Positive Predictive Value of Rapid Antigen Tests in School During SARS-CoV-2 Omicron Variant Surge

Eun Jung Jang, MPH, †Young June Choe®, MD, ‡Go-Woon Yun, MS, * Ryu Kyung Kim, MS, * Heegwon Jeong, BS, ‡ Sangwon Lee, PhD, * and Young-Joon Park, MD, MPH*

METHODS

Since March 2022, nationwide RAT screening for SARS-CoV-2 has been implemented in kindergartens (4–6 years of age), elementary schools (grades 1–6), middle schools (grades 7–9) and high schools (grades 10–12). Students with and without symptoms were tested twice weekly, and teacher/staff were screened once weekly. Those who had a close contact history with patients with SARS-CoV-2 were screened 3 times per week voluntarily. Each student was asked to report about symptoms (multiple choice), including fever, chills, cough, headache, myalgia, sore throat, runny nose, loss of taste/smell, fatigue, nausea, vomiting or diarrhea. The RAT results were reported through the Student Health Self-Diagnosis App developed by the Ministry of Education. If the RAT result was positive, the patient would be referred for a confirmatory polymerase chain reaction (PCR) test within 72 hours. We merged the symptoms and RAT results data with the PCR data collected between March 2 and April 3, 2022. Individuals with incomplete information (ie, input errors, blank dates) and a history of SARS-CoV-2 infection were excluded from the analysis. The RAT results were compared with the PCR results, and the positive predictive value and binomial 95% confidence intervals were calculated. The weekly positivity rate of COVID-19 in the RAT and PCR was estimated by dividing the number of enrolled students and teachers/staff with COVID-19 by the total number of tested individuals.

The study was reviewed and approved by the Korea Disease Control and Prevention Agency Institutional Review Board (2021-12-03-PE-A).

RESULTS

Between March 2 and April 3, 2022, of the 2,822,544 RAT results collected, 136,902 (4.9%) were positive, of which 126,042 were confirmed by PCR, resulting in a positive predictive value of 92.1% (Table 1). The RAT positivity rate ranged from 68.7% to 83.8% among individuals with symptoms, while the rate ranged from 0.3% to 0.7% in individuals without symptoms (Table 1). The weekly SARS-CoV-2 RAT positivity rate in South Korea ranged from 4.9% to 5.9%, whereas the positive predictive value of RAT ranged from 86.4% to 93.2% (Figure 1, Supplemental Digital Content 1, http://links.lww.com/INF/E851). The positive predictive value was the highest among elementary school students with symptoms (95.7%) and lowest among teachers/staff without symptoms (70.9%).

The overall rate of true positive results among the RAT tests for COVID-19 was high, especially in students with symptoms, which is consistent with other studies. Establishing an early diagnosis of COVID-19 requires interpreting test results appropriately. Currently, RAT is widely available and its appropriate use may improve case detection and therefore could reduce transmission and absenteeism. As this study was conducted parallel with the policy of returning to school if the RAT result was negative, the results may inform the policymakers to minimize school closure due to the COVID-19 outbreak.

The probability of infection depends on the SARS-CoV-2 prevalence in the community, which was high in South Korea with the Omicron variant surge during the observation period, which increased the performance of RAT in schools. During the peak of the COVID-19 community outbreak, a positive RAT result is highly likely to represent a true SARS-CoV-2 infection. Furthermore, a negative test result suggests a low possibility of COVID-19. Here, most students presenting with respiratory symptoms and fever with a positive RAT result would have COVID-19, and conversely, if the prevalence is low, positive RAT results are more
TABLE 1. Result of Nationwide School COVID-19 RAT Screening Reflexed to PCR Confirmation During SARS-CoV-2 Omicron Variant Surge in South Korea, March 2 to April 3, 2022

| Symptom* | Status          | Tested Persons | RAT Screening | Reflex PCR Confirmation† |
|----------|-----------------|----------------|---------------|--------------------------|
|          |                 |                | Positive   | Negative   | Positive | Negative |
|          |                 |                | n   | % | n   | % | n   | % | n   | % | n   | % |
| Symptomatic Students Kindergarten | 8974| 6872 | 76.6 | 2102 | 23.4 | 6499 | 94.6 | 373 | 5.4 |
| Elementary school | 79,435| 56,246 | 70.8 | 23,189 | 29.2 | 53,820 | 95.7 | 2426 | 4.3 |
| Middle school | 36,551| 25,119 | 68.7 | 11,432 | 31.3 | 23,770 | 94.6 | 1349 | 5.4 |
| High school | 28,679| 20,083 | 70.0 | 8596 | 30.0 | 18,228 | 90.8 | 1855 | 9.2 |
| Teachers/staffs | 13,060| 10,943 | 83.8 | 2117 | 16.2 | 9088 | 83.1 | 1855 | 17.0 |
| Asymptomatic Students Kindergarten | 172,746| 1133 | 0.7 | 171,613 | 99.3 | 969 | 85.5 | 164 | 14.5 |
| Elementary school | 1,087,744| 7534 | 0.7 | 1,080,210 | 99.3 | 6659 | 88.4 | 875 | 11.6 |
| Middle school | 614,195| 4568 | 0.7 | 609,627 | 99.3 | 3773 | 82.8 | 795 | 17.4 |
| High school | 474,160| 3392 | 0.7 | 470,768 | 99.3 | 2519 | 74.3 | 873 | 25.7 |
| Teachers/staffs | 307,000| 1012 | 0.3 | 307,000 | 99.7 | 717 | 70.9 | 295 | 29.2 |
| Total | 2,822,544| 136,902 | 4.9 | 2,686,654 | 95.1 | 126,042 | 92.1 | 10,860 | 7.9 |

* Symptom refers to fever, chills, cough, headache, myalgia, sore throat, runny nose, loss of taste/smell, fatigue, nausea, vomiting, and diarrhea.
† All positive results from RAT screening are reflexed to undergo PCR testing for confirmation.

FIGURE 1. The positive predictive value of rapid antigen test screening among students and teachers/staff by presence or absence of symptoms (fever, chill, cough, headache, myalgia, sore throat, runny nose, loss of taste/smell, fatigue, nausea, vomiting, and diarrhea).

likely to be false-positive. The study limitations include the convenience sample based on passive surveillance using volunteered symptoms and RAT positivity, therefore may lack clear generalizability. Moreover, reported symptoms were aggregated as symptomatic versus asymptomatic, therefore, we were unable to assess the most significant symptom suggestive of RAT or PCR positivity.

Interpreting SARS-CoV-2 RAT appropriately can provide useful information for decision-making in the educational setting. RAT screening during the community outbreak of SARS-CoV-2 provides a high positive predictive value; therefore, provides helpful information to policymakers to optimize the school health policy.

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