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Hospital-Based COVID-19 Surveillance in the Context of National and Global Pandemic Trends: A Retrospective Study of Demographic and Temporal Patterns

Yasemin Ardicoglu Akisin [1,*], Rohat Sakar [2], Ebrar Gultekin [2], Parisa Sharafi [3] and Julide Sedef Gocmen [4]

[1] Department of Medical Biochemistry, Faculty of Medicine, TOBB University of Economics and Technology, Ankara 06560, Türkiye
[2] Faculty of Medicine, TOBB University of Economics and Technology, Ankara 06560, Türkiye; rsakar@etu.edu.tr (R.S.); egultekin@etu.edu.tr (E.G.)
[3] Department of Medical Biology, Faculty of Medicine, TOBB University of Economics and Technology, Ankara 06560, Türkiye; psharafi@etu.edu.tr
[4] Department of Medical Microbiology, Faculty of Medicine, TOBB University of Economics and Technology, Ankara 06560, Türkiye; jgocmen@etu.edu.tr
* Correspondence: yardicoglu@tobbetuhastanesi.com.tr; Tel.: +90-533-336-7432

Abstract

Background: Institutional COVID-19 testing patterns may differ from population-level trends owing to differences in testing practices, case ascertainment, and demographic composition. Retrospective evaluation of these patterns may provide insights into future surveillance of infectious diseases. This study aimed to characterise the demographic and temporal patterns of COVID-19 at TOBB University of Economics and Technology Faculty of Medicine Hospital and to contextualise these patterns within contemporaneous surveillance data from Turkey, the WHO European Region, and globally. Methods: In this retrospective descriptive study, SARS-CoV-2 reverse transcription polymerase chain reaction records from the hospital and aggregate World Health Organization surveillance data were evaluated from September 2020 to November 2022. Hospital data were evaluated according to age, sex, test positivity, and calendar month. Test positivity rates with 95% confidence intervals (CIs) were calculated, and sex-specific positivity rates were compared using Pearson's chi-square test. Monthly hospital values were compared with the corresponding monthly national values for Turkey using Spearman's rank correlation. Results: Among 49,318 SARS-CoV-2 reverse transcription polymerase chain reaction test results taken from the hospital data, 4810 were positive (9.75%; 95% CI: 9.49–10.01%). Test positivity did not differ between females and males (9.86% vs. 9.65%, $p = 0.43$). Adults aged 30–39 years represented the largest proportion of reported cases in the hospital (27.03%), Turkey (20.28%), the WHO European Region (16.48%), and globally (18.11%), whereas hospital testing was concentrated among adults aged 20–59 years. Hospital case counts peaked in November 2020 and February 2022, with the latter coinciding with the major COVID-19 surge in early 2022 in broader surveillance data. Monthly hospital case counts were positively correlated with monthly national case counts for Turkey (Spearman rho = 0.55, $p = 0.003$). Conclusions: Hospital-based surveillance identified major demographic and temporal features of the pandemic. However, differences in testing populations, case ascertainment, and reporting practices limit direct comparisons. Integrating institutional- and population-level data may strengthen surveillance frameworks for future respiratory infectious disease outbreaks.

Keywords: COVID-19; SARS-CoV-2; epidemiological surveillance; hospital-based surveillance; demographic patterns; pandemic preparedness

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1. Introduction

Coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), was first reported in Wuhan, China, in late 2019 and rapidly developed into a global pandemic [1,2]. Over the course of the pandemic, successive SARS-CoV-2 variants, including Alpha, Beta, Gamma, Delta, and Omicron, contributed to distinct epidemic waves and were associated with changes in transmissibility, immune evasion, and disease burden [3]. The epidemiological profile of COVID-19 has evolved in parallel with changes in population immunity, vaccination, public health interventions, and testing practices. Age and sex were among the most consistently reported demographic factors associated with differences in infection patterns and clinical outcomes, whereas substantial temporal fluctuations in case numbers have been observed throughout the pandemic [4–6].

COVID-19 surveillance data were generated through heterogeneous systems, ranging from individual hospital-based testing records to national and international reporting platforms. These data sources capture different dimensions of epidemic activity and are not necessarily directly comparable. Hospital-based surveillance provides detailed information on tested individuals and test positivity within a defined healthcare setting, whereas population-level surveillance is influenced by broader testing policies, case definitions, reporting practices, and healthcare-seeking behaviour. Moreover, changes in testing strategies, case definitions, and reporting practices over the course of the pandemic have affected case ascertainment and the interpretation of epidemiological trends [7]. Evaluating institutional observations within the context of national and international surveillance provides broad descriptive contextualisation, while highlighting the limitations arising from differences in data collection and case ascertainment.

These analyses remain relevant beyond the acute phase of the COVID-19 pandemic. Current World Health Organization (WHO) guidance emphasises sustained collaborative surveillance for COVID-19 and recommends integrating SARS-CoV-2 surveillance with surveillance for other respiratory infections [8]. WHO has also developed an integrated surveillance framework in which SARS-CoV-2 and other respiratory viruses of epidemic or pandemic potential are incorporated into an established respiratory surveillance infrastructure, including the Global Influenza Surveillance and Response System [9]. Importantly, lessons from COVID-19 surveillance and response efforts are now being incorporated into preparedness strategies for future respiratory pathogen pandemics [10]. Retrospective evaluation of pandemic-era surveillance data may therefore contribute not only to documenting the epidemiology of COVID-19 but also to understanding how surveillance systems operating at different levels capture major epidemic patterns.

In this context, the present study examined SARS-CoV-2 reverse transcription polymerase chain reaction (RT-PCR) test data from TOBB University of Economics and Technology Faculty of Medicine Hospital in Turkey between September 2020 and November 2022, and contextualised these findings using contemporaneous WHO surveillance data from Turkey, the WHO European Region, and globally. This study aimed to characterise age, sex, test positivity, and temporal patterns at the institutional level and to examine how these patterns related to broader national and international epidemiological trends. Given the differences in case definitions, testing practices, and reporting structures across the datasets, the analysis aimed to identify convergent patterns rather than assume direct quantitative equivalence between institutional and population-level surveillance data.

2. Materials and Methods

2.1. Study Design, Setting, and Data Sources

This retrospective descriptive study analysed hospital-based SARS-CoV-2 testing data and population-level COVID-19 surveillance data collected between September 2020 and

November 2022. Individual-level data were retrospectively retrieved from the Hospital Information System of TOBB University of Economics and Technology Faculty of Medicine Hospital in Turkey and included all SARS-CoV-2 RT-PCR test records registered during the study period, together with age at testing, sex, and test results. Age is exported by the hospital information system as fixed categorical strata rather than as raw age or date of birth, and raw age and birth year were therefore not available for analysis. To contextualise institutional patterns within broader epidemiological trends, aggregate surveillance data for Turkey, the WHO European Region and the world were obtained from the WHO COVID-19 database [11]. The WHO dataset provided confirmed case counts and demographic distributions by age and sex for the corresponding study period.

2.2. Study Population and Eligibility Criteria

The SARS-CoV-2 RT-PCR test results between September 2020 and November 2022 were taken from the hospital information system and were eligible for inclusion, regardless of age, sex, or test outcome. No clinical exclusion criteria were applied. Overall testing, positivity, and sex-based analyses included all available records (n = 49,318). For age-stratified analyses, only records with available age information were included (n = 35,117; 71.4% of all tests); records with missing age information ($n \approx$ 14,200) contributed to the overall testing analysis but were excluded from age-stratified analyses.

For population-level analyses, all available WHO surveillance records for Turkey, the WHO European Region, and global aggregates within the study period were included. Weeks for which the total testing data were unavailable or zero were retained for confirmed case-count analyses but excluded from test-positivity calculations.

2.3. Case Definitions and Data Comparability

At the hospital, a hospital-level laboratory-positive case was defined as a positive SARS-CoV-2 RT-PCR result. In contrast, WHO population-level surveillance data use the applicable WHO case definitions and may include cases identified using diagnostic approaches other than RT-PCR, depending on the reporting definition and period [7]. Consequently, hospital-level and population-level datasets differed in case ascertainment, testing denominators, and reporting systems and were not considered directly quantitatively equivalent. Cross-level comparisons were descriptive and used primarily to contextualise demographic and temporal patterns.

2.4. Age-Group Classification

For the WHO population-level data for the hospital, Turkey, the WHO European Region, and globally, cases were aggregated from the original WHO reporting strata into standard 10-year age intervals (0–9, 10–19, 20–29, 30–39, 40–49, 50–59, 60–69, 70–79, and $\geq$80 years). The following WHO strata were combined: <5 and 5–9 years into 0–9 years; 10–14 and 15–19 years into 10–19 years; 20–24 and 25–29 years into 20–29 years; 60–64 and 65–69 years into 60–69 years; and 70–74 and 75–79 years into 70–79 years. The 30–39-, 40–49-, 50–59-, and >80-year categories did not require further aggregation.

2.5. Statistical Analysis

Statistical analyses were performed using R (version 4.6.0; R Foundation for Statistical Computing, Vienna, Austria). Categorical variables were presented as counts and proportions. For hospital-level data, overall and sex-specific test-positivity rates were calculated as the number of positive RT-PCR tests divided by the total number of RT-PCR tests, with corresponding 95% confidence intervals (CIs). Wald intervals were used for the overall and sex-specific rates. For the monthly positivity rates, Wilson score intervals were used because several monthly denominators were small. The association between sex and

SARS-CoV-2 test results, as well as between the complete and missing data groups, was evaluated using Pearson's chi-square test.

To quantify the correspondence between institutional and national trends, monthly hospital values were compared with the corresponding monthly national values for Turkey using Spearman's rank correlation coefficient. Weekly WHO data were aggregated to calendar months for this purpose, with each week assigned to the month of its reported date. Two comparisons were performed: monthly confirmed case counts across the full period of overlap, and monthly test positivity restricted to those months in which every constituent week had an available testing denominator. November 2022 was excluded from both comparisons as an incomplete month.

All tests were two-sided, and $p < 0.05$ was considered statistically significant. Beyond these correlation analyses, population-level WHO data were analysed descriptively because the individual-level denominators required for equivalent inferential analyses were not available.

2.6. Ethical Considerations

This study was approved by the TOBB University of Economics and Technology Faculty of Medicine Clinical Research Ethics Board (approval date: 12 November 2022; protocol no. KAEK-118/145). Hospital data were fully anonymised before analysis. The requirement for individual informed consent was waived because of the retrospective design and use of anonymised data, in accordance with the ethics committee approval. WHO surveillance data were accessed and used in accordance with the applicable WHO terms and conditions.

3. Results

3.1. Hospital-Based Testing and Overall Positivity

Between September 2020 and November 2022, 49,318 SARS-CoV-2 RT-PCR test results were taken from the hospital data. Of these, 4810 tested positive, corresponding to an overall test-positivity rate of 9.75% (95% CI: 9.49–10.01%) (Table 1). Because the dataset reflects total laboratory surveillance volume without patient-level de-duplication, overall positivity rates are defined as test-level positivity rather than population-based infection prevalence.

Table 1. Sex distribution and SARS-CoV-2 test positivity at TOBB University of Economics and Technology Faculty of Medicine Hospital, contextualised alongside reported sex distributions in Turkey, the WHO European Region, and globally.

Characteristic	Hospital (Tested)	Hospital (Positive)	Turkey	EU	Global
Data type	RT-qPCR results	RT-qPCR-confirmed cases	WHO-confirmed cases	WHO-confirmed cases	WHO-confirmed cases
Total, *n*	49,318	4810	16,001,644	237,528,448	363,533,501
Female, *n* (%)	24,866 (50.4%)	2451 (51.0%)	8,392,415 (52.4%)	127,937,838 (53.9%)	182,573,245 (53.4%) [a]
Male, *n* (%)	24,452 (49.6%)	2359 (49.0%)	7,609,229 (47.6%)	109,590,610 (46.1%)	159,540,516 (46.6%) [a]
Overall positivity rate, % (95% CI)	9.75% (9.49–10.01%)	N/A	N/A	N/A	N/A
Female positivity rate, % (95% CI)	9.86% (9.49–10.23%)	N/A	N/A	N/A	N/A
Male positivity rate, % (95% CI)	9.65% (9.28–10.02%)	N/A	N/A	N/A	N/A

Table 1. *Cont.*

Characteristic	Hospital (Tested)	Hospital (Positive)	Turkey	EU	Global
Sex × result, $\chi^2(1)$, *p*-value	0.61, $p = 0.43$	—	—	—	—

Hospital data represent SARS-CoV-2 RT-PCR test results and include all records with available sex information (n = 49,318). Turkey, WHO European Region, and global data represent confirmed COVID-19 cases reported in WHO surveillance data and are presented for descriptive contextualisation only. Hospital and WHO percentages should not be interpreted as directly equivalent because of differences in case ascertainment and reporting structures. Dashes indicate quantities that cannot be derived rather than missing values. Positivity is undefined for the Hospital (Positive) column, which is the numerator of that rate. For the Turkey, WHO European Region, and global columns, WHO surveillance reports confirmed cases without sex-disaggregated testing volumes, so sex-specific positivity cannot be derived for any period, and testing denominators were reported only until mid-2022, so an overall positivity rate covering the full study period cannot be calculated. [a] Global sex percentages are calculated among 342,113,761 confirmed cases with recorded sex data; 21,419,740 global cases lacked sex data in the WHO database. The overall WHO global confirmed case total was 363,533,501. CI: confidence interval; EU: the WHO European Region; N/A: not applicable; RT-PCR: reverse transcription polymerase chain reaction; WHO: World Health Organization.

3.2. Sex Distribution and Sex-Specific Positivity

Among the 49,318 test records obtained from the hospital data, 24,866 (50.4%) were female, and 24,452 (49.6%) were male. Among the 4810 RT-PCR-positive test records, 2451 (51.0%) were female, and 2359 (49.0%) were male. The test-positivity rate was 9.86% (95% CI: 9.49–10.23%) in females and 9.65% (95% CI: 9.28–10.02%) in males, with no statistically significant association between sex and test result ($\chi^2(1) = 0.61$, $p = 0.43$) (Table 1). Women accounted for 52.4% of the reported cases in Turkey and 53.9% in the WHO European Region. Globally, of the 342,113,761 confirmed cases with recorded sex, 53.4% were female, and 46.6% were male (Table 1).

When stratified by major calendar periods, sex-specific test positivity remained consistently similar across all years: in 2020 (Females: 18.11% [749/4136] vs. Males: 18.40% [799/4342]; Total positivity: 18.26%), in 2021 (Females: 3.06% [407/13,291] vs. Males: 3.05% [403/13,214]; Total positivity: 3.06%), and in 2022 (Females: 17.41% [1295/7439] vs. Males: 16.76% [1156/6896]; Total positivity: 17.10%). These findings indicate that temporal testing shifts did not confound sex-specific positivity distributions. In contrast, females represented a modestly higher proportion of reported cases in national, WHO European Region, and global surveillance data, serving as broad descriptive context for our institutional findings.

3.3. Age Distribution

Among the population-level reported cases, the 30–39-year age group represented the largest proportion across all three surveillance levels, accounting for 20.28% of the cases in Turkey, 16.48% in the WHO European Region, and 18.11% globally (Figure 1A). The combined 30–59-year age group accounted for 51.77% of the global reported cases with recorded demographic data.

Age information was available for 35,117 hospital-tested results (71.4% of the total hospital cohort). The largest age category was 30–39 years (n = 9492; 27.03%), followed by 40–49 years (n = 6915; 19.69%) and 20–29 years (n = 4653; 13.25%) (Figure 1B). Individuals aged $\geq$ 75 years accounted for less than 3% of hospital-tested results with available age data (n = 872).

To evaluate potential selection bias associated with missing age data, a comparative sensitivity analysis was conducted between the complete-data cohort (N = 49,318) and the missing-age cohort (N = 14,201). Pearson's Chi-square tests revealed no statistically significant differences between the groups regarding sex distribution (50.42% female vs.

50.33% female; $x^2 = 0.038$, $p = 0.845$), female test-positivity rates (9.86% vs. 9.76%; $x^2 = 0.054$, $p = 0.816$), or male test-positivity rates (9.65% vs. 9.58%; = 0.031, $p = 0.860$). Although overall test positivity was slightly higher in the missing-age cohort (11.30% vs. 9.75%; $x^2 = 32.12$, $p < 0.001$), the high degree of demographic and sex-specific clinical concordance confirms that missing age data occurred independently of sex distribution and sex-specific infection status, supporting the Missing Completely at Random (MCAR) assumption.

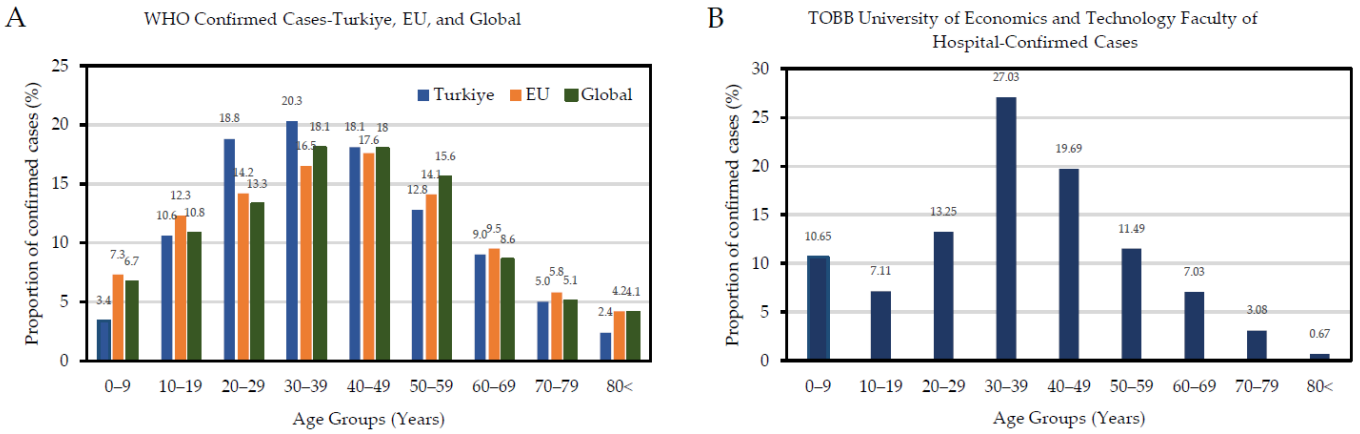


Figure 1. Age distribution of confirmed COVID-19 cases in Turkey, the WHO European Region, globally, and at TOBB University of Economics and Technology Faculty of Medicine hospital-based SARS-CoV-2 testing during the study period (September 2020 to November 2022). (**A**) Distribution of confirmed COVID-19 cases by age group in Turkey, the European Union (EU), and globally based on WHO surveillance data. (**B**) Age distribution of confirmed COVID-19 cases or SARS-CoV-2 tested by RT-PCR at the Hospital. Hospital age categories follow the WHO age-group classification. (WHO age groups are presented in 10-year intervals (0–9 to ≥80 years).

3.4. Temporal Patterns

The temporal patterns of reported cases and test positivity are shown in Figure 2. At the hospital, monthly test positivity across the 26 complete months ranged from 1.1% in February 2021 to 36.9% in July 2022. The highest monthly positivity was recorded in July 2022 (219/593; 36.9%; 95% CI: 33.1–40.9%), followed by November 2020 (793/3263; 24.3%; 95% CI: 22.9–25.8%), August 2022 (139/577; 24.1%; 95% CI: 20.8–27.7%), and February 2022 (828/3722; 22.2%; 95% CI: 20.9–23.6%). The July and August 2022 values were based on small monthly testing volumes and should be interpreted with caution.

The highest monthly reported case count was recorded in February 2022 ($n = 828$), followed by November 2020 ($n = 793$). Monthly testing volumes ranged from 34 tests in November 2022, when the data were incomplete, to 3722 tests in February 2022, and fell to fewer than 600 tests per month from June 2022 onward.

At the population level, multiple increases in reported case counts were observed in Turkey, the WHO European Region, and globally during the study period, with prominent increases in early 2022 (Figure 2A). The highest weekly reported case counts in Turkey, the WHO European Region, and globally all occurred in January 2022. Test-positivity rates are presented only for periods in which the testing denominators are available (Figure 2B).

Monthly hospital confirmed case counts were positively correlated with monthly national confirmed case counts for Turkey (Spearman rho = 0.55, $p = 0.0033$, $n = 26$ months). Monthly hospital test positivity was likewise positively correlated with national test positivity over the period for which national testing denominators were available (Spearman rho = 0.57, $p = 0.0065$, $n = 21$ months, September 2020 to May 2022).

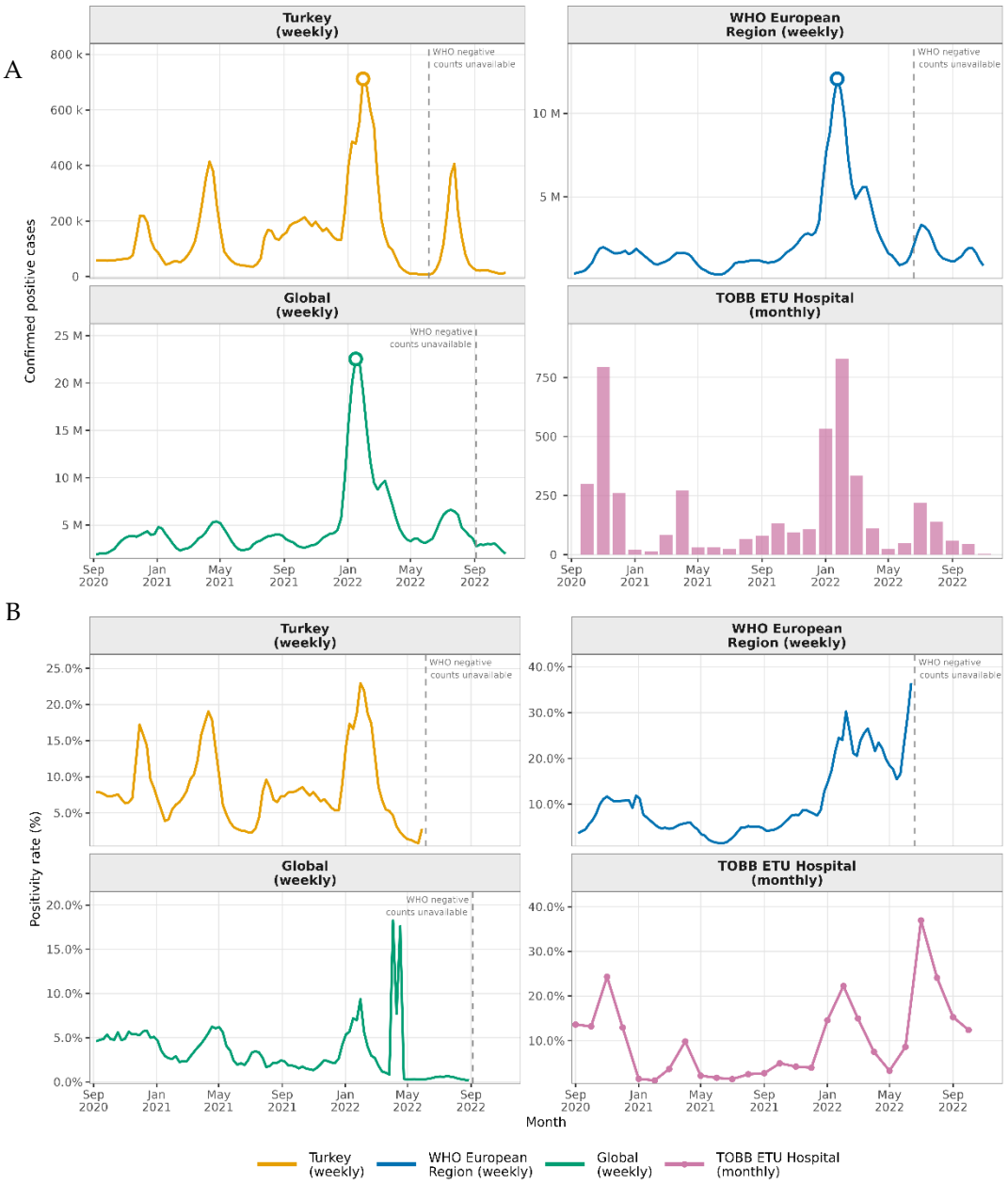


Figure 2. Temporal distribution of confirmed COVID-19 cases (**A**) and test positivity (**B**) at TOBB University of Economics and Technology Faculty of Medicine Hospital in Turkey, in the WHO European Region, and globally from September 2020 to November 2022. Panel A: WHO data are weekly (line); hospital data are monthly (bars). Open circles mark the peak week in each WHO panel. Panel B: Positivity rate is the number of positive tests divided by the total number of tests, expressed as a percentage. Dots mark monthly hospital observations. Dashed lines mark the date on which each region ceased reporting negative test counts to WHO (Turkey 5 June 2022; WHO European Region 19 June 2022; global 4 September 2022). Hospital positivity is shown for all complete months; November 2022 is excluded as an incomplete month (n = 34 tests). The July 2022 hospital value (36.9%) rests on a low denominator (n = 593) and should be interpreted with caution. Weekly population-level positivity is sensitive to variation in the number of countries reporting testing data in a given week.

4. Discussion

This retrospective descriptive study evaluated hospital-based SARS-CoV-2 testing patterns in the context of national, regional, and global COVID-19 surveillance data between September 2020 and November 2022. Three principal findings were identified in this study. First, adults of working age represented the largest proportion of reported cases across

the population-level datasets and constituted the majority of test results from the hospital. Second, SARS-CoV-2 test positivity at the hospital was similar in females and males, despite the modest female predominance among reported cases in the broader surveillance datasets. Third, major increases in hospital test counts temporally coincided with the epidemic surges observed in national and international surveillance, particularly in early 2022. These findings illustrate both the potential value and methodological constraints of interpreting institutional testing data alongside population-level surveillance.

4.1. Age Distribution

Adults aged 30–39 years represented the largest proportion of reported cases in the hospital, Turkey, the WHO European Region, and globally. The predominance of working-age adults was consistent with epidemiological observations reported during the pandemic [2]. Although greater mobility, occupational activity, and frequency of interpersonal contact may have contributed to this pattern, these factors were not measured in the present study and should, therefore, not be interpreted as causal explanations.

The lower representation of older adults may similarly reflect multiple factors, including differences in exposure, healthcare-seeking behaviour, testing practices, and age-specific public health measures. Importantly, the hospital and WHO age distributions cannot be directly compared because the hospital data represent tested individuals, whereas the WHO data represent reported cases, and the age categories used by the two data sources differ. Nevertheless, the concentration of observations among working-age adults across surveillance levels indicates a shared qualitative trend in demographic distribution.

4.2. Sex Distribution

At the hospital, test-positivity rates were nearly identical between females and males (9.86% vs. 9.65%), with no statistically significant association between sex and SARS-CoV-2 test results ($p = 0.43$). When stratified by major calendar periods, sex-specific test positivity remained consistently similar across all years (2020: 18.11% vs. 18.40%; 2021: 3.06% vs. 3.05% %; 2022: 17.41% vs. 16.76%), indicating that temporal testing patterns did not confound overall sex distributions. In contrast, females represented a modestly higher proportion of reported cases in national, WHO European Region, and global surveillance data, serving as descriptive context for our institutional findings [4,5].

These findings emphasise the distinction between case distribution and test positivity. A higher proportion of female reported cases in population-level surveillance does not necessarily indicate greater biological susceptibility, particularly when the underlying numbers of tested females and males are unavailable. Differences in healthcare utilisation, occupational exposure, testing behaviour, and reporting may have influenced the observed case distributions. As these variables were not captured in the present study, the observed sex differences cannot be attributed to specific behavioural or biological mechanisms.

4.3. Temporal Patterns

Hospital case counts showed two prominent peaks in November 2020 and February 2022, whereas national, EU, and global surveillance data demonstrated multiple increases in reported case counts during the study period. The early-2022 increase was particularly evident across the surveillance levels and occurred during a period of widespread SARS-CoV-2 Omicron-variant circulation. Temporal variations in COVID-19 incidence have previously been associated with complex interactions among viral evolution, population immunity, public health interventions, human behaviour, and environmental or seasonal factors [6,12]. Accordingly, the temporal patterns observed in this study should be interpreted as descriptive epidemiological patterns rather than evidence of seasonality or a specific causal mechanism.

The study period also encompassed the successive predominance of the Alpha, Delta, and Omicron variants and the progressive rollout of COVID-19 vaccination [3]. Variant and vaccination data were not collected in the present study, and these developments are noted here only as context for interpretation rather than as measured explanatory variables. Changes in testing practice are equally relevant. Hospital testing volume fell from 3722 tests in February 2022 to fewer than 600 tests per month from June 2022 onward, so the elevated positivity observed in mid-2022 should be interpreted in the light of a markedly reduced testing denominator rather than as a direct measure of increased transmission.

Nevertheless, observing local institutional activity alongside broader epidemic waves provides valuable descriptive context from a surveillance perspective. This correspondence was supported by the positive rank correlations between the monthly hospital series and the corresponding national series. Hospital-based testing data may provide detailed local information that complements population-level surveillance, particularly when interpreted within the context of broader epidemiological trends. However, differences in reporting frequency (monthly at the hospital and weekly in the WHO dataset), as well as changing testing strategies and the availability of testing denominators, preclude direct quantitative comparison of the curves.

The temporal variations in test positivity observed across our hospital cohort reflect broader community-level transmission dynamics and evolving population immunity over the course of the pandemic. Longitudinal studies in paediatric and general cohorts demonstrate how seroprevalence and infection rates shifted significantly between the pre-vaccination era and subsequent pandemic waves driven by emerging variants [13,14]. Furthermore, evidence on anti-Spike antibody kinetics following primary and booster BNT162b2 vaccination highlights the progressive impact of vaccine rollout and waning humoral immunity on population susceptibility over time [15]. Household transmission and antibody decay profiles across successive epidemic phases further illustrate the changing background transmission environment [16]. While individual variant characterisation was not performed in our laboratory dataset, contextualising our monthly testing trends alongside these established seroepidemiology and vaccination dynamics provides valuable insight into overall epidemic patterns in our setting.

4.4. Implications for Surveillance

One of the main observations of this study is that surveillance datasets collected at different levels can show broadly similar demographic and temporal patterns, while remaining methodologically non-equivalent. During the COVID-19 pandemic, changes in case definitions, testing strategies, reporting requirements, and diagnostic availability have complicated comparisons across countries and surveillance systems. The WHO has identified these issues as important lessons from pandemic surveillance and emphasised the need for complementary, interoperable surveillance approaches rather than relying on a single data source [8,9].

This perspective underscores the relevance of retrospective institutional datasets. Current WHO guidance recommends sustaining COVID-19 surveillance within integrated respiratory pathogen surveillance systems and preserving the capacities developed during the pandemic for future epidemic and pandemic preparedness [8]. The present findings are consistent with this approach by demonstrating that hospital-based testing data can reflect major epidemic patterns, while also highlighting the importance of clearly defined denominators, standardised case definitions, and transparent reporting when institutional and population-level data are interpreted together.

4.5. Strengths and Limitations

A strength of this study is the inclusion of a relatively large hospital-based dataset comprising 49,318 SARS-CoV-2 RT-PCR test results, together with contemporaneous national, regional, and global surveillance data covering more than two years of the pandemic. The availability of hospital test results permitted the calculation of test-positivity rates and sex-specific statistical comparisons.

This study has several limitations. First, case ascertainment differed between the hospital and WHO datasets; hospital cases were identified by RT-PCR, whereas population-level surveillance may include cases identified using other diagnostic approaches. Second, age information was unavailable for approximately 28.6% of the tested encounters. To address potential selection bias, a comparative sensitivity analysis was performed between the cohorts with complete and incomplete age data. Demographic and sex-stratified positivity distributions were consistent across both groups, confirming that data were MCAR and that the absence of age records did not systematically distort the observed epidemiological patterns.

Third, population-level data lacked equivalent individual-level testing denominators, precluding inferential comparisons with the hospital datasets. Fourth, negative test counts ceased to be reported to WHO on 5 June 2022 for Turkey, 19 June 2022 for the WHO European Region, and 4 September 2022 globally, which restricted the calculation of population-level positivity rates in the latter part of the study period. Fifth, information on vaccination status, comorbidities, disease severity, mortality, socioeconomic characteristics, occupational exposure, and behavioural factors was not available; consequently, the study could not determine the mechanisms underlying the observed demographic or temporal patterns. Sixth, this study was designed strictly as a comprehensive laboratory-based surveillance analysis utilising central repository records. Due to the absence of clinical indication data within the database (e.g., distinguishing diagnostic testing in symptomatic patients from routine screening in asymptomatic individuals, pre-operative clearances, or occupational testing), no clinical exclusion criteria could be applied. Consequently, all processed RT-qPCR test encounters were included to reflect overall institutional testing dynamics. The lack of clinical stratification and the potential confounding effect of asymptomatic screening on overall positivity rates represent an inherent limitation of our dataset. Additionally, the dataset reflects total test encounters (n = 49,318) rather than unique individuals, as patient-level de-duplication was not feasible. Although serial testing can theoretically inflate sample sizes in chi-square analyses, sex differences remained non-significant. Thus, this data structure did not produce false-positive significance or alter our main conclusions.

Finally, potential diagnostic and selection biases must be acknowledged. As a hospital-based surveillance study, the dataset reflects individuals seeking care or requiring testing, which may not fully capture asymptomatic cases within the broader community. Additionally, temporal shifts in testing strategies and variant dynamics over the pandemic period represent recognised sources of variability, as reported in the broader literature.

Furthermore, when evaluating hospital-based surveillance data, the exposure risks and outcomes of specific vulnerable sub-populations must be taken into account. Pandemic waves and strict lockdown measures have been reported to impact peripartum and maternal outcomes in distinct patient cohorts [17]. Additionally, studies evaluating specific demographic groups, such as pregnant women, have demonstrated unique seroprevalence patterns and exposure risks compared to non-pregnant controls [18]. Although our surveillance protocol encompassed all individuals presenting for RT-PCR testing without selecting patients by specific clinical departments or pregnancy status, incorporating population-wide surveillance trends alongside data from high-risk sub-cohorts

provides a more comprehensive framework for understanding the overall trajectory of community transmission.

5. Conclusions

This study demonstrates that hospital-based SARS-CoV-2 testing data can provide valuable descriptive context for broader temporal trends observed in national and international surveillance, despite important differences in case ascertainment, reporting structures, and available denominators. Adults of working age accounted for the largest proportion of observations across the surveillance levels, whereas hospital-based SARS-CoV-2 test-positivity rates were similar between females and males. Major institutional increases in reported case numbers also broadly coincide with population-level epidemic surges, particularly in early 2022. These findings highlight the complementary value of institutional- and population-level data while underscoring the need for standardised case definitions, clearly defined denominators, and transparent reporting when interpreting surveillance data across different settings. Lessons from COVID-19 surveillance may contribute to the development of integrated and resilient surveillance systems for future respiratory epidemics and pandemics.

Author Contributions: J.S.G. and Y.A.A. conceived the study and developed the research hypothesis. E.G. and R.S. were responsible for data collection and data curation. P.S., J.S.G. and Y.A.A. performed the data analysis, interpreted the findings, and contributed to the statistical evaluation. R.S. prepared the figures, and E.G. prepared the tables. The manuscript was drafted by E.G., R.S., and Y.A.A. under the supervision of Y.A.A. All authors critically reviewed the manuscript for important intellectual content, approved the final version for publication, and agree to be accountable for all aspects of the work. All authors have read and agreed to the published version of the manuscript.

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Data Availability Statement: Correspondence and requests for materials should be addressed to Yasemin ARDICOGLU AKISIN.

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