Analysis of COVID-19 Test Positivity Rate in West Sumatra, Indonesia: A Cross-sectional Study of One-year Observation

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Abstract

Background: The test positivity rate (TPR) of COVID-19 is an epidemiological indicator used to estimate SARS-CoV-2 transmission in a population at a certain time. However, large data analysis on the TPR in Indonesia is still limited. In this study, we determined COVID-19 TPR dynamics of Indonesian West Sumatra Province in the first year of cases were recorded.

Method: We conducted an observational study with a cross-sectional approach from one-year secondary data of COVID-19 test using qualitative reverse transcription polymerase chain reaction (q-RT-PCR) in West Sumatra collected from April 2020 until March 2021. The TPR(s) in the province, its regions (cities/regencies), and districts were determined annually, quarterly, and monthly to analyze their trends.

Results: From a total of 410,424 individuals taking COVID-19 q-RT-PCR examination during one-year observation, the provincial TPR was 8.11%. The highest TPR quarterly and monthly was detected in the third quarter (October 2020 – December 2020, 12.18%) and October 2020 (15.62%) respectively. The TPR of cities was likely two times higher than regencies. There were significant differences in annual TPR between regions, districts, and any period of times detected in this study.

Conclusion: We have shown the COVID-19 q-RT-PCR TPR dynamics to describe SARS-CoV-2 transmission control among different areas in West Sumatra. This study should be beneficial to ensure an effective COVID-19 preventive strategy in the future.

Background

Coronavirus Disease 2019 (COVID-19) pandemic caused by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) infection on humans has been responsible for at least four million people dead in July 2021 (1, 2). Indonesia recorded 3.3 million cases and 92 thousand deaths at the same time. As many as 37 thousand cases with 800 deaths were detected in West Sumatra Province (3). Meanwhile, it is believed that the actual COVID-19 data is higher than the currently recorded due to the lack of mass screening and the presence of asymptomatic cases that are difficult to evaluate (4). Large data analysis should be performed to estimate and control the pandemic across the country and to find an appropriate strategy to prevent massive mortality due to COVID-19.

Some research has pointed to the test positivity rate (TPR) as a reliable indicator to manage the COVID-19 pandemic (5, 6). COVID-19 TPR is also used by World Health Organization (WHO) as a standard to determine the control level of SARS-CoV-2 transmission by dividing the number of positive confirmed cases by the number of people tested. A positivity rate above 5% in an area indicates that the outbreak is out of control and larger scope of mass screening is required (7). COVID-19 diagnosis is confirmed molecularly by examining the genetic material of SARS-CoV-2 from swab specimens of the nasopharynx, oropharynx, tracheal aspirate, or broncho-alveolar lavage using q-RT-PCR methods. This examination is a gold standard to be a reference for calculating the positivity rate to assess the level of outbreak control in an area (8, 9).
Center for Diagnostic and Research on Infectious Diseases, Faculty of Medicine, Universitas Andalas (PDRPI Lab), and Bukittinggi Veterinary Laboratory (Balivet Lab) are the two main laboratories certified by the Indonesian Ministry of Health to detect COVID-19 in West Sumatra Province, Indonesia. The study of COVID-19 q-RT-PCR TPR in these two laboratories is essential to provide scientific evidence for the policymakers of the provincial to city/ regency levels to strategically control the viral transmission and develop preventive strategy, particularly in the West Sumatra Province in the future. Thus, we performed an analysis of large data including first-time positive individuals in these two laboratories in the first year period when new cases were recorded to obtain the figure of COVID-19 TPR in West Sumatera Province. Furthermore, we presented the analysis of TPR in each city/ regency in the province monthly and quarterly. To the best of our knowledge, this is the first study in Indonesia describing the level of control of SARS-CoV-2 transmission in the province specifically. In addition, the result of this study demonstrated the TPR dynamics before the massive COVID-19 vaccine distribution in Indonesia which may be essential for future data analysis.

Methods

Study design and data collection

This research was an observational study with a cross-sectional approach. The population of this study was the people who have taken COVID-19 q-RT-PCR examination in West Sumatra Province from April 2020 to March 2021. Samples were collected from medical records at the PDRPI Lab and Balivet Lab as the only two laboratories remained in the province. Samples were selected totally with inclusion and exclusion criteria. The inclusion criteria were all individuals who were administratively registered for the examination in the laboratories, while the exclusion criteria were individuals who taking the swabbing procedure in the airport where the viral source was difficult to figure, and those with a follow-up current COVID-19 infection or who had reinfection. This study has been ethically approved by The Research Ethics Committee of the Medical Faculty of Universitas Andalas with grant number 463/UN.16.2/KEP-FK/2021.

Province, cities-regencies, and districts classification

West Sumatra is a province in a west coastal line of Sumatra Island of Indonesia with 5.53 million residents and a population density of 131 people/ square kilometers. The province consists of 19 districts that are classified into 7 cities and 12 regencies according to the national administrative territory (Fig. 1). The density of population is highly variable across the districts, from 4,795 people/ square kilometers in Kota Bukittinggi to 14 people/square kilometers in Kepulauan Mentawai. Generally, the cities have a higher density than regencies (10)(11).

Definition and statistical analysis

COVID-19 test positivity rate (TPR) was defined as the percentage of individuals who were confirmed positive of COVID-19 for the first time per all individuals who have taken COVID-19 q-RT-PCR test in the
laboratories at a certain period. The administrative area (district) was the location of the healthcare facilities where the COVID-19 specimens were taken from individuals before being sent to the laboratories. We determined the TPR(s) of the province, regions (cities and regencies), and districts by periods (yearly, quarterly, and monthly). TPR differences between regions, districts, quarters, and months in one year were examined with chi-squared/ chi-squared for trends test. A \( p \)-value < 0.05 is significantly different.

**Results**

**Characteristic of test positivity rate**

From a total of 410,424 individuals who were taking COVID-19 q-RT-PCR examination in West Sumatra from April 2020 until March 2021, the TPR was 8.11% (Table 1). The annual TPR of cities was nearly two times higher than regencies. The highest TPR was Kota Bukittinggi (13.12%), followed by other major cities including Kota Padang Panjang, Kota Solok, and Kota Padang with TPR above 10%. Agam had the highest PR among other regencies with 10.89%. The lowest TPR in cities and regencies was Kota Sawahlunto (7.46%) and Dharmasraya (3.07%) respectively. There were significant differences in TPR between all variables with a \( p \)-value < 0.001.

Table 1

| Characteristic of COVID-19 q-RT-PCR test positivity rate in one year period |
| --- |
| --- |
| --- |
| --- |
| Variables | n   | COVID-19 Cases | Test Positivity Rate/ TPR (%) | p-value** |
|-----------|-----|----------------|-------------------------------|-----------|
| Region    |     |                |                               |           |
| Cities    | 218,450 | 22,794 | 195,656 | 10.43 | <0.001* |
| Regencies | 191,974 | 10,475  | 181,499 | 5.46  |
|           |     |                |                               |           |
| District  |     |                |                               |           |
| Cities    |     |                |                               |           |
| Kota Bukittinggi | 15,849 | 2,079  | 13,770 | 13.12 |
| Kota Padang Panjang | 6,111 | 756    | 5,355 | 12.37 |
| Kota Solok | 8,362  | 965    | 7,397 | 11.54 |
| Kota Padang | 162,921 | 16,765 | 146,156 | 10.29 |
| Kota Pariaman | 6,528  | 607    | 5,921 | 9.30  |
| Kota Payakumbuh | 12,927 | 1,193  | 11,734 | 9.23  |
| Kota Sawahlunto | 5,752  | 429    | 5,323 | 7.46  |
| Regencies |     |                |                               |           |
| Agam      | 20,269 | 2,207  | 18,062 | 10.89 |
| Solok     | 8,614  | 696    | 7,918 | 8.08  |
| Pesisir Selatan | 15,864 | 1,280  | 14,584 | 8.07  |
| Lima Puluh Kota | 10,699 | 672    | 10,027 | 6.28  |
| Sijunjung | 15,519 | 874    | 14,645 | 5.63  |
| Tanah Datar | 20,563 | 1,085  | 19,478 | 5.28  |
| Pasaman Barat | 12,674 | 593    | 12,081 | 4.68  |
| Padang Pariaman | 21,771 | 897    | 20,874 | 4.12  |
| Solok Selatan | 16,905 | 584    | 16,321 | 3.45  |
| Kepulauan Mentawai | 18,342 | 611    | 17,731 | 3.33  |
| Pasaman   | 12,032 | 401    | 11,631 | 3.33  |
| Dharmasraya | 18,722 | 575    | 18,147 | 3.07  |
| Quarter   |     |                |                               |           |
| 1st (Apr-20 to Jun-20) | 39,371 | 762    | 38,609 | 1.94  | <0.001* |
| Period               | Tested  | Pos  | Positive | Rate (%) |
|---------------------|---------|------|----------|----------|
| **2nd (Jul-20 to Sep-20)** | 122,917 | 6,505 | 116,412  | 5.29     |
| **3rd (Oct-20 to Dec-20)** | 140,210 | 17,383 | 122,827  | 12.40    |
| **4th (Jan-21 to Mar-21)** | 107,926 | 8,619 | 99,307   | 7.99     |
| **Month**           |         |      |          |          |
| Apr-20              | 2,795   | 189  | 2,606    | 6.76     | <0.001*  |
| May-20              | 12,302  | 391  | 11,911   | 3.18     |
| Jun-20              | 24,274  | 182  | 24,092   | 0.75     |
| Jul-20              | 21,404  | 217  | 21,187   | 1.01     |
| Aug-20              | 42,324  | 1,567| 40,757   | 3.70     |
| Sep-20              | 59,189  | 4,721| 54,468   | 7.98     |
| Oct-20              | 54,035  | 8,442| 45,593   | 15.62    |
| Nov-20              | 41,711  | 5,495| 36,216   | 13.17    |
| Dec-20              | 44,464  | 3,446| 41,018   | 7.75     |
| Jan-21              | 61,415  | 3,522| 57,893   | 5.73     |
| Feb-21              | 23,010  | 2,265| 20,745   | 9.84     |
| Mar-21              | 23,501  | 2,832| 20,669   | 12.05    |
| **Total West Sumatra** | 410,424 | 33,269| 377,155  | 8.11     |

*p-value <0.05 was statistically significant

**Chi-squared/ chi-squared for trend test

**Test positivity rate trends**

To provide the TPR trends in West Sumatra by periods, we evaluated the TPR of one-year COVID-19 between regions and the province quarterly and monthly (Fig.1). There was a significant increase in the provincial TPR from 1.94% in the first quarter to a peak of 12.4% in the third quarter (Fig. 2(a)). However, the TPR tended to decrease in the last quarter. The trends between the cities and regencies were similar while the TPR of cities was likely two times higher than regencies in each quarter. The peak point of TPR in cities compared to regencies was 15.88% and 8.33% respectively.
From April 2020 to March 2021, the TPR trend of the province was gradually decreased in the first three months (Fig. 2(b)). The lowest point of TPR was noted in June 2020 with only 0.75%. However, there was a significant increase of TPR from July 2020 to October 2020 by 15 times until its's highest peak point reached 15.62%. At this point, the TPR of cities was 22.05%, nearly three times higher than regencies with 7.7%. Provincial TPR tended to decline to January 2021 before rearose in February and March 2021, yet the TPR of the cities re-increased earlier in January 2021. Generally, the trend of TPR in the regencies was likely following the trend of the cities, except in December 2020 when the TPR of regencies was slightly higher than the cities (8.08% versus 7.55%).

Based on districts quarterly (Fig. 3), the highest TPR in West Sumatra was found in Kota Padang Panjang in the third quarter (23.73%) followed by Kota Solok in the fourth quarter (22.17%). The TPR(s) in six districts used to increase every next quarter, namely Kota Bukittinggi, Kota Sawahlunto, Kota Solok, Kepulauan Mentawai, Lima Puluh Kota, and Solok Selatan. These trends were also seen monthly (Fig. 4 and Fig. 5). The data showed that COVID-19 TPR trends in West Sumatra were different across the region and district quarterly and monthly.

**Discussion**

A large-scale COVID-19 TPR is often used globally to control the pandemic as the SARS-CoV-2 transmission indicator and may estimate COVID-19 prevalence, predicting health care requirements, and monitoring the severity of cases in a country (12–14). Here we determined the COVID-19 q-RT-PCR TPR in West Sumatra Province of Indonesia from April 2020 to March 2021 by using large retrospective data from the two labs. Our analysis showed that the TPR of West Sumatra in the first year period was surpassing WHO recommendation of 5%. The COVID-19 TPR in cities reached above 10%, two times compared to regencies, indicating that SARS-CoV-2 transmission was still out of control especially in these regions. In some districts, nearly one of four samples tested was positive in a monthly period. TPR trends also increased over time although some short declines were recorded but never far beyond recommendation.

Our study result demonstrated that the TPR in West Sumatra was high (> recommendation of 5%) in the first-year period of COVID-19 pandemic entered the province, especially in cities. There was a significant difference in the TPR between cities and regencies, where the annual TPR of cities was two times higher. This finding may be related to urban or rural types of regions based on population density where the cities were mostly had higher densities than regencies (15). West Sumatra had an average population density of 131 people/ square kilometers, with a high average density in cities of 1,219 people/ square kilometers compared to regencies with only 100 people/ square kilometers (10, 11). The highest number of population densities was Kota Bukittinggi of 4,795 people/ square kilometers and Kota Padang Panjang of 2,448 people/ square kilometers, in line with the TPR of these cities as the highest among other districts in the province. Some studies had highlighted the population density as the main factor of viral spreading in a region due to the increase of contact rates (16–18). Further analysis should be
performed to find other confounding factors that affect a high TPR in cities, such as testing capability, health care capacity, transportation, behavioral factors, and government policy.

Although many districts in the province had a higher annual TPR than the global recommendation to control the pandemic, 6 of 19 (35%) districts were not. Dharmasraya, Kepulauan Mentawai, Pasaman, Solok Selatan, Padang Pariaman, and Pasaman Barat regencies were the six districts in the province that have annual TPR below 5%, showing that the SARS-CoV-2 transmission was under control during the one-year period. These findings may be explained by the relatively low population density in these regencies with an average of 109 people/square kilometers. Furthermore, our results showed a significant difference in TPR between the cities and the regencies ($p < 0.001$). Thus, the density level appeared to be an important factor to TPR. However, none of the six regencies had TPR < 5% in their all quarter or month in a whole one-year period. In the third quarter, especially in October 2020, the TPR(s) were sharply rose to their highest peak, as similar as provincial TPR. The annual TPR of West Sumatra seemed to fell in December 2020 before rearose in the next three months. This data is in line with a cumulative number of COVID-19 new cases recorded in West Sumatra at the same time (3). However, daily TPR might predict the number of hospitalized patients after 15 days, much longer than daily incidence cases with only 4 days, so further research is needed to confirm (13).

Using TPR as an epidemiological indicator of COVID-19 growth should be more beneficial to estimate viral transmission than using the cumulative number of new cases. Incidence number might be informative in the early epidemic phase, but when the number of new cases is surpassing testing capacity, it would create bias and subsequently, the curve of epidemic growth will continue to be constant. When the testing rate is increased, the cumulative cases also exponentially surges, but the TPR will fall significantly (19). Since the number of COVID-19 testing in West Sumatra was high in the third quarter while the TPR was increased, we predicted that the actual cumulative cases were far higher than recorded and the testing capacity is not yet adequate. This hypothesis also comes from our findings in January 2021 where the TPR was declining to 5.79% after testing was increased to its largest capacity. Our data also showed that in March 2021 when the testing rate declined, the TPR increased significantly. Therefore, consistent massive testing and appropriate treatment are necessary to find new cases and reducing the health public burden due to COVID-19 pandemic.

Based on the period, a fluctuated trend of TPR and the surge in the third quarter especially October 2020 in West Sumatra might be related to not only density level, but also due to changes in mobility and people’s behavior. At the beginning of the epidemic, COVID-19 TPR of West Sumatra recorded 6.76%, slightly higher than the control threshold. The national government responded to enforce a large-scale social distancing policy (PSBB) to lock down the provincial border and to close any public activities in schools, offices, houses of worship, and other social events. West Sumatra government applied PSBB on 20 April 2020 (20). As the result, the TPR trends fell to reach their lowest point of 0.75% since the pandemic in June 2020. This finding was in line with some studies that found public mobility restriction was related with declining of SARS-CoV-2 transmission (21–23). However, when national and provincial governments replace PSBB with a new normal policy (TNBPAC) at the end of June 2020 where the public
spaces slowly opened with the implementation of health protocols such as washing hands, wearing a mask, and physical distancing, the TPR increased to 10 times in September 2020 and reached its peak on October 2020 (24). It is assumed that disinformation about COVID-19 in West Sumatra community also contributed to the TPR surge by affecting public behavior in which the health protocols were not applied effectively and consequently (25, 26). Therefore, it is believed that government policies and public cooperation are vital in controlling pandemics.

The TPR trends on the cities-regencies level periodically were similar to provincial trend. However, the higher TPR in cities might be mainly related to population density and their mobility. Besides, the regencies tended to have a monthly late TPR trend following cities especially from September 2020. For example, City of Kota Padang was having a peak of 22.66% in October 2020 while the neighboring regencies of Solok and Padang Pariaman just reached the peak in November 2020, one month later when the TPR of Kota Padang was declined. From this data, we assumed that the transmission rate in regencies was lower than in cities. We also hypothesized that the surge of infection in regencies is mainly due to high epidemic transmission in cities followed by regencies-cities-regencies migration, although the source of infection might come from both regions (27). It is important to control the regional border to prevent COVID-19 outbreak in an area during pandemic situation due to its high spreading potential.

The limitation of this study is that the data on the origin of the sample is available only from the location of the health facility sending the specimen, not from the individual's domicile origin. However, assuming that the patient was in the location at the time of sampling, it should represent the presence of the virus in the district at the same time. Further research is suggested to use domicile data to get a better and more representative picture. Finally, this study should be helpful to enhance information about TPR as a useful indicator to estimate and predict COVID-19 transmission and severity in a country.

**Conclusion**

In summary, our study determined COVID-19 q-RT-PCR TPR dynamics to describe the control level of SARS-CoV-2 transmission in West Sumatra periodically. We have shown that TPR in the province are still out of global recommendation and the trends are related to regional characteristic, testing rates, people's behavior, and government policy. It is better to use daily TPR to consider COVID-19 preventive strategy and predicting the health care capacity required to bear with the disease. Once more, this study is an actual situation of COVID-19 pandemic in West Sumatra before vaccinations were applied massively across the country. Further research should be performed to enhance our understanding of reducing COVID-19-related morbidity and mortality globally.

**Abbreviations**

COVID-19: Coronavirus Disease 2019; PDRPI: the center for diagnostic and research on infectious disease, faculty of medicine, Universitas Andalas; PSBB: a large-scale social distancing policy; q-RT-PCR: qualitative reverse transcription polymerase chain reaction; SARS-CoV-2: Severe Acute Respiratory
Syndrome Coronavirus 2; TNBPAC: a new normal policy; TPR: Test Positivity Rate; WHO: World Health Organization.

Declarations

Ethics approval and consent to participate

This study has been approved by the Research Ethics Committee of Medical Faculty of Universitas Andalas number 463/UN.16.2/KEP-FK/2021 on 9th August 2021. The written informed consent to use COVID-19 secondary data has been obtained and approved by the Head of the Center for Diagnostic and Research on Infectious Disease, Faculty of Medicine, Universitas Andalas.

Consent for publication

Not applicable

Availability of data and materials

The data is available from PDRPI but restrictions apply to the availability of these data. Data are available directly from PDRPI (divisi_diagnostik_infeksi@med.unand.ac.id).

Competing interests

The authors declare that there is no competing interest in this study.

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Authors' contributions

SPP: conceptualization, data collection, data curation, methodology, formal analysis, writing the original manuscript. ML: conceptualization, data analysis, statistical reviews, writing the original manuscript. LEM: conceptualization, project administration, writing the original manuscript. SR: data collection, writing review. AEP: supervision, conceptualization, data resources, methodology, writing review, validation. All authors have read and approved the manuscript.
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Figures
Figure 1

Population density in cities and regencies of West Sumatra Province.
Figure 2

COVID-19 test positivity rate trends of one-year period quarterly (a) and monthly (b).
Figure 3

COVID-19 test positivity rate trends of one-year period quarterly in different districts.
Figure 4

COVID-19 test positivity rate trends of one-year period monthly in cities.
Figure 5

COVID-19 test positivity rate trends of one-year period monthly in regencies.