Impact of COVID-19 on human immunodeficiency virus tests, new diagnoses, and healthcare visits in the Republic of Korea: a retrospective study from 2016 to 2021

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ABSTRACT

Objectives: Public health workers have been at the forefront of treating patients with coronavirus disease 2019 (COVID-19) and managing the pandemic. The redeployment of this workforce has limited or interrupted other public health services, including testing for human immunodeficiency virus (HIV). This study aims to examine the impact of COVID-19 on HIV testing and diagnosis in the Republic of Korea from 2016 to 2021, comparing data before and after the onset of COVID-19.

Methods: Annual HIV testing data were collected from each institution through direct communication or from open-source databases. The annual number of new HIV cases was obtained from the official report of the Korea Disease Control and Prevention Agency. Data on healthcare visits for HIV diagnosis or treatment were extracted from the open-source database of the National Insurance Health Service of Korea. Interrupted time series regression was conducted, stratified by institution type.

Results: In 2020, HIV tests, diagnoses, and visits decreased. Notably, public health centers experienced a substantial reduction in 2020−2021 compared to previous years. The annual percentage change in HIV tests was −53.0%, while for HIV diagnoses, it was −31.6%. The decrease in visits for HIV was also most pronounced for public facilities: −33.3% in 2020 and −45.6% in 2021 relative to 2019.

Conclusion: The numbers of tests, diagnoses, and healthcare visits for HIV at public health centers in the Republic of Korea substantially decreased in 2020 and 2021. The impacts of these changes on the early diagnosis and treatment of HIV necessitate further monitoring.

Keywords: COVID-19; Diagnosis; Epidemiology; HIV; Korea; Statistics
Introduction

The disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), initially reported as pneumonia of unknown origin [1,2], rapidly escalated into a global pandemic. In addition to representing an emerging infectious condition to which there was no pre-existing immunity, the infection was transmitted via airborne respiratory droplets and had a basic reproductive rate of about 2.2 [3,4]. Termed coronavirus disease 2019 (COVID-19), the condition soon overwhelmed hospitals, impacting the treatment of other diseases due to the scarcity of healthcare professionals and hospital beds [5]. Healthcare services in the public health sector, along with care in clinics, were discontinued or downsized as staff were reallocated in response to COVID-19-related policies [6–8]. Concurrently, to curb the rapid community spread of the virus, many countries enacted stringent non-pharmaceutical interventions (NPIs). These included closing schools, museums, and restaurants, as well as restricting social gatherings to minimize face-to-face interactions [9].

To promote awareness and prevention of human immunodeficiency virus (HIV) transmission, public health centers have long administered combined counseling and testing [10], with many countries adopting community-based programs [11]. These initiatives have improved adherence to testing and the detection of HIV. They are often paired with educational efforts on prevention, such as pre-exposure prophylaxis, and actions aimed at reducing the stigma associated with HIV infection [12–15].

Many facilities providing HIV testing and prevention services were closed or faced disruptions in accordance with the rigorous NPIs implemented within society. Additionally, some personnel who typically focused on HIV prevention were reassigned to manage the COVID-19 pandemic [16–19]. In Sydney and Melbourne, prescriptions for HIV post-exposure prophylaxis and HIV testing decreased by about 37% to 46% and 32% to 41%, respectively, with an even greater reduction of around 60% observed during lockdown [18]. It has been estimated that a 6-month interruption of antiretroviral therapy could lead to approximately 500,000 additional deaths from acquired immunodeficiency syndrome (AIDS)-related illnesses in sub-Saharan Africa [19,20]. In the Republic of Korea, HIV testing is available at public health centers without a copayment and does not require personal identification; however, these facilities were generally closed from 2020 to early 2022 [21–23].

This study was conducted to examine the impact of the COVID-19 pandemic on HIV tests, incident cases, and healthcare visits in the Republic of Korea. We analyzed these 3 metrics by type of institution from 2016 to 2021, comparing the periods before and after the onset of COVID-19.

Materials and Methods

Study Design

We performed a time series study to analyze annual statistics of 3 parameters in the Republic of Korea from 2016 to 2021: (1) HIV tests, (2) incident HIV cases, and (3) HIV-related visits to hospitals or clinics. While certain institutions predominated, our study also incorporated categories with smaller numbers, endeavoring to represent the entire population and to compare trends across types of institutions.

Information on these variables was collected from several data sources, detailed in later sections. We analyzed the annual trends in HIV tests and newly diagnosed HIV cases across 6 categories: hospitals or clinics, public health centers, HIV prevention centers, the Korean Red Cross Blood Services, the Military Manpower Administration, and correctional facilities. For the analysis of HIV-related healthcare visits, the facilities were divided into 5 groups: tertiary general hospitals, general hospitals, hospitals, clinics, and public health centers.

Description of Data for HIV Tests

Data regarding HIV tests at hospitals and clinics were originally extracted from the databases of the National Health Insurance Service (NHIS) and the Health Insurance Review and Assessment Service (HIRA) [24] (Supplementary Material 1), in collaboration with the NHIS office responsible for managing the data. Korean citizens residing in the country can receive benefits from the nationwide health insurance provided by the NHIS, as Medical Aid beneficiaries, or (in the case of veterans) as Health Care beneficiaries.
Information regarding medical expenses and claims is submitted to HIRA, which evaluates the appropriateness of treatment. The outcomes of these evaluations are then communicated to the respective institutions and to the NHIS. The NHIS and HIRA collaborate to produce medical claims data, which are made available for download and organized according to the Korean Standard Classification of Diseases [25], aligned with the International Statistical Classification of Diseases and Related Health Problems, 10th Revision [26].

Annual HIV test data from public health centers were obtained from a report on HIV tests conducted at these centers and a presentation published by the Division of Analysis of Viral Infection within the Korea Disease Control and Prevention Agency (KDCA) [27,28]. Public health centers, which are regional government organizations, oversee health policy and promote public health within their respective cities, counties, or districts. As of December 2021, the Republic of Korea has 255 public health centers across 17 municipalities, all under the jurisdiction of the Ministry of Public Health and Welfare. These centers administer a prevention program for HIV, which includes voluntary testing, counseling, education, and community outreach to encourage early HIV testing. The HIV prevention efforts at public health centers receive support from the KDCA.

In addition to hospitals or clinics and public health centers, voluntary HIV testing is available at HIV prevention centers. The Republic of Korea is home to 5 such centers, which are non-governmental organizations overseen by the Division of HIV/AIDS Prevention within the KDCA. These centers offer counseling and testing for HIV to anyone who seeks it. However, they are most frequently visited by men who have sex with men (MSM) and foreigners who may face challenges accessing services at other institutions due to stigma or language barriers. The Division of HIV/AIDS Prevention staff at the KDCA collects annual reports from these prevention centers each year.

Two separate institutions, the Korean Red Cross Blood Services and the Military Manpower Administration, administer HIV tests to all eligible individuals during the screening process prior to blood donation or as part of the regular physical examination for military enlistment. Annual participant numbers are available from the Korean Statistical Information Service [29,30], and these figures have been verified through communication with officials from each institution. Notably, the HIV testing conducted by the Korean Red Cross Blood Services and the Military Manpower Administration is a component of an overall blood test; therefore, fluctuations in testing numbers are attributable to changes in participant enrollment rather than direct results of HIV policies.

Finally, some inmates at correctional facilities operated by the Korean Correctional Service of the Ministry of Justice are required to undergo HIV testing prior to imprisonment. Data on annual HIV tests conducted at HIV prevention centers and correctional facilities were obtained through official correspondence with the administrative office. In recent years, individuals in correctional facilities requiring HIV testing or care have increasingly received services at external hospitals. Consequently, the annual figures reported under the “correctional facilities” category represent the number of cases handled and reported by these institutions and may not accurately reflect HIV services provided to inmates.

**Description of Data for HIV Cases**

In the Republic of Korea, cases of HIV/AIDS are monitored through a mandatory surveillance system. A 2-step test protocol is used to confirm the diagnosis of HIV infection. Initially, blood samples that test positive—whether from a rapid test or a blood test—are sent for confirmatory testing to one of the laboratories of the 18 Institutes of Health and Environment Research or to the laboratory in the Division of Analysis of Viral Infection of the KDCA. Public health centers are notified of these initial positive tests by hospitals and clinics. As officials at public health centers receive positive results from the confirmatory laboratories, they report each case to the KDCA via a secure web-based system. Additionally, information on sociodemographic factors, clinical status, and epidemiologic variables, including transmission routes, is collected. Diagnoses are anonymized, and the information is handled exclusively by authorized personnel. The official report on HIV statistics in the Republic of Korea, which was a primary source for our study, is published annually in June. It is accessible through the official KDCA website [31] and is also available through Statistics Korea [32], underscoring the transparency and credibility of our research.

**Description of Data for HIV-Related Healthcare Visits**

Lastly, to examine whether the COVID-19 pandemic has impacted access to healthcare facilities for HIV counseling or treatment, we analyzed the annual trend of visits to medical institutions for HIV/AIDS-related conditions. The data for this analysis were obtained from an open resource of the NHIS/HIRA [33]. We searched for the following codes: HIV disease resulting in infectious and parasitic diseases (B20), HIV disease resulting in malignant neoplasms (B21), HIV disease resulting in other specified diseases (B22), HIV disease resulting in other conditions (B23), unspecified HIV diseases.
(B24), laboratory evidence of HIV (Z21), and asymptomatic HIV infection status (R75). Although clinical management of HIV is limited at most public centers, this category was included in the analysis to observe any trends.

Study Population
The target population of this study comprised residents of the Republic of Korea, specifically those who underwent HIV testing, those with newly diagnosed HIV, and people living with HIV (PLWH) who had visited healthcare institutions for HIV-related conditions. Our study included annual data on these 3 variables from 2016 to 2021, as we aimed to compare trends before and after the onset of COVID-19. To assess HIV-related hospital and clinic visits, we utilized the annual number of medical claims submitted by institutions to HIRA for medical cost reimbursement review. For each year between 2016 and 2021, in the Republic of Korea, an average of 7,811,860 HIV tests were conducted (ranging from 7,574,427 to 8,070,989), 1,135 new HIV cases were detected (ranging from 975 to 1,223), and 63,295 HIV-related hospital and clinic visits were recorded (ranging from 56,314 to 67,528).

Statistical Analysis
The numbers of annual HIV tests, new HIV cases, and healthcare visits related to HIV/AIDS in the Republic of Korea from 2016 to 2021 were recorded and categorized by the type of institution. To assess a linear trend over time, average annual percentage changes (APCs) and 95% confidence intervals (CIs) were computed. Given the apparent nonlinear trend in annual variation for several categories, interrupted time series regression was performed [34–36]. For the regression analysis, we utilized Joinpoint Desktop software (ver. 5.02), which was developed and distributed by the US National Cancer Institute [37]. The software analyzes trend data and fits the simplest joinpoint model, allowing users to select the minimum and maximum joinpoints. Based on a preliminary review of data over the 6-year period, we established a maximum of 1 joinpoint and a minimum of 0. Significance testing was conducted using the Monte Carlo permutation method [38]. In the selection of the final model, weighted Bayesian information criteria (BIC) were considered. The optimal model was selected based on the smallest BIC value.

Results
HIV Tests
In the Republic of Korea, the number of HIV tests conducted in 2016 was 7,574,427. This figure exhibited slight annual increases until 2019, with 7,745,833 tests in 2017 (a 2.26% increase), 7,817,794 tests in 2018 (a 0.93% increase), and 8,070,989 tests in 2019 (a 3.24% increase). However, in 2020, only 7,704,916 HIV tests were recorded, marking a 4.5% reduction from the previous year. In 2021, the number of tests rose by 252,283 (3.27%) from 2020, totaling 7,957,199 tests, but this was still 113,790 fewer than in 2019 (a 1.4% decrease). Over the period from 2016 to 2021, the average APC for HIV tests was 0.75% (95% CI, −0.29% to 1.78%), as shown in Table 1.

Hospitals and clinics provided the most HIV tests, accounting for 52.0% of the total between 2016 and 2019. This proportion increased to 60.6% in 2020 to 2021. The average APC for hospitals and clinics was 5.50% (95% CI, 4.65%–6.25%) from 2016–2021. HIV tests rose by 252,283 (3.27%) from 2020, totaling 7,957,199 tests, but this was still 113,790 fewer than in 2019 (a 1.4% decrease). Over the period from 2016 to 2021, the average APC for HIV tests was 0.75% (95% CI, −0.29% to 1.78%), as shown in Table 1.

Table 1. HIV tests with APC values based on time series regression in the Republic of Korea, 2016–2021

<table>
<thead>
<tr>
<th>Category</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>Average APC</th>
<th>APC1</th>
<th>APC2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital or clinic</td>
<td>3,792,164</td>
<td>3,907,340</td>
<td>4,082,357</td>
<td>4,434,694</td>
<td>4,560,354</td>
<td>4,935,387</td>
<td>5.50</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Public health center</td>
<td>485,120</td>
<td>500,867</td>
<td>455,902</td>
<td>440,144</td>
<td>178,653</td>
<td>103,963</td>
<td>(4.65 to 6.25)</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>HIV prevention center</td>
<td>5,436</td>
<td>5,510</td>
<td>5,742</td>
<td>6,166</td>
<td>4,719</td>
<td>6,509</td>
<td>0.12</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Korean Red Cross Blood Services</td>
<td>2,866,330</td>
<td>2,928,670</td>
<td>2,883,270</td>
<td>2,791,092</td>
<td>2,611,401</td>
<td>2,604,437</td>
<td>−2.52</td>
<td>−0.2</td>
<td>−4.16</td>
</tr>
<tr>
<td>Military Manpower Administration</td>
<td>353,932</td>
<td>337,530</td>
<td>329,687</td>
<td>337,653</td>
<td>294,023</td>
<td>266,374</td>
<td>−3.21</td>
<td>−1.31</td>
<td>−6.3</td>
</tr>
<tr>
<td>Correctional facility</td>
<td>71,445</td>
<td>65,916</td>
<td>60,836</td>
<td>61,240</td>
<td>55,766</td>
<td>40,529</td>
<td>−9.04</td>
<td>−3.93</td>
<td>−16.2</td>
</tr>
<tr>
<td>Total</td>
<td>7,574,427</td>
<td>7,745,833</td>
<td>7,817,794</td>
<td>8,070,989</td>
<td>7,704,916</td>
<td>7,957,199</td>
<td>0.75</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

Data are presented as n (column %) or APC (95% confidence interval).
HIV, human immunodeficiency virus; APC, annual percent change; APC1, APC of the first slope; APC2, APC of the second slope; NA, not applicable.

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Figure 1. Graphs of interrupted time series regression analysis of annual counts of human immunodeficiency virus (HIV) tests in the Republic of Korea, categorized by type of institution, from 2016 to 2021: (A) for hospital or clinics, (B) for public health centers, (C) for HIV prevention centers, (D) for Korean Red Cross Blood Services, (E) for Military Manpower Administration, and (F) for correctional facilities. The observed counts are indicated by red dots, while the blue and green lines represent the first and second slopes of the analysis, respectively. APC, annual percent change.
and clinics rose by only 2.83%, which was below the average increase. However, 2021 saw an 8.22% increase compared to 2020, indicating a rebound from the previous year. Public health centers administered approximately 6.03% of the HIV tests recorded from 2016 to 2019; this figure declined in 2020 and 2021, marking the most pronounced decrease across all types of HIV testing institutions. We found that a 1-joinpoint regression model was the best fit for the data on HIV tests at public health centers, with an APC of −6.20% (95% CI, −12.1% to 5.50%) for the first slope and −53.0% (95% CI, −36.7% to −27.4%) for the second (Table 1; Figure 1B; Table S1). HIV prevention centers saw a 23.5% decrease in HIV tests in 2020, but this figure recovered in 2021, reaching a value more than 5.6% greater than that in 2019 (Figure 1C). The Korean Red Cross Blood Services conducted the second-highest number of tests after hospitals and clinics, but their testing numbers declined from 2019 to 2021 (APC2, −4.16%) (Figure 1D). The Military Manpower Administration and correctional facilities experienced greater decreases in HIV testing in 2020 and 2021 compared to the period from 2016 to 2019, with the second APC displaying a steeper downward slope than the first (Figure 1E, F).

HIV Diagnosis
From 2016 to 2019, the number of HIV cases exhibited a slight yearly increase: there were 1,197 cases in 2016 and 1,223 cases in 2019, with an annual average of 1,204 cases (Table 2). However, the number of cases decreased to 1,016 in 2020, representing a 16.9% reduction compared to 2019, and further declined to 975 cases in 2021, marking a 20.3% decrease from 2019 and a 4.0% decrease from 2020. Most cases were reported by hospitals/clinics, followed by public health centers, the Korean Red Cross Blood Services, and the other categories. In 2020 and 2021, the proportion of cases reported by hospitals/clinics increased to 72.5%, up from 63.3% between 2016 and 2019. Conversely, a decrease was noted in the proportion of cases reported by public health centers, from 27.8% between 2016 and 2019 to 16.2% in 2020 to 2021. The number of cases from hospitals or clinics decreased by 3.05% in 2020 and by 5.57% in 2021 compared to 2019. Furthermore, cases from public health centers decreased by 3.05% in 2020 and by 5.57% in 2021 compared to 2019. Based on regression analysis, cases reported from public health centers increased until 2018 (APC, 30.4%; 95% CI, 18.7%–41.7%) but subsequently decreased (APC, −31.6%; 95% CI, −36.7% to −27.4%) (Figure 2B; Table S1).

We calculated the HIV positivity rates for hospitals and clinics, public health centers, and HIV prevention centers by dividing the number of positive tests by the total number of tests conducted in each category for each year. From 2016 to 2021, the positivity rate of HIV (per 10,000 tests) for hospitals and clinics steadily declined, at 2.14, 1.97, 1.75, 1.60, and 1.44, respectively. In contrast, the rates for public health centers and HIV prevention centers increased; for public health centers, these rates were 5.46, 6.51, 8.38, 8.34, 9.29, and 15.10, while for HIV prevention centers, the rates rose from 7.36 to 14.5, 22.6, 211, 42.4, and 44.6.

**Table 2.** HIV diagnoses with APC values based on time series regression in the Republic of Korea, 2016–2021

<table>
<thead>
<tr>
<th>Category</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>Average APC</th>
<th>APC1 (95% CI)</th>
<th>APC2 (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital or clinic</td>
<td>812</td>
<td>768</td>
<td>716</td>
<td>754</td>
<td>731</td>
<td>712</td>
<td>−2.15</td>
<td>−4.68</td>
<td>−0.42</td>
</tr>
<tr>
<td>(67.8)</td>
<td>(64.5)</td>
<td>(59.4)</td>
<td>(61.7)</td>
<td>(71.9)</td>
<td>(73.0)</td>
<td>(73.0)</td>
<td>(3.23 to −0.96)</td>
<td>(−7.41 to −1.28)</td>
<td>(−3.02 to 3.07)</td>
</tr>
<tr>
<td>Public health center</td>
<td>265</td>
<td>326</td>
<td>382</td>
<td>367</td>
<td>166</td>
<td>157</td>
<td>−11.5</td>
<td>30.4</td>
<td>−31.6</td>
</tr>
<tr>
<td>(22.1)</td>
<td>(27.4)</td>
<td>(31.7)</td>
<td>(30.0)</td>
<td>(16.3)</td>
<td>(16.1)</td>
<td>(16.1)</td>
<td>(−14.7 to −9.03)</td>
<td>(18.7 to 41.7)</td>
<td>(−36.7 to −27.4)</td>
</tr>
<tr>
<td>HIV prevention center</td>
<td>4</td>
<td>8</td>
<td>13</td>
<td>13</td>
<td>20</td>
<td>29</td>
<td>42.8</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>(0.3)</td>
<td>(0.7)</td>
<td>(1.1)</td>
<td>(1.1)</td>
<td>(2.0)</td>
<td>(3.0)</td>
<td>(2.44 to 66.1)</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Korean Red Cross</td>
<td>90</td>
<td>63</td>
<td>60</td>
<td>51</td>
<td>48</td>
<td>45</td>
<td>−7.67</td>
<td>−17.7</td>
<td>−0.31</td>
</tr>
<tr>
<td>Blood Services</td>
<td>(7.5)</td>
<td>(5.3)</td>
<td>(5.0)</td>
<td>(4.2)</td>
<td>(6.7)</td>
<td>(4.6)</td>
<td>(−10.3 to −5.07)</td>
<td>(−23.3 to −10.8)</td>
<td>(−6.08 to 11.1)</td>
</tr>
<tr>
<td>Military Manpower Administration</td>
<td>21</td>
<td>24</td>
<td>18</td>
<td>16</td>
<td>16</td>
<td>20</td>
<td>−4.97</td>
<td>−13.1</td>
<td>8.62</td>
</tr>
<tr>
<td>Correctional facility</td>
<td>5</td>
<td>1</td>
<td>17</td>
<td>22</td>
<td>15</td>
<td>12</td>
<td>50.1</td>
<td>152</td>
<td>−31.1</td>
</tr>
<tr>
<td>(0.4)</td>
<td>(0.1)</td>
<td>(1.4)</td>
<td>(1.8)</td>
<td>(1.5)</td>
<td>(1.2)</td>
<td>(6.63 to 108)</td>
<td>(39. to 583)</td>
<td>(−76.5 to 76.1)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1,197</td>
<td>1,190</td>
<td>1,206</td>
<td>1,223</td>
<td>1,016</td>
<td>975</td>
<td>−4.47</td>
<td>0.04</td>
<td>−10.9</td>
</tr>
</tbody>
</table>

Data are presented as n (column %) or APC (95% confidence interval).
HIV, human immunodeficiency virus; APC, annual percent change; APC1, APC of the first slope; APC2, APC of the second slope; NA, not applicable.

**Visits to Medical Institutions for HIV Care**
Most HIV care services were provided by tertiary general hospitals (approximately 66%) and general hospitals (around 33%) (Table 3). The number of visits to medical institutions for HIV care increased steadily each year by an average of 5.39% (95% CI, 3.82%–8.15%) until 2019. However, this was followed by a 3.78% decrease from 67,109 visits in 2019 to 64,572 in 2020. Although the number of visits rebounded to...
Figure 2. Graphs of interrupted time series regression analysis of annual counts of human immunodeficiency virus (HIV) diagnoses in the Republic of Korea, categorized by type of institution, from 2016 to 2021: (A) for hospital or clinics, (B) for public health centers, (C) for HIV prevention centers, (D) for Korean Red Cross Blood Services, (E) for Military Manpower Administration, and (F) for Correctional facilities. The observed counts are indicated by red dots, while the blue and green lines represent the first and second slopes of the analysis, respectively. APC, annual percent change.

Table 3. HIV-related healthcare visits with APC values based on time series regression in the Republic of Korea, 2016–2021

<table>
<thead>
<tr>
<th>Category</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>Average APC</th>
<th>APC1</th>
<th>APC2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tertiary general hospital</td>
<td>37,575</td>
<td>39,857</td>
<td>40,772</td>
<td>42,358</td>
<td>41,204</td>
<td>44,756</td>
<td>2.65</td>
<td>(1.91 to 3.06)</td>
<td>(−0.54 to 2.64)</td>
</tr>
<tr>
<td>General hospital</td>
<td>18,364</td>
<td>20,477</td>
<td>22,317</td>
<td>24,205</td>
<td>22,223</td>
<td>22,233</td>
<td>3.56</td>
<td>(2.77 to 4.34)</td>
<td>(−6.87 to −2.34)</td>
</tr>
<tr>
<td>Hospital</td>
<td>201</td>
<td>231</td>
<td>259</td>
<td>286</td>
<td>267</td>
<td>400</td>
<td>10.8</td>
<td>(4.12 to 15.7)</td>
<td>19.3</td>
</tr>
<tr>
<td>Clinic</td>
<td>126</td>
<td>107</td>
<td>93</td>
<td>103</td>
<td>101</td>
<td>118</td>
<td>−1.95</td>
<td>(−9.99 to 35.5)</td>
<td>−17.7</td>
</tr>
<tr>
<td>Public health center</td>
<td>48</td>
<td>71</td>
<td>63</td>
<td>57</td>
<td>38</td>
<td>31</td>
<td>−11.3</td>
<td>(−16.8 to −8.60)</td>
<td>13.7</td>
</tr>
<tr>
<td>Total</td>
<td>56,314</td>
<td>60,743</td>
<td>63,504</td>
<td>67,109</td>
<td>64,572</td>
<td>67,528</td>
<td>3.17</td>
<td>(2.25 to 4.21)</td>
<td>(−38.4 to −20.7)</td>
</tr>
</tbody>
</table>

Data are presented as n (column %) or APC (95% confidence interval).

HIV, human immunodeficiency virus; APC1, annual percent change; APC2, APC of the first slope; APC 2, APC of the second slope.
67,528 in 2021, representing a 0.62% increase compared to 2019, the overall trend from 2019 to 2021 showed a negative slope of −0.07% (95% CI, −2.52% to 2.55%). The increase in total visits in 2021 was primarily due to tertiary hospitals, which accounted for the largest volume of visits. Visits to tertiary hospitals decreased by 2.72% in 2020 but rose by 5.66% in 2021 compared to 2019 (Figure 3A). In contrast, visits to general hospitals continued to decline, with numbers 5.14% lower in 2020 and 8.19% lower in 2021 compared to 2019 (Figure 3B). HIV-related visits to "hospitals or clinics” and “public health centers” were somewhat rare compared to the above mentioned categories. Visits to public health centers for HIV care saw significant reductions of 33.3% in 2020 and 45.6% in 2021 compared to 2019. HIV care services provided by public centers were the least utilized and experienced a sharp decline from 2018 to 2021 (APC2, −24.8%; 95% CI, –24.8% to 2.55%).

Figure 3. Graphs of interrupted time series regression analysis of annual visits to medical institutions for human immunodeficiency virus (HIV) care in the Republic of Korea, categorized by type of institution, from 2016 to 2021: (A) for tertiary general hospitals, (B) for general hospitals, (C) for hospitals, (D) for clinics, and (E) public health centers. The observed counts are indicated by red dots, while the blue and green lines represent the first and second slopes of the analysis, respectively. APC, annual percent change.
suggests that the reported volume of HIV tests from these patients or conducting surgery. Furthermore, the HIV as hospitals routinely perform HIV tests before admitting or the early diagnosis of HIV infection at these facilities, necessarily reflect a consistent focus on HIV prevention a slight increase, at 5.5%. However, this trend does not influenced a shift toward less risky sexual behaviors. 

From 2016 to 2021 in the Republic of Korea, the number of HIV tests conducted at public health centers decreased significantly, with a 53.0% reduction observed from 2019 to 2021. The number of new HIV diagnoses at public health centers was 54.8% lower in 2020 and 57.2% lower in 2021 compared to 2019. A similar trend was noted in Japan, where a time series analysis of HIV cases from public health centers between January 2015 and June 2020 revealed decreases in HIV tests and counseling appointments from 35,908 and 32,565 in 2019 to 9,584 (−73.3%) and 11,689 (−64.1%) in 2020, respectively, for the second quarter of each year [39]. In the Republic of Korea, community-based activities at public health centers, including HIV testing services not related to SARS-CoV-2, were suspended in 2020 and 2021 [23]. For instance, in October 2021, only 4 of the 25 public health centers (16%) in Seoul were offering HIV tests [40]. Similarly, during the COVID-19 pandemic, HIV testing services provided by public health centers in Japan were disrupted [39].

After the onset of COVID-19, the population who would otherwise take HIV tests at public health facilities may have avoided or delayed taking these tests. In the Republic of Korea, public health centers offer anonymous, free HIV testing services, which can be a compelling reason to utilize these centers for HIV testing. A web-based survey of 1,004 MSM residing in this country found that those who were younger, had primary sex partners, engaged in anal sex, and had sexually transmitted diseases displayed a greater need for HIV screening tests at public health centers than their counterparts within the study population [22]. In Japan, of the individuals with new HIV cases diagnosed at public health centers from 2015 to June 2020, 72.5% were MSM, and 13.3% were non-Japanese [39]. The substantial reduction in HIV testing services at public health centers during the SARS-CoV-2 pandemic merits further evaluation to determine whether it has worsened delays in care or has influenced a shift toward less risky sexual behaviors.

From 2016 to 2021, the number of annual HIV tests at hospitals and clinics did not decrease; rather, they displayed a slight increase, at 5.5%. However, this trend does not necessarily reflect a consistent focus on HIV prevention or the early diagnosis of HIV infection at these facilities, as hospitals routinely perform HIV tests before admitting patients or conducting surgery. Furthermore, the HIV positivity rates at hospitals and clinics have decreased. This suggests that the reported volume of HIV tests from these institutions has been sustained through routine testing rather than through visits specifically for HIV diagnosis.

In this study, the annual percentage of positive tests increased over time at public health centers and HIV prevention centers, which primarily serve high-risk groups. Data from the AIDS Healthcare Foundation Global Quality Program, which supports HIV testing programs across 44 countries on 4 continents, corroborates these findings; an analysis revealed a decrease in the number of HIV tests conducted, while the rates of HIV-positive results increased across all continents studied [41]. However, when examining instances of face-to-face HIV care, the study revealed a downward trend in Africa (71%) and Latin America (24.3%), in contrast to increases in Europe (8.8%) and Asia (3.9%), from January to August 2020 compared to the same period in 2019 [41]. Regarding enrollment in new treatment, decreases were observed in Africa (40.8%), Asia (32.1%), and Latin America (38.2%), whereas Europe experienced an increase (28.8%) [41]. In a Korean cross-sectional study, which included 112 PLWH and 174 people at risk (PAR), a reduction in hospital visits was reported by 17% of PLWH and 59% of PAR, and an interruption in treatment was reported by 36% of PLWH and 63% of PAR [42]. Despite inter-country variations, these findings suggest that the COVID-19 pandemic’s negative impact on HIV care has been particularly pronounced among newly diagnosed individuals and PAR.

If COVID-19 had not impacted medical practices, we would expect to see an annual increase in hospital and clinic visits for HIV, as the population requiring regular testing and treatment is on the rise. The estimated number of PLWH who are aware of their status in the Republic of Korea grew from 11,252 in 2016 to 15,197 in 2021, and it increased further to 15,880 in 2022 [31,32]. However, our analysis revealed a 3.78% decrease in visits to medical facilities for HIV care in 2020. A slight uptick was noted in 2021, prompting speculation that some PLWH who needed care in 2020 may have delayed their healthcare visits for around a year, whether to avoid the risk of SARS-CoV-2 infection or for other reasons. Although the period examined was too short to support statistical significance, a negative trend from 2019 to 2021 was observed in regression analysis. These findings suggest that the increase in visits in 2021 was not large enough to compensate for the previous year’s shortfall in medical utilization by PLWH. Reduced or delayed hospital visits could result in the postponement of the initiation of HIV treatment, inadequate viral load suppression, or late-stage presentation of HIV infection, all of which warrant further investigation.

Since the COVID-19 epidemic began to spread globally in December 2019, NPIs have been widely implemented
in most countries, including lockdowns in early 2020 [9]. The first case of SARS-CoV-2 in the Republic of Korea involved an individual who entered Incheon International Airport from Wuhan, China, and was reported on January 20, 2020 [43]. 22 days after the Chinese Center for Disease Control and Prevention submitted an official report to the World Health Organization under the International Health Regulations on December 30, 2019 [1]. Subsequently, the Korean government rapidly strengthened quarantine guidelines and NPI policies, activating the highest level of the Infectious Disease Risk Alert System on February 23, 2020 [21]. Recommendations for school nonattendance and remote work were in place until August 2020; however, the Republic of Korea never implemented a total lockdown during the COVID-19 pandemic. Instead, the Korean government upheld broad inclusion criteria for SARS-CoV-2 polymerase chain reaction testing, stringent self-isolation and admission guidelines, and an aggressive approach to tracing the contacts of infected individuals. Controlling the transmission of SARS-CoV-2 became a public health priority for many government workers and public health officials across ministries, local governments, and public health centers in the country.

With the rigorous efforts to control the transmission of SARS-CoV-2, reports from around the world have indicated that HIV prevention services—including community education activities, HIV testing, and the reporting of new HIV diagnoses—have largely declined in many countries, with low- and middle-income countries being significantly affected [41,44]. At the 49th meeting of the The Joint United Nations Programme on HIV/AIDS (UNAIDS) Programme Coordinating Board, held from December 7 to 10, 2021, member state representatives reported that routine HIV prevention and treatment services had been reduced by 66%. Additionally, 90% of students had been unable to attend school, and violence prevention education programs were shuttered [45,46]. A time series analysis of 65 primary care clinics in South Africa revealed that the lockdown was associated with both a 47.6% reduction in HIV testing and a 46.2% reduction in antiretroviral therapy initiation [44]. Close and long-term monitoring is required to better assess the negative impact of the pandemic on the HIV care continuum from social, epidemiological, and clinical perspectives [17,47–49].

To our knowledge, this study represents the first report from the Republic of Korea on the parameters of the HIV test-and-treat cascade across the entire population. In this country, HIV infection surveillance is both active and mandatory, with all cases reported by physicians to public health centers, then ultimately to the KDCA. Diagnosis is confirmed by the KDCA or by one of the 17 Institutes of Health and Environment Research, which operate under the auspices of the KDCA. In our study, the annual statistics for HIV testing were primarily gathered from official sources. Consequently, we are confident that the statistics for HIV tests and cases encompass the entire population residing in the Republic of Korea. However, these data have limitations. We were unable to analyze social, epidemiological, or behavioral factors that may have been related to the observed yearly decreases in HIV tests and cases following the onset of the COVID-19 pandemic. Additionally, the datasets used in our analysis could not be integrated due to the absence of identifiable information.

The data source used to examine trends in HIV care was the Korea National Institute of Health (KNIH), which is the sole national medical insurance payer in the Republic of Korea. These data have several strengths for analyzing medical condition trends: first, they are sufficiently large, and the possibility of sampling bias is minimized through the inclusion of all residents in the Republic of Korea; second, they are readily accessible to the public; third, a consistent methodology has been applied to the basic cleaning of the data, ensuring integrity for trend analysis. However, the data from KNIH/HIRA are primarily derived from medical claims submitted by practitioners for reimbursement, meaning that the disease codes may not always precisely correspond to the conditions for which patients sought treatment. Nonetheless, antiviral medications for HIV are seldom prescribed for other infectious diseases, suggesting that the incidence of HIV misclassification or miscoding in the KNIH/HIRA data is likely relatively low. Furthermore, the handling of multiple clinic or hospital visits by the same individual is accounted for in the open data. However, the exclusion criteria are limited to visits within the same month and to the same type of institution. Consequently, the open data may contain instances of undercounting or overcounting cases, but with relatively little impact on the analysis of time trends.

In our analysis, we were able to quantify the reduction in HIV testing and the decrease in newly identified cases. The observed trend aligned with findings from the United Kingdom [50] and South Africa [44]. However, the rate of antiretroviral therapy management did not decline in either the United Kingdom or South Africa. Furthermore, the reduction in the number of tests and newly detected cases among gay men, bisexual men, and other MSM was relatively small compared to the reductions observed in heterosexual men and women in the United Kingdom. These findings indicate that education on prevention and high adherence to treatment are powerful tools for eradicating the disease and improving the quality of life for PLWH.
In the Republic of Korea, significant decreases were noted in HIV testing and diagnoses at public health centers during the COVID-19 pandemic. The positivity rates of HIV tests and the number of visits for HIV at hospitals and clinics were likewise impacted. Further research must be conducted to examine the long-term effects of the suspension of HIV services in the public sector during 2020 and 2021. This research will inform efforts to achieve the 95-95-95 targets, which aim to eliminate the disease and improve the quality of life for PLWH in the Republic of Korea by 2030.

**Supplementary Material**

**Supplementary Material 1.** Codes of human immunodeficiency virus (HIV) tests; Table S1. Result of the selection method of the final model. Supplementary data are available at https://doi.org/10.24171/j.phrp.2024.0123.

**Notes**

**Ethics Approval**
Not applicable.

**Conflicts of Interest**
The authors have no conflicts of interest to declare.

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**Availability of Data**

**Authors’ Contributions**
Conceptualization: YK, EP, YJ, TK; Data curation: EP, YJ, KK; Formal analysis: YK, EP, YJ; Funding acquisition: YK; Investigation: EP, YJ; Methodology: YK, EP; Project administration: YK, TK; Resources: YJ, KK, TK; HSK; Supervision: HSK; Visualization: YK; Writing—original draft preparation: YK, EP; Writing—review & editing: all authors. All authors read and approved the final manuscript.

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