the Delta variant period. This difference may be linked with the fact that, although a lasting immune response was not developed even after the infection, vaccination was more widespread during the Omicron variant period and antibody levels were raised through repeated booster shots. Rapid antigen tests provided to employees who had close contact with infected persons were quite effective in detecting positive cases, and patient isolations were managed successfully.

Vaccination had, without a doubt, the most defining impact on the COVID-19 pandemic. When we assessed the vaccination status of cases, Group 5 was fully vaccinated, while Group 4 comprising the age group of 14-18 had the highest ratio of vaccination among students. Most COVID-19 cases and incidence densities were seen in Group 3, where the vaccination ratio was lowest. ($p= 0.000001$). This could be resulting from the fact that parents of Group 3, which comprises students aged 10-13, are able to keep them under control less frequently when outside school, and their risky social interaction after school is as frequent as Group 4. The

meta-analysis of 32 studies conducted by Viner et al. and the study by Arvanitis et al. shows that adolescents at the age of 10-14 have lower sensitivity to the infection of SARS-CoV-2 compared to older adolescents and adults (Viner RM et al., 2020)(Arvanitis M et al., 2021).

A school health study (10,000 students and 2,500 cases) carried out by Akira et al. examined pandemic management strategies at schools and simulated respiratory disease infections inside and across classrooms. One point discussed there was the need to make an epidemiologic assessment of the strengths and weaknesses of response methods while planning school infection management. It was concluded that regular testing enables rapid detection and isolation of positive cases, almost crossing out the requirement of closing classrooms. One should not forget that combined, rather than isolated, implementation of measures including vaccination and treatment is essential in fighting a pandemic caused by an agent contracted via the respiratory tract (Endo A et al., 2022). Although rapid antigen tests we used in our study were used to detect positive cases, its high selectivity in identifying negative cases made it much easier for us to handle Covid-19 cases at the school.

Sensitivity and specificity of SARS-CoV-2 rapid antigen tests with oral, intranasal and nasopharyngeal implementation was examined in a study carried out by Wölfl-Duchek et al. In this study, sensitivities of nasopharyngeal and intranasal swabs taken from persons with a CT value (cycle threshold value) below 30 by professionals were found to be similar. This shows the reliability of the results produced by rapid antigen tests implemented with interior nasal swabs (Wölfl Duchek M et al., 2022).

When one looks at the scale of the pandemic, this school could be considered a small population despite hosting students and adults of all ages and being located in Istanbul. With the awareness that every country has a different pandemic strategy, implementation of the same rules at all schools in similar time periods had a positive impact on the management of crowded spaces like schools in Turkey. We agree with McKaylee M. Robertson et al which suggested that population-based surveys are an important surveillance tool (Robertson MM et al., 2022).

Our study, despite being conducted on the basis of data obtained via close monitoring of all students and employees during the academic period with face-to-face instruction, has certain restrictions. They include the inability of identifying the sources of contraction among positive cases and asymptomatic cases, as well as the inability of preventing social interaction among students, who came together after a long period of restrictions, which sometimes prevented the measures in place from being effective.

CONCLUSION

As a result of this study

1. This study could guide potential pandemics in the future since no similar study was conducted in Turkey and it is an appropriate summary of the period experienced.

2. The difference between positive cases among vaccinated and unvaccinated persons in Group 3 was found to be significant (p= 0.000001). In this group, we see that being vaccinated reduces the risk of Covid-19 disease in a statistically significant manner.

3. When we separated all cases into groups of vaccinated and unvaccinated persons, we saw a difference, albeit being not statistically significant, between disease ratios. Reasons as to why this difference was insignificant included the virus maintaining itself with different variants, people not having booster shots, and the existence of continued exposure to virus.

4. During the Delta variant period when employees were receiving vaccines, protective features of the vaccine were more evident by looking into the low number of cases in Group 5 compared to the general population in Turkey. However, due to more prevalent mutations of the Omicron variant with the capability of evading vaccines, and to employees not having booster shots starting from December 2021, the number of cases among vaccinated persons reached similar levels with the cases among unvaccinated persons.

5. Being vaccinated prevents hospitalizations and death; however, it does not have a significant impact on whether the disease will be experienced with mild or no symptoms.

6. Implementation of continuous and regular preventive measures and the importance of surveillance is essential according to our study.

7. Rapid antigen tests' ratio of detecting negative cases was 99%, therefore we could consider such cases as true negative cases. As PCR tests' and rapid antigen tests' ratios of detecting positive values are quite similar, we think that rapid antigen testing saves time and labor, while playing a facilitating role in pandemic management as a practical and viable method at school.

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