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The Effect of COVID-19 Rapid Antigen Testing in Education on Early Detection and Prevention of Epidemics: A Faculty Example from Trakya University

Eğitim Alanında COVID-19 Hızlı Antijen Testinin Olguları Erken Tespit Etmede ve Salgının Önlenmesinde Etkisi: Trakya Üniversitesinden Bir Fakülte Örneği

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ABSTRACT

Introduction: *To ensure the safe continuation of face-to-face education, there is ongoing discussion regarding the routine use of easily applicable tests. This study aimed to determine the effectiveness of the COVID-19 rapid antigen tests in the early diagnosis of COVID-19 cases among university students studying face-to-face.*

Materials and Methods: *Our study spanned a duration of eight weeks and included students from three different departments within a faculty. The first group of students underwent rapid antigen tests twice a week, with positive results confirmed by PCR testing. The second group was visited twice a week, and students displaying symptoms underwent both rapid antigen and PCR tests. The third group was monitored solely through the use of "Hayat Eve Sığar (Life Fits Into Home)" codes. To identify asymptomatic cases and students who did not report their symptoms in the second group, all volunteers on the final day of the study underwent screening using rapid antigen tests. The groups were compared based on the obtained results, and a questionnaire was administered to the students during each visit. This approach allowed for the investigation of factors associated with positive cases.*

Results: *A total of 274 students participated in our study, with 114 (41.6%) in the first group, 96 (35.0%) in the second group, and 64 (23.4%) in the third group. The rate of detecting the cases in the first group was significantly higher than in the second and third groups.*

Conclusion: *The obtained findings indicate that COVID-19 rapid antigen tests, as mentioned, can serve as a screening tool for the early detection of cases and prevention of further spread among students during face-to-face education. These results align with the criteria established by international organizations and epidemiological standards. By screening all participating students, the potential for bias is minimized, enabling the identification of asymptomatic individuals who may unknowingly transmit the virus.*

Key Words: *COVID-19; Education; Rapid antigen testing; SARS-CoV-2; Surveillance*

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ÖZ

Eğitim Alanında COVID-19 Hızlı Antijen Testinin Olguları Erken Tespit Etmede ve Salgının Önlenmesinde Etkisi: Trakya Üniversitesinden Bir Fakülte Örneği

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Giriş: *Yüz yüze eğitimin güvenli biçimde devam edebilmesi için uygulanması basit olan testlerin rutin kullanıma girmesi tartışılmaktadır. Bu çalışma, yüz yüze eğitim gören üniversite öğrencilerinde COVID-19 vakalarının erken teşhisinde COVID-19 hızlı antijen testinin etkinliğini belirlemeyi amaçlamıştır.*

Materyal ve Metod: *Çalışmamız sekiz hafta sürmüştür. Bir fakülteden üç farklı bölümün öğrencileri çalışmaya dahil edilmiştir. Birinci gruba her hafta iki defa hızlı antijen testi yapılmış, pozitif çıkanlar PCR testi ile doğrulanmıştır. İkinci grup haftada iki defa ziyaret edilmiş, sadece semptomu olan öğrencilerden hem hızlı antijen hem de PCR testi çalışılmıştır. Üçüncü grup ise sadece "Hayat Eve Sığar" kodlarıyla takip edilmiştir. İkinci grupta asemptomatik vakaları ve semptomunu belirtmemiş öğrencileri tespit edebilmek için çalışmanın son gününde gönüllü olan tüm öğrenciler hızlı antijen testi ile taranmıştır. Elde edilen sonuçlar ile gruplar karşılaştırılmıştır. Her ziyaret sırasında öğrencilere bir anket uygulanmıştır. Böylece pozitif vakalar ile ilişkili faktörler araştırılmıştır.*

Bulgular: *Çalışmamıza birinci grupta 114 (%41.6), ikinci grupta 96 (%35.0) ve üçüncü grupta 64 (%23.4) olmak üzere 274 öğrenci katılmıştır. Birinci grupta vakaların yakalanma oranı ikinci ve üçüncü gruba göre anlamlı şekilde yüksek bulunmuştur.*

Sonuç: *Elde edilen bu değerler hem uluslararası kuruluşların belirlediği kriterlere hem de epidemiyolojik standartlara göre söz konusu COVID-19 hızlı antijen testinin yüz yüze eğitim sürerken olguları erken saptamada bir tarama testi olarak kullanılabileceğini ortaya koymaktadır. Derse katılan tüm öğrencilerin taranması ile hem bias ihtimali ortadan kalkmakta hem de asemptomatik olan ancak virüsü yayan öğrenciler tespit edilebilmektedir.*

Anahtar Kelimeler: *COVID-19; Eğitim; Hızlı antijen testi; SARS-CoV-2; Sürveyans*

INTRODUCTION

The global impact of the ongoing coronavirus disease-19 (COVID-19) pandemic, which originated in December 2019, remains significant. Effective public health measures based on scientific evidence are crucial for successfully combating the pandemic. To interrupt the transmission chain of the disease, it is essential to expedite the vaccination process while promptly identifying and isolating contacts[1].

Since the beginning of the pandemic, the scientific community has been focused on understanding the performance of tests that detect SARS-CoV-2 in terms of their high sensitivity and specificity when administered. However, the purpose of these tests needs to be addressed. In addition, it is not always possible to identify all asymptomatic cases. During the process of collecting samples for polymerase chain reaction (PCR) tests, sending them to testing centers, and awaiting the test results, infected individuals may have unknowingly transmitted the virus to numerous individuals. Consequently, rapid antigen tests (RAT) have gained prominence as they can be conducted at the point of care, provide quick results, are more cost-effective, and require less labor compared to PCR tests. A RAT performed at regular intervals acts as a filter for COVID-19. Naturally, at this stage, it is essential to determine the specific criteria for administering this test, including the target population, and timing. Moreover, it is important to establish the expected turnaround time for obtaining the test results and define the frequency at which the test should be conducted[2].

An affordable rapid antigen test that can be conducted frequently would be adequate for

the timely detection of infections without the need to identify individuals with low viral loads. After the virus enters the body, the viral load cannot be detected by PCR before it enters the logarithmic phase. It becomes detectable by PCR at the initial stages of the logarithmic phase. To reach a detectable level with a rapid antigen test (RAT), the viral load should be in the logarithmic phase, preferably in the middle range. However, considering that the viral load peaks within a few hours and decreases more gradually afterward, using RAT may only result in a delay of a few hours in detection. In the recovery phase of the disease, it is possible to encounter viral loads that are undetectable by RAT but can still be detected by PCR. However, during this period, the virus has largely lost its contagiousness. As the risk decreases further in the subsequent days, it is believed that quarantining the individuals has limited effects on public health[2,3].

During the COVID-19 pandemic, the closure of schools has emerged as a pressing concern to adhere to social distancing measures. The United Nations Educational, Scientific and Cultural Organization (UNESCO) has estimated that schools were fully closed in 138 countries and partially closed in others[4]. The suspension of in-person education in schools due to the COVID-19 pandemic has been one of the most widely discussed issues globally, including in Türkiye[5-7]. This study was conducted in response to the lack of precise knowledge regarding the impact of keeping schools open during periods of increasing COVID-19 cases and new waves of the epidemic. The absence of scientific data-based information on the conditions necessary for the continuation of face-to-face education prompted this study. The objective was to evaluate the effectiveness of COVID-19 rapid antigen testing (RAT) in the early diagnosis of COVID-19 cases among university students engaged in face-to-face learning.

MATERIALS and METHODS

The study continued for eight weeks from 15.11.2021 to 06.01.2022. Two classes from the Department of "Health Management," and one class from each of the departments of "Physiotherapy and Rehabilitation" and "Audiology" from the Faculty of Health Sciences of Trakya University were included in our study. No sampling was conducted within the selected classes, and the intention was to include all students in the study on a voluntary basis. The students were provided with detailed explanations regarding the duration of the investigation (eight weeks), the nature of the nasal swab collection during the testing process, the confidentiality of test results (shared only with the respective student), and their freedom to withdraw from the study at any time. Those who declined participation were also requested to provide written reasons for their decision.

When selecting the departments to be included in the study, one of the criteria considered was that the students should not be undergoing an internship at a hospital. The participating students were divided into three groups: the first group consisted of Health Management students, the second group comprised Physiotherapy & Rehabilitation students, and the third group consisted of Audiology students. The students in the first and second groups were visited in their classrooms two non-consecutive days per week before their lessons.

The study included several independent variables, such as age, gender, symptoms outlined in the Ministry of Health's COVID-19 guide, place of residence, smoking status, mask usage, mode of transportation to school, hand-washing practices, previous COVID-19 status, vaccination status, presence of underlying diseases, history of medication use, number of individuals residing together, participation in social activities, traveling outside the city, arrival from outside the city, and history of hospitalization[8]. Dependent variables were determined as COVID-19 rapid antigen and SARS-CoV-2 PCR tests. A questionnaire was developed, taking into account the independent variables, and it was administered to the volunteer students who attended the lessons during each visit.

In Türkiye, the Ministry of Health has developed a mobile application called "Hayat Eve Sığar (HES)," an electronic coding system where citizens can monitor risks and health conditions. Through the HES application, individuals can

conveniently access the latest updates on the virus, view the risk map of their location, and find information about nearby healthcare institutions, pharmacies, subway stations, and other relevant facilities. This is facilitated by completing the questionnaire about their health status. This practice aims to minimize the risks associated with the pandemic and prevent its spread. As part of this application, a unique HES code is generated for each individual[9]. People needed this HES code to enter indoor public areas such as groceries and hospitals or participate in any activity. In Türkiye, not everyone has access to SARS-CoV-2 PCR testing. To undergo the test, individuals are required to visit a hospital and have it requested by a physician based on the indications outlined in the Ministry of Health COVID-19 Guidelines[8]. The result of the test is shown in the person's HES code. Based on this process, individuals are classified as "risky" or "risk-free." In this study, all students' HES codes were recorded, and a daily check was conducted using the university's computer program to identify any students whose HES codes transitioned to the "risky" category. This allowed for the monitoring of students who became infected during the study, as well as those who were diagnosed with COVID-19 outside the study.

In the first group, RAT was performed twice a week on all the volunteer students, regardless of their symptoms. Students who received a positive result on the rapid antigen test (RAT) underwent confirmation testing using the SARS-CoV-2 PCR test. Samples could not be collected from students who were absent from class on a given day. In the second group, students who reported symptoms on the questionnaire form underwent both rapid antigen tests (RAT) and SARS-CoV-2 PCR tests twice a week. Students who did not report any symptoms were not tested. Students who were absent from class on a particular day were unable to participate in the questionnaire. The third group was designated as the control group, and neither rapid antigen tests (RAT) nor SARS-CoV-2 PCR tests were conducted on these students. Instead, their tracking and monitoring were solely based on the HES code system.

By the eighth week, the low rate of symptom reporting in the second group and the detection of only one case through the tests raised the need to assess the actual situation among the students. To address this, rapid antigen tests (RAT) were conducted on students who voluntarily provided samples at the end of the eighth week. This allowed for the identification of asymptomatic cases and students who did not report their symptoms within the second group. SARS-CoV-2 PCR testing was performed to confirm the positive cases detected by RAT.

The screening test utilized in this study was the FDA-approved Becton Dickinson Veritor™ System, a SARS-CoV-2 rapid antigen test. The test was conducted following the recommendations provided by the manufacturer[10]. The swab included in the kit was advanced two centimeters through both nostrils and rotated five times to collect a sample. The samples on the swab were homogenized in the extraction kit and studied within half an hour. The test result was evaluated within 15 minutes. SARS-CoV-2 PCR (DS Coronex COVID-19 multiplex qRt-PCR test kit ver. 2.0, DS Bio and Nano Technology, Türkiye) was used for the confirmation test.

Statistical data analysis was performed using SPSS 22 (SPSS Inc., Chicago, IL, USA). Initially, the conformity of the variables to a normal distribution was assessed using statistical tests such as the Kolmogorov-Smirnov or Shapiro-Wilk test. Descriptive statistics were provided for the variables. In the statistical analysis, discrete variables were compared using the Chi-square test and its variants, such as Fisher's exact test, while continuous variables were compared using the t-test and ANOVA. For dependent groups, the McNemar test was used for Chi-square analysis, and t-tests and repeated measures ANOVA (RM-ANOVA) were employed for continuous variables. The significance level was set at $p< 0.05$.

Permission was obtained from the Ministry of Health of the Republic of Türkiye, the Faculty of Health Sciences of Trakya University, and the Scientific Research Ethics Committee of Trakya University (TUTF-BAEK 2021/383) to conduct the study. The Scientific Research Projects

Commission of Trakya University supported the study within the "Priority Area Project" scope (TUBAP 2021/116).

RESULTS

A total of 274 students, 114 (41.6%) of whom were in the first group, 96 (35.0%) in the second group, and 64 (23.4%) in the third group, participated in our study (Figure 1). The students participating in the research represented 30.3% of the class size in the first group. This rate was 95.0% and 87.7% for the second and third groups. Of the 269 students who did not participate in the study, 48 (17.8%) stated the reason for not participating in the study in writing. All of these students were in the first group. The reasons for non-participation were reported as follows: "I do not want to participate" (31.3%), "I will not be able to maintain continuity" (25%), "I am nervous about the PCR test" (10.4%), "I am afraid of being positive" (10.4%), and "I do not trust the PCR test" (8.4%). "Fear of nosebleeds," "having a chronic illness," and "not attending because he/she will apply to a health institution if he/she has symptoms" are among the other reasons.

The mean age of the participants was 20.0 ± 1.6, and the essential characteristics of the participants are shown in Table 1. Upon evaluating the sections in terms of basic characteristics, it was observed that the third group had a lower proportion of male students, a higher percentage of students residing in dormitories, and a lower frequency of using public transportation ($p< 0.05$). It was found that the first group smoked more than the other groups and changed masks more frequently during the day ($p< 0.05$). There were no students with a hospitalization history. No significant differences were found among the other independent variables between the groups ($p> 0.05$).

Nine hundred eighty-one questionnaires were filled out in the first group and 1093 in the second group. In the first group, 59 out of 114 students reported symptoms during eight weeks. Eight students were positive at different weeks. The RAT results of these eight students were also confirmed by SARS-CoV-2 PCR (Ct value, the lowest: 18.0, the highest= 28.5). Among the eight students who tested positive, three of them reported no symptoms in the questionnaire conducted during the visit, while the remaining five reported experiencing at least one symptom.

None of the study participants were identified as having a "risky" HES code outside of the study. Within the second group, a total of 32 out of 96 students reported symptoms over the course of the eight-week study. Since some students reported symptoms repeatedly on different days, RAT and SARS-CoV-2 PCR tests were performed on 32 students 65 times in total. While no student's RAT was positive, one student's SARS-CoV-2 PCR test was positive.

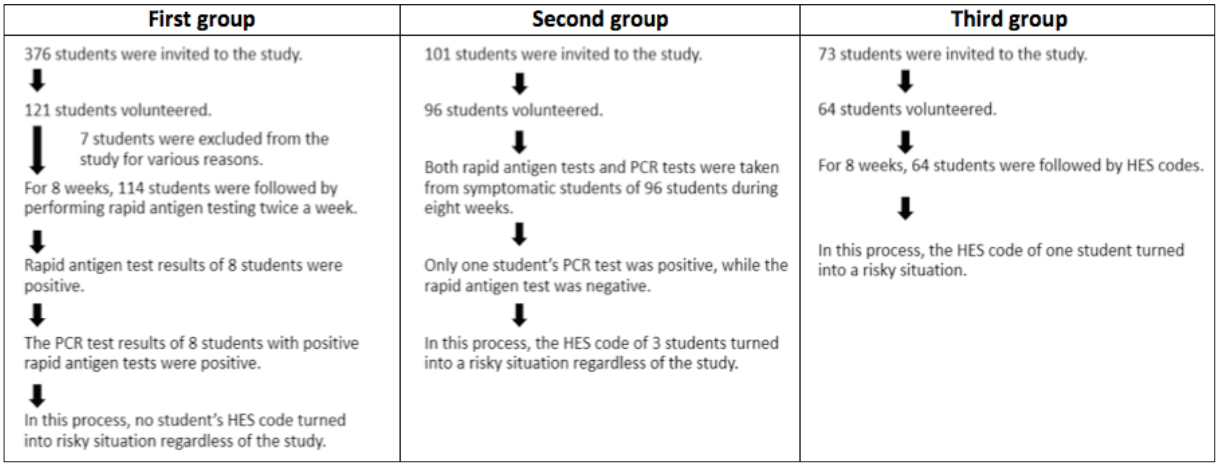

Figure 1. Study plan.

HES: Hayat eve sığar (Life Fits Into Home), PCR: Polymerase chain reaction.

Table 1. Some characteristics of the students participating in the study

	First group (n= 114)		Second group (n= 96)		Third group (n= 64)		
Characteristic	**n**	**%**	**n**	**%**	**n**	**%**	**p**
Gender							
Female	75	65.8	62	64.6	55	85.9	<0.05
Male	39	34.2	34	35.4	9	14.1	
Place of Residence							
Student dormitory	66	57.9	62	64.6	54	84.4	<0.05
Others	48	39.3	34	35.4	10	15.6	
Smoking							
Yes	54	47.4	34	35.4	14	21.9	<0.05
No	60	52.6	62	64.6	50	78.1	
Mask use							
1 per day	47	41.2	50	52.1	41	64.1	<0.05
More than 1 per day	67	58.8	46	47.9	23	35.9	
Transportation to school							
Public transport	58	50.9	54	56.2	16	25.0	<0.05
Others	56	49.1	42	43.8	48	75.0	
Hand-washing							
Less than five a day	22	19.3	15	15.8	13	20.5	>0.05
Five or more per day	92	80.7	80	84.2	51	79.7	
Previous COVID-19 status							
Yes	26	22.8	19	20.0	17	26.6	>0.05
No	88	78.2	76	80.0	47	73.4	
Vaccination status							
Inadequate vaccination	7	6.2	3	3.1	7	11.0	>0.05
Adequate vaccination	107	93.8	93	96.9	57	89.0	
Underlying disease							
Yes	5	4.4	7	7.4	9	14.1	>0.05
No	109	95.6	88	92.6	55	85.9	
Drug use history							
Yes	9	7.9	14	14.7	8	12.5	>0.05
No	105	92.1	81	85.3	56	87.5	
Number of people living together							
<2	42	38.2	35	38.5	15	23.8	>0.05
>2	68	61.8	56	61.5	48	76.2	
Social Activities Attended							
Yes	54	47.3	46	43.4	32	50	>0.05
No	60	52.7	50	56.6	32	50	

Table 1. Some characteristics of the students participating in the study (continue)

	First group (n= 114)		Second group (n= 96)		Third group (n= 64)		
Characteristic	**n**	**%**	**n**	**%**	**n**	**%**	**p**
Going Out of the City							
Yes	82	71.9	72	75.0	37	57.8	>0.05
No	32	28.1	24	25.0	27	42.2	
Coming From Outside the City							
Yes	62	54.3	44	45.8	39	60.9	>0.05
No	52	45.7	52	54.2	25	39.1	

COVID-19: Coronavirus disease-19.

The HES code of three students participating in the study turned risky on the days outside the study. In the third group, 43 out of 64 students reported symptoms during this period, and the HES code of one person turned "risky" during the study (Table 2).

When comparing the detection rate of infected students between the first and second groups, the detection rate was higher in the first group than the detection rate based on RAT or SARS-CoV-2 PCR test in the second group ($p< 0.05$).

When examining the rates of reported symptoms among all three groups during the study period, it was observed that the second group reported significantly fewer symptoms compared to the other groups ($p< 0.05$). However, upon reviewing the questionnaires filled out by the students who tested positive in RATs during the week, it was found that there were no notable differences compared to other students in terms of gender, place of residence, smoking status, mask usage, method of transportation to school, hand-washing habits, vaccination status, underlying diseases, or symptomatic characteristics ($p> 0.05$).

When examining the rates of participation and symptom reporting in the first and second groups, it was observed that participation in the study varied from week to week. The rate of reporting symptoms did not change by weeks in the first group, while it decreased significantly in the following weeks in the second group ($p< 0.05$).

In the eighth week, the rate of symptom reporting in the second group reached its lowest level compared to previous weeks. Only one case was detected through the tests, indicating a need for re-evaluation of the students to ascertain their actual condition. On the final day of the eighth week, 45 out of 96 students were persuaded to undergo RAT. Six students, representing 13.3% of the total, tested positive for COVID-19 in the RAT It was determined that only one of these six students had symptoms and the others were

Table 2. Results of SARS-CoV-2 research in student groups for eight weeks

	First group		Second group		Third group		Total	
Indicators	**Positive**	**Negative**	**Positive**	**Negative**	**Positive**	**Negative**	**Positive**	**Negative**
Symptom	59	55	32	64	43	21	134	140
Rapid antigen test	8	106	0	32	-	-	8	138
SARS-CoV-2 PCR test	8	0	1	31	-	-	9	31
HES code	0	114	3	93	1	63	4	270
Total	**114**		**96**		**64**		**274**	

HES: Hayat eve sığar (Life Fits Into Home), PCR: Polymerase chain reaction.

Table 3. Research results in the eight week and at the end of the eighth week, during which rapid antigen testing was performed in the second group

	Eight-week process		At the end of the eighth week	
Status	**Positive**	**Negative**	**Positive**	**Negative**
Symptom	32	64	1	44
Rapid antigen test	0	32	6*	39
SARS-CoV-2 PCR test	1	31	5	0
HES code	3	93	0	45
Total	96		45	

*One student did not want to have a PCR test.
HES: Hayat eve sığar (Life Fits Into Home), PCR: Polymerase chain reaction.

asymptomatic (Table 3). Five of the six students were confirmed by PCR (Ct value, lowest= 17.1, highest= 24.3). One student was unwilling to take a PCR test.

RAT and SARS-CoV-2 PCR tests were performed on 40 students 78 times (eight in the first and 70 in the second groups). Accordingly, the sensitivity of the RAT was 92.8%, the specificity was 100%, the negative predictive value was 98.5%, and the positive predictive value was 100%.

DISCUSSION

This study highlights the potential of RAT (Rapid Antigen Test) for screening purposes to mitigate the transmission of the virus from symptomatic or asymptomatic students to their peers by enabling early detection of COVID-19 infections in a classroom setting. However, the sensitivity and specificity of the RAT were presented as secondary outcomes.

RT-PCR has been used in respiratory secretions as a screening and diagnostic test for COVID-19 disease. These tests have demonstrated good sensitivity and specificity in accurately detecting the presence of the virus[11]. However, PCR tests are technically complex and labor-intensive. In addition, the transport and reporting of the sample must be done correctly. However, the high cost associated with RT-PCR testing creates inequitable access to this test for individuals worldwide[12].

Furthermore, there is a significant time delay in RT-PCR testing, as it often takes hours or even days for the samples to reach the laboratory and for the results to be obtained. In contrast, RATs offer the advantage of providing results without the need for such waiting periods[13]. More than 350 RATs are commercially available worldwide[14]. However, as of December 2021, only 28 RATs have been approved by the FDA for diagnosis of SARS-CoV-2[15]. A RAT is approved by the FDA only if it has a minimum sensitivity of 80% and a specificity of 98% compared to the PCR test, the reference method[16]. In addition, the FDA requires a cohort study of 30 people, each with and without COVID-19, for approval[15]. An FDA-approved kit was also utilized in our research.

To facilitate the implementation of the first group, a larger number of students were invited to participate in the study. This decision was based on the assumption that students might be less inclined to provide samples on a weekly basis. The fact that the number of students volunteering for the first group was less than one-third of the total class size validates this belief. In addition, considering that the students in the first group may not have participated in the study every time, it was essential to include more students in this group compared to other groups (Table 1,3). Furthermore, it was discovered that the students who willingly participated in the study had lower attendance in the first group. This can be attributed to the discomfort experienced during RAT administration and the time required for testing, albeit brief. Additionally, the anxiety associated with the possibility of testing positive contributed to lower

acceptance among students in the first group compared to other groups. Some participants opted not to take part in the study due to the difficulties associated with conducting the PCR test, as well as the reasons outlined in the results section. This finding raises the possibility that these individuals may be less likely to seek hospital-based PCR testing even when experiencing mild symptoms. It underscores the importance of developing more accessible testing methods to address this issue.

When all three groups were compared, the detection of significantly more cases in the first group than in the other groups indicates that RAT is an effective screening test in the early diagnosis of COVID-19 (Table 2). In the second group, no students tested positive for a period of eight weeks when the RAT was employed as a screening test. Only one student was identified as positive when the PCR test was utilized. The presence of a risky HES code in three of the students participating in the study indicates that the cases within this group were not adequately detected. The results suggest that if the goal is to effectively control the number of cases within the education system, it would be preferable to administer RAT tests to all students, regardless of symptom questioning.

A study was conducted on people crossing a public square, where simultaneous RAT and PCR testing were performed. The study emphasized the significance of screening asymptomatic individuals, as it revealed that without such screening, half of the infected individuals with a high viral load would have gone undetected[11]. In this study, the first group underwent RAT testing regardless of reported symptoms. The third group did not receive RAT testing in either case. However, if the second group reported symptoms, both RAT and PCR tests were conducted. It is hypothesized that students in the second group may have reported fewer symptoms intentionally to avoid testing. Consequently, even with a high sensitivity of RATs in symptomatic individuals, relying solely on self-reported symptoms for screening, whether through RAT or PCR tests, may not yield the desired results. In our study, the similarity in characteristics between the untested third group and the second group, which underwent testing in symptomatic patients, emphasizes the lack of significance in relying solely on a symptom-based testing strategy.

The rate of students reporting symptoms in the second group was significantly lower compared to the first and third groups. Similar to the reservations expressed by students in the first group, it is believed that students in the second group also chose not to disclose symptoms as they knew they would not be tested unless they reported them. This raised concerns about the accuracy of reported data, prompting an additional screening procedure for the second group. Therefore, on the final day of the study, RAT testing was conducted again on the students in the second group. Despite a total of four students in the second group, with one positive case identified through PCR testing and three through HES code checks over the course of eight weeks, it is noteworthy that six cases, five of which were confirmed by PCR, were detected during the screening on the last day of the eighth week. With this additional procedure, significant results were found, showing that the concerns about student statements are valid. However, in the second group, no case could be detected when screened with RAT for eight weeks, and one student could be identified when screened with PCR. At the end of the eighth week, after persuading 45 volunteers to undergo retesting, the identification of six additional cases served as evidence that relying solely on symptom-based questioning could yield highly misleading information. This additional process emphasized that, unlike the first group, the second group had a higher number of individuals carrying the virus simultaneously, indicating a higher level of contagiousness among students within this group. These findings suggest that students who tested positive for SARS-CoV-2 continue to attend classes, participate in social activities, and take exams without being aware that they are spreading the virus. However, it has been demonstrated that these students are unaware that they are transmitting the virus, as most of them exhibit no symptoms of upper respiratory tract infection, while only

one student experiences mild symptoms. In light of these findings, it would be advisable to implement twice-weekly RAT testing to minimize the number of cases and ensure uninterrupted educational activities.

In comparison to the early stages of the pandemic, there has been an increase in COVID-19-related hospitalizations among children. Additionally, school outbreaks have been reported, highlighting the importance of protecting school-age students to prevent them from becoming potential reservoirs of the virus. It is equally crucial to safeguard individuals at home who have indirect contact with these students. By implementing measures to protect both school-age children and their close contacts, we can help mitigate the spread of COVID-19 within communities. In addition, the closure of schools has social and economic costs for families and caregivers[17]. During the study, the rate of COVID-19-positive cases was 1.6% in the third group, the control group, and 7% in the first group. These data show that case detection is more effective in the first group than in the second and third groups. Identifying and isolating asymptomatic individuals is crucial in reducing the spread of the disease, as they can act as reservoirs. This, coupled with a high vaccination rate among students, can contribute to achieving herd immunity and effectively protect the population from COVID-19 transmission[18]. Since vaccinated individuals typically survive the disease without requiring hospitalization, relying solely on screening symptomatic individuals within this group will not be sufficient to detect cases adequately[19]. In addition, the fact that no SARS-CoV-2 positive student had severe symptoms may be due to the high vaccination rate in the study group, the low average age, and the low number of underlying diseases.

The guidelines of the "World Health Organization," "Centers for Disease Control and Prevention," and "European Center for Disease Prevention and Control" approve and recommend the use of RATs for diagnosis in individuals with symptoms compatible with COVID-19 and for screening asymptomatic individuals at high risk for acute SARS-CoV-2 infection[20-22]. Rapid antigen test successfully captures pre-symptomatic individuals and individuals in the early phase of the disease. Therefore, it is a good alternative in populations with a low prevalence. However, these tests are not recommended in cases where high sensitivity is required, such as screening healthcare professionals, personnel who care for the elderly, or individuals who will undergo invasive interventions[3,23]. Furthermore, studies have indicated that the frequency of testing and the speed of reporting results are more effective for achieving efficient surveillance, rather than solely relying on the high sensitivity of the test[24,25]. The specificity of antigen tests is close to 100%. However, their sensitivity varies depending on the target population and the test itself. Therefore, the population in which the test is performed is also important. In a study conducted on patients who applied to the hospital for PCR testing, the sensitivity of RAT was found to be 63.5%[26]. However, in another study conducted in the field, the sensitivity was 93.3%[11]. The specificity value of 100% obtained in this study is compatible with these studies, and our sensitivity level is 92.8%, similar to the second study conducted in the field. Nevertheless, the absence of false-positive results in RAT testing demonstrated the reliability of this test when a positive result was obtained. However, it is important to acknowledge that conducting PCR testing exclusively on RAT-positive students in the first group may have contributed to a higher sensitivity of the RAT test.

The study was designed to focus on screening students attending the lesson on a given day, rather than following the students individually throughout the study period. Thus, an attempt was made to create a model that could be applied in practice. However, collecting samples from the students in the first group twice a week, students with positive RAT giving a PCR test, and the necessity of going into quarantine in case the PCR test was positive brought along some reservations for the students. The quarantine period was 14 days at the time of the study. Some of the students stayed away from their families in student dormitories. Students' most significant concerns revolved around the restrictions imposed during the quarantine period, such as the inability to leave the dormitory,

the risk of missing important lessons, and the potential inability to sit for certain exams. To successfully pass a course, students are granted the opportunity to take two types of exams: the final exam, which consists of multiple-choice questions, and the make-up exam, which requires essay-type responses.

It was observed that student participation in the study decreased, particularly as the exam week approached. This trend can be attributed to students' preference for multiple-choice exams, as well as their desire to exercise their right to take an exam.

Furthermore, the study had certain limitations. Firstly, students exercised their right to absenteeism, which led to their non-attendance of certain lessons. Additionally, some lecturers were unable to conduct in-person classes due to COVID-19 or other reasons, resulting in lessons being delivered through distance education. Moreover, due to the high number of students, classes were occasionally divided into groups, resulting in students attending classes at different times. Lastly, not every student who tested positive on a RAT was willing to undergo a PCR test.

Another limiting factor was that other respiratory tract pathogens were not studied in symptomatic students whose RAT or PCR were negative. However, it is important to acknowledge that there was a significant decrease in diseases associated with respiratory system pathogens during the pandemic[27].

CONCLUSION

For education to resume in a healthy face-to-face manner, simply relying on screening students with HES codes, as currently practiced, will not suffice. Merely allowing students to self-declare and conducting screenings only on symptomatic individuals using RAT or PCR tests can yield misleading results due to potential misrepresentation or reservations by the students. This study has provided evidence that screening asymptomatic individuals is of greater significance in detecting COVID-19 cases compared to solely relying on collecting samples from symptomatic patients and diagnosing through PCR tests.

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ETHICS COMMITTEE APPROVAL

This study was approved by Trakya University Scientific Research Ethics Committee (Decision no: 18/27, Date: 20.09.2021).

CONFLICT of INTEREST

The authors have no conflicts of interest to declare that are relevant to the content of this article.

AUTHORSHIP CONTRIBUTIONS

Concept and Design: İD, CE, GE, OH, ŞG

Analysis/Interpretation: All of authors

Data Collection or Processing: All of authors

Writing: All of authors

Review and Correction: İD, CE, HTEM, GE, OH, ŞG

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