

COVID-19 test positivity rate dynamics in West Sumatra, Indonesia: a retrospective study

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Research Article

Keywords: COVID-19, SARS-CoV-2, test positivity rate, dynamics, transmission control

Posted Date: December 14th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-792991/v2>

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Abstract

Background: COVID-19 test positivity rate (TPR) is essential to estimate and control SARS-CoV-2 transmission in a population at a specific time, yet the TPR trends at a provincial level in Indonesia are unclear. This study aimed to determine the COVID-19 TPR dynamics of the Indonesian West Sumatra province in the first year of documented cases.

Methods: We conducted a retrospective study using secondary data of the COVID-19 quantitative reverse transcription-polymerase chain reaction (q-RT-PCR) test in West Sumatra Province from April 2020 to March 2021. To examine trends, we estimated TPR(s) on an annual, quarterly, and monthly basis in the province, its regions (cities/ regencies), and districts.

Results: From a total of 410,424 individuals taking the COVID-19 q-RT-PCR examination during one year, the provincial TPR was 8.11%. The third quarter (October 2020 – December 2020, 12.18%) and October 2020 (15.62%) had the highest TPR quarterly and monthly, respectively. The TPR of cities was almost certainly twice that of regencies. Annual TPR varied significantly ($p < 0.001$) across regions, districts, and periods.

Conclusion: The COVID-19 TPR trends in West Sumatra at the first year of the pandemic were generally higher than the global recommendation. Further study on population density, public mobility, and implementation of health protocol in the province should be valuable to understand TPR dynamics.

Introduction

The coronavirus disease 2019 (COVID-19) pandemic, caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection in humans, killed at least four million people in July 2021(1,2). Indonesia reported 3.3 million cases and 92 thousand deaths at the same time. In West Sumatra Province, there were as many as 37 thousand cases, with 800 deaths(3). Meanwhile, the actual COVID-19 cases are considered higher than official records(4). Thus, some indicators in a large-scale community are required to estimate and control the pandemic.

The test positivity rate (TPR) is a reliable indicator for managing the COVID-19 pandemic(5). The World Health Organization (WHO) also uses COVID-19 TPR 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 of more than 5% in a particular area indicates that the outbreak has gone out of control and that a broader scope of mass screening is required(6). The q-RT-PCR test of SARS-CoV-2 genetic materials obtained from the nasopharyngeal or oropharyngeal swab is the COVID-19 standard diagnostic procedure. This examination is a benchmark of excellence for calculating the TPR to assess the level of outbreak control in a particular region(7,8)

Although the COVID-19 TPR was considered essential in controlling the outbreak, the TPR analysis in the particular region of Indonesia remains unclear. To fill the gap, we evaluated all COVID-19 datasets in West

Sumatra Province from April 2020 to March 2021. This study aimed to determine the COVID-19 TPR in the province at this period, including in its regions and districts. We also evaluate the TPR trends on a quarterly and monthly basis to discuss the control level of viral transmission in the areas. To our knowledge, this is the first study describing COVID-19 TPR in a specific province of Indonesia.

Materials And Methods

Study design and data collection

This research was an observational retrospective study. The study population consisted of people who took the COVID-19 q-RT-PCR test in West Sumatra Province between April 2020 and March 2021. The Center for Diagnostic and Research of Infectious Disease (PDRPI Lab) and Bukittinggi Veterinary Lab (Balivet Lab) provided the data. These two laboratories were the only laboratories certified by the Indonesian Ministry of Health to detect COVID-19 in West Sumatra Province. The samples were all individuals registered in PDRPI Lab and Balivet Lab to take the q-RT-PCR test. The study excluded persons who took the swab in the airport where the viral source was difficult to determine. We also excluded reinfected persons or in a follow-up current COVID-19 infection to minimize the bias. The collected data were individual identification (name and lab number), specimen source and arrival date, and q-RT-PCR result (COVID-19 negative or positive). The Research Ethics Committee of the Medical Faculty of Universitas Andalas had ethically approved the study with grant number 463/UN.16.2/KEP-FK/2021.

Province, cities-regencies, and districts classification

West Sumatra is an Indonesian province located on the west coast of Sumatra Island, with a population of 5.53 million people and a population density of 131 people per square kilometer. There are 19 districts in the province (7 cities and 12 regencies) (Figure 1). The population density differs considerably between districts, ranging from 4,795 people per square kilometer in Kota Bukittinggi to 14 people per square kilometer in Kepulauan Mentawai. Cities, on average, have a higher density than regencies(9),(10).

Definition and statistical analysis

The COVID-19 test positivity rate (TPR) was defined as the proportion of individuals who tested positive for COVID-19 for the first time per all individuals who took the COVID-19 q-RT-PCR test at a given time. We defined the specimen source as the district where the specimens were collected. We calculated the TPR(s) for the province, regions (cities and regencies), and districts based on periods (yearly, quarterly,

and monthly). The chi-squared test or chi-squared for trends test was used to examine TPR differences between regions, districts, quarters, and months for a year. A p-value <0.05 was significantly different.

Results

Characteristic of the test positivity rate

The TPR was 8.11% among 410,424 people who took the COVID-19 q-RT-PCR test in West Sumatra between April 2020 and March 2021 (Table 1). The annual TPR of cities was nearly twice that of regencies. Kota Bukittinggi had the highest TPR (13.12%), followed by other major cities including Kota Padang Panjang, Kota Solok, and Kota Padang, which all have TPR above 10%. In the regency region, Agam had the highest TPR with 10.89%. Kota Sawahlunto (7.46%) and Dharmasraya (3.07%) had the lowest TPR in cities and regencies, respectively. TPR varied significantly across regions, districts, quarterly, and monthly.

Table 1 Characteristic of COVID-19 q-RT-PCR TPR in one year period

Variables		n	COVID-19 Cases		Test Positivity Rate/ TPR (%)	p-value*
			POSITIVE	NEGATIVE		
Region	Cities	218,450	22,794	195,656	10.43	<0.001**
	Regencies	191,974	10,475	181,499	5.46	
District	<i>Cities</i>					<0.001***
	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	
	<i>Regencies</i>					
	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	1 st (Apr-20 to Jun-20)	39,371	762	38,609	1.94	<0.001***

	2 nd (Jul-20 to Sep-20)	122,917	6,505	116,412	5.29	
	3 rd (Oct-20 to Dec-20)	140,210	17,383	122,827	12.40	
	4 th (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 test

***Chi-squared for trend test

Test positivity rate trends

To provide TPR trends of West Sumatra province, we evaluated the one-year COVID-19 TPR quarterly and monthly by region (cities and regencies) (Figure 1). The provincial TPR increased significantly from 1.94% in the first quarter to a high of 12.4% in the third quarter (Figure 2a). The TPR, on the other hand, has

generally fallen in the last quarter. The trends in cities and regencies were similar, with cities having a TPR that was likely twice as high as regencies in each quarter. TPR in cities peaked at 15.8%, while TPR in regencies peaked at 8.3%.

The province's TPR trend decreased gradually during the first three months of the annual period of study (Figure 2b). TPR reached its lowest point in June 2020, at 0.7%. However, there was a 15-fold increase in TPR from July 2020 to October 2020, with the highest peak point reaching 15.6%. Cities had a TPR of 22.05% at this point, nearly three times that of regencies, which had a TPR of 7.7%. Provincial TPR fell until January 2021, then rose again in February and March 2021, whereas city TPR rose earlier in January 2021. In general, the trend of TPR in the regencies was likely to follow that of the cities, except for December 2020, when the TPR in the regencies was slightly higher than that of the cities (8.08% versus 7.55%).

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 (Figure 3) (22.17%). The TPR(s) used to rise every quarter in six districts, namely Kota Bukittinggi, Kota Sawahlunto, Kota Solok, Kepulauan Mentawai, Lima Puluh Kota, and Solok Selatan. The TPR(s) also tended to rise monthly (Figure 4 and Figure 5). The COVID-19 TPR trends in West Sumatra differed by region and district quarterly and monthly.

Discussion

As the SARS-CoV-2 transmission indicator, a large-scale COVID-19 TPR is frequently used to control the pandemic. The TPR could estimate COVID-19 prevalence, predict healthcare needs, and monitor the severity of cases in a country(11–13). To determine the COVID-19 TPR, we used retrospective q-RT-PCR results from April 2020 to March 2021 in West Sumatra Province. According to our findings, the province's annual TPR exceeded the WHO recommendation of 5%. At its peak, the TPR exceeded 15%. The TPR of cities was approximately twice as high as regencies. The province's TPR trend increased significantly after the first quarter, with a brief drop from December 2020 to January 2021.

A higher population density may induce a higher TPR. In the West Sumatra Province, the average population density of cities was likely 12 times higher than that of regencies(9,10). Based on this, we assumed that cities should represent the urban, while the regencies are rural(14). Our study showed that the cities had the higher TPR, consistent with the density. In the districts with a low population density (below 109 people per square kilometer in average) such as Dharmasraya, Kepulauan Mentawai, Pasaman, Solok Selatan, Padang Pariaman, and Pasaman Barat, the TPRs were observed lower. Also, some studies previously explained that population density is a determinant for SARS-CoV-2 transmission(15–17). However, we believed that other confounding factors should also influence a high TPR in cities, such as higher mobility, so further study is needed.

Some studies highlighted the TPR as a more reliable indicator for predicting viral transmission than the incidence rates. The number of new cases depends on the capacity of the test, unlike the TPR. The larger

the testing scale, the lower the TPR(18):(19). However, in West Sumatra, the TPR was high (12.40%) when the COVID-19 testing capacity increased in the third quarter (140,210 tests). So, we predicted that the actual cumulative cases would be far higher than recorded and testing capacity merely insufficient, meaning the SARS-CoV-2 transmission was out of control. Moreover, in January 2021, the TPR fell to 5.79% after the cumulative test at its maximum quantity (61,415 tests) and surged again to 12.05% after testing capacity decreased about 60% in two months. Thus, massive testing is vital for finding the case and controlling outbreaks, especially when the transmission is high.

The TPR trends addressed people's mobility and behaviour in West Sumatra during a year. The TPR fell to the lowest point in June 2020 (0.75%) when the provincial government implemented a large-scale social distancing policy (*PSBB*) since April 2020. At this time, public facilities such as schools, offices, houses of worship were closed, so social gatherings were prohibited(20). This finding was consistent with previous studies, which found that restricting public mobility was associated with a decrease in SARS-CoV-2 transmission(21–23). However, the rates sharply rose ten times in September 2020 as the government replaced PSBB with a new normal policy (*TNBPAC*) since the end of June 2020. This new regulation opened up public spaces under the implementation of health protocols such as hand washing, mask-wearing, and physical distancing(24). Besides, misinformation about the COVID-19 policy resulting in ineffective health protocol implementation also contributed to the TPR surge(25,26). Therefore, government policies and public cooperation are vital in controlling pandemics.

TPR trends at the regional level were similar to provincial. However, the TPR trends of the regencies were likely to follow the cities a month late, especially for the neighbouring districts. For example, the City of Kota Padang had a TPR peak of 22.66% in October 2020, while the neighbouring regencies of Solok and Padang Pariaman reached the peak a month later. This condition might be due to a higher viral transmission in cities and regencies-cities-regencies migration, though infection could have come from either region(27). Thus, controlling district borders may prevent viral spreading between regions.

This study is limited in the specimen source information that was only available from the location of the health facility sending the specimen, not from the individual's domicile origin. However, because the patient was present at the facility, it should also represent the virus in the district. Our study should contribute to a better understanding of TPR in estimating SARS-CoV-2 transmission in West Sumatra.

Conclusion

In summary, we here determine the COVID-19 q-RT-PCR TPR dynamics in West Sumatra. The TPR trends of the first year of the pandemic were higher than the global recommendation, meaning that the SARS-CoV-2 transmission was uncontrolled. Possible factors that influence the TPR level are population density, testing capacity, public mobility, and the implementation of health protocols. Further study should explore these factors to achieve a better approach to control the COVID-19 situation. This study assesses the COVID-19 prevention strategy in Indonesia, particularly in West Sumatra Province, and should provide valuable data for future COVID-19 control measurement.

Declarations

Ethical 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 August 9th, 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 interest

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

Funding

The funding was received from the Faculty of Medicine, Universitas Andalas (FK Unand) allocated to the project "Budget Implementation List (DIPA) of Beginner Lecturer Scheme", with grant number 678/UN16.02.D/PP/2021. The FK Unand had no role in the design of the study, collection, analysis, and interpretation of data, and in writing the manuscript.

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.

Acknowledgments

We would like to thank all the PDRPI staff for their contribution in providing the data, especially the managerial boards: Linosefa, Gestina Aliska, Nita Afriani, Desmawati, Dessy Arisanty, Ikhwan Resmala Sudji, and Syafrizayanti. We also thank Mega Liani Putri to provide geographical figures in the study, and for the Medical Faculty of Universitas Andalas which provide the funding of this project.

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: quantitative 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.

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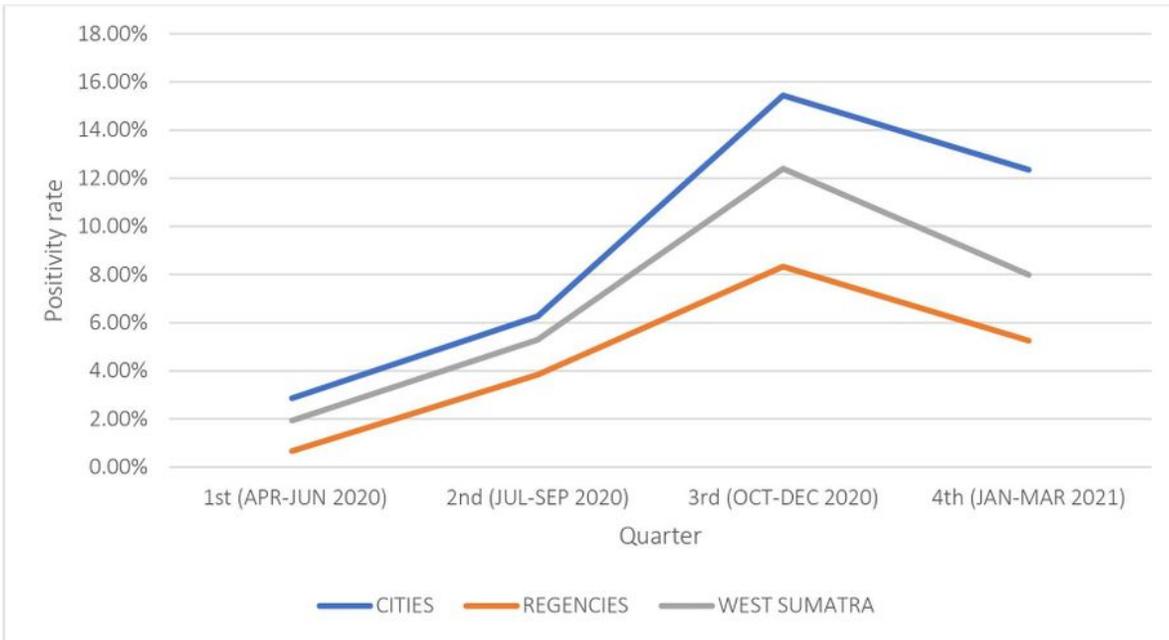
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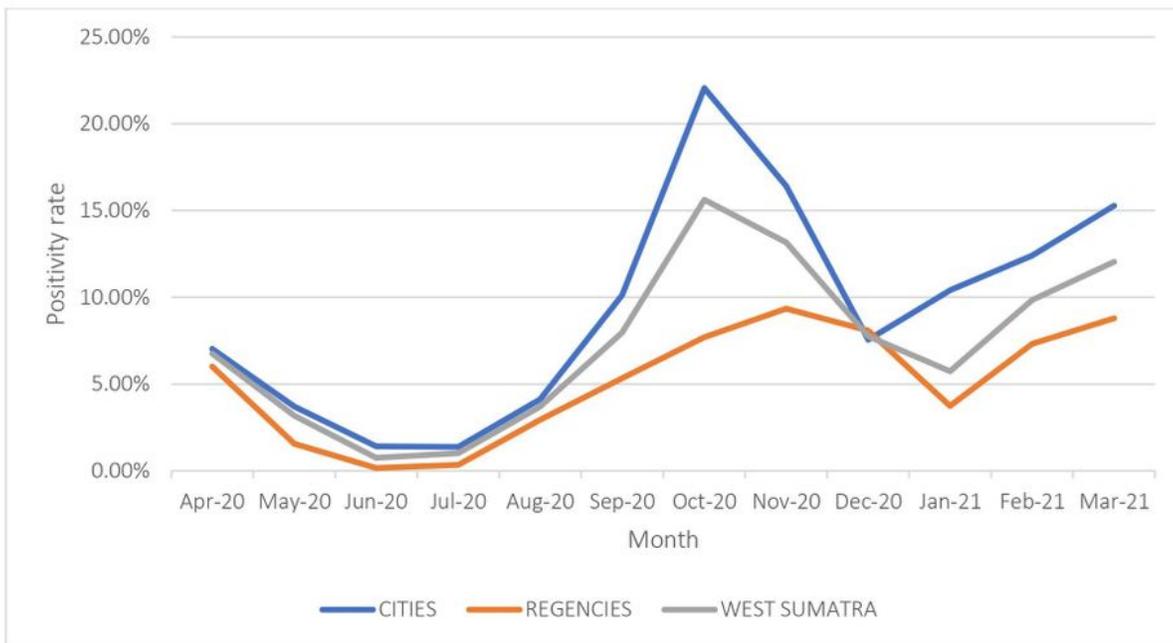
Figures

Figure 1

Population density in cities and regencies of West Sumatra Province.



(a)



(b)

Figure 2

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

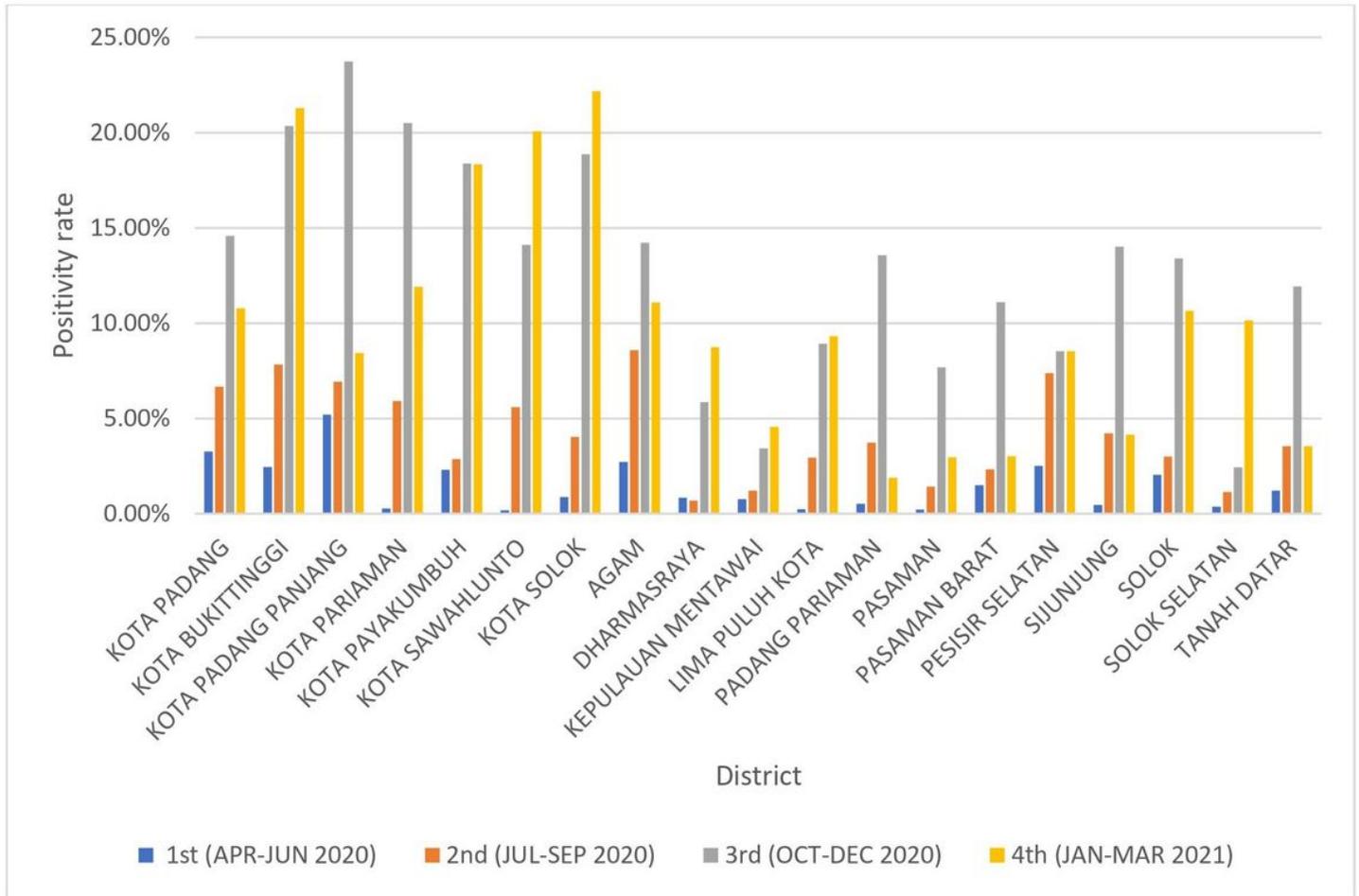


Figure 3

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

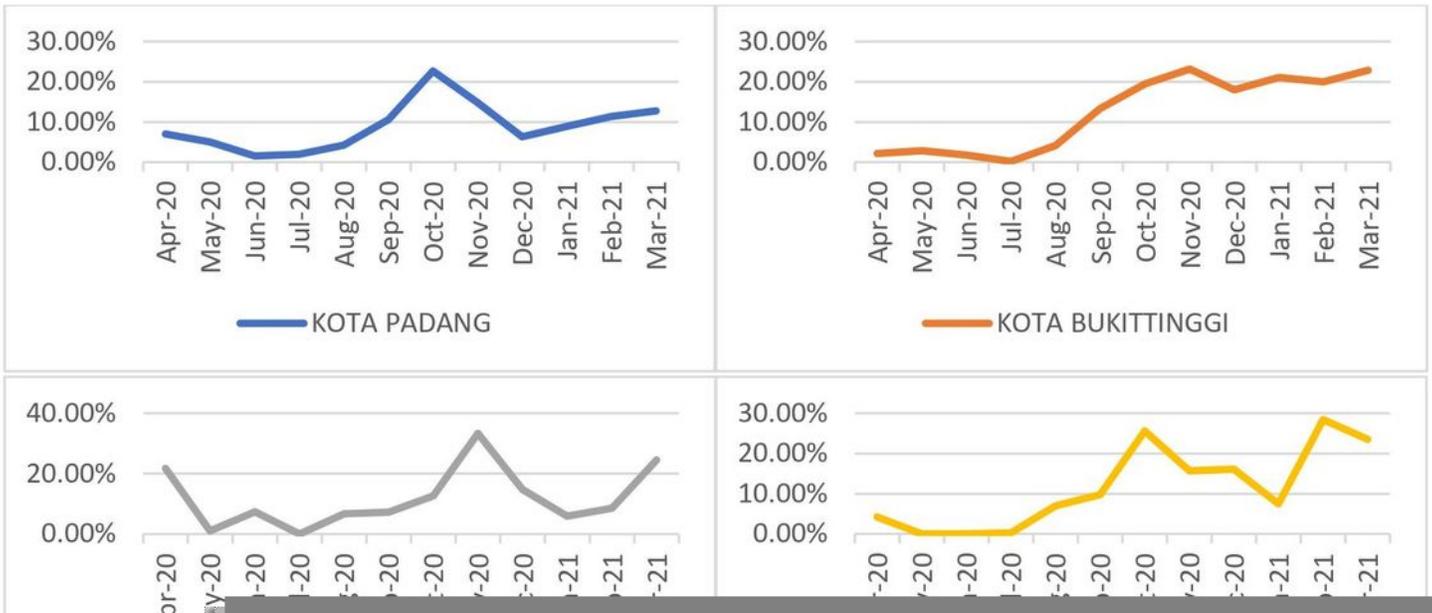


Figure 4

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.