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Spatial Autocorrelated Analysis Of Tuberculosis Incidents In Padang City

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ABSTRACT

Tuberculosis (TB) is a chronic infectious disease caused by the bacteria mycobacterium tuberculosis. Indonesia has the second highest number of TB cases after India, and West Sumatra will have 14,398 TB cases by 2020. Risk factors for TB include environmental, social, and economic behavior. The purpose of this study was to determine the risk factors for the incidence of tuberculosis in Padang City. Methods: This type of research is analytic observational

using case control design by displaying data descriptively and spatially. The focus of this research is spatial autocorrelation analysis of tuberculosis incidence in Padang City from January to December 2024. Data were collected by observation, interview, and air quality measurement in selected sample houses. Results: There was a positive correlation between sanitation facility factors and TB incidence (clustering pattern) and no correlation between knowledge, behavior and environmental conditions with TB incidence. There were 5 sub-districts that were spatially significant between knowledge, behavior, sanitation facilities and environmental conditions, namely West Padang, East Padang, Kuranji, Bungus Teluk Kabung, and Lubuk Kilangan. Conclusion: Based on the above results, it can be concluded that there is a positive correlation between sanitation facilities and the incidence of tuberculosis, and there is no relationship between the factors of knowledge, behavior and environmental conditions on the incidence of tuberculosis. Therefore, it is expected that the community can implement a clean and healthy lifestyle and for related institutions to re-inspect people's homes and educate people who have contracted tuberculosis

Keywords: Tuberculosis (TB) , Risk Factors, Spatial Analysis, Autocorrelation

INTRODUCTION

Tuberculosis (TB) is a chronic infectious disease caused by Mycobacterium tuberculosis and is one of the leading causes of death in the world. Based on the WHO Global TB Report 2021, TB is ranked 13th as a cause of global death. In Indonesia, the country is second only to India with the highest number of TB patients in the world, which is around 969,000 cases, meaning one person is diagnosed with TB every 33 seconds. The incidence of TB in Indonesia is 354 cases per 100,000 population. The death rate from TB is also very high, reaching 150,000 cases per year, or one person dies every 4 minutes. This death rate has increased by 60% compared to 2020, which recorded 93,000 cases of death from TB. The death rate from TB in Indonesia is 55 per 100,000 population. This data shows that TB remains a major public health challenge in Indonesia.

Tuberculosis (TB) has various risk factors. There are several factors that influence the incidence of TB, including: (1) Environmental Factors, i.e. a poor environment can influence the incidence of TB. Examples are overcrowded housing, poor sanitation, lack of access to clean water, and air pollution. (2) External environmental factors such as climate and climatology (temperature, humidity, wind speed) play a significant role in the spread of TB. (3) Socio-economic Factors, people with low socio-economic conditions have a higher risk of developing TB. (4) Behavioral Factors, bad habits such as smoking, lack of sleep, excessive alcohol consumption, and lack of physical activity can affect the risk of developing TB.(3)

West Sumatra is one of the provinces in Indonesia with a total of 14,398 cases in 2020 based on the report of the Indonesian Ministry of Health. This figure is still above the national target of 200 cases per 100,000 population. Padang City with a large incidence of TB in West Sumatra experiences an increase in cases every year. In 2020, there were around 1,672 TB cases diagnosed in Padang City. Padang City is the capital city of the province with a high population density and relatively hot temperatures. The population is spread across coastal and hilly areas, so an in-depth study of the incidence of tuberculosis (TB) in Padang City is needed. Various previous studies have been conducted on this issue, mostly using observational designs that have potential biases, such as selection bias and information bias. Therefore, the researcher aims to reduce the potential bias of previous studies by presenting the data in the form of an autocorrelation analysis of TB incidence. This analysis was conducted to determine the pattern of TB distribution and the factors that influence it by considering the topography of the region.

METHODS

This study is an analytic observational study using a case-control design, which displays data descriptively and spatially in the form of maps with respect to regional boundaries. This study design was not designed to measure spatial autocorrelation or clustering patterns. Therefore, additional analyses such as Moran's I or LISA are required to capture the spatial aspects in more depth. The combination of descriptive and spatial analysis allows researchers to identify overall spatial patterns as well as map specific areas that require more attention. Primary data in this study was obtained through interviews and direct observation to the homes of selected respondents, namely tuberculosis patients who selected using the Simple Random Sampling (SRS) method where each individual in the population has an equal chance of being selected as a respondent. In this method, the sample is taken randomly without regard to certain characteristics of the individual, so that each member of the population has an equal chance of being selected. The secondary data used was sourced from the Health Profile of Padang City in 2023. The study population was all people who were recorded to have tuberculosis disease in 11 sub-districts in Padang City, while the sample was tuberculosis patients selected for the study. The dependent variable in this study was the number of pulmonary tuberculosis cases, while the independent variables included the level of knowledge of respondents, behavioral factors, sanitation facilities, and environmental conditions around respondents.

Moran's index (I) ranges from -1 to 1. The higher the value, the stronger the correlation, while a value of 0 indicates no autocorrelation or spatial interaction. To evaluate whether there is autocorrelation between regions, the value of I is compared with the expected value, E[I]. If I is greater than E[I], it indicates positive autocorrelation (clustering pattern). If I is equal to E[I], this means there is no spatial autocorrelation. Meanwhile, if I is smaller than E[I], it indicates negative autocorrelation with a data dispersion pattern. After the Moran's I value was calculated, the next step was to conduct a bivariate LISA analysis to examine the spatial relationship between regions based on the variables used in the study. The results of this analysis are in the form of cluster maps and significance maps with an association level of $p < 0.05$.

RESULTS

Based on Figure 1, the results of the global autocorrelation test on four variables using GeoDa software show the Moran's I value for each variable, namely the knowledge factor (0.1352), behavior factor (0.1828), sanitation facilities factor (0.1963), and environmental conditions factor (0.1544). The Moran's I value for all four variables is less than 1, indicating a positive spatial autocorrelation between sub-districts. In addition, the Moran's I value for these four variables is greater than the E[I] value, which is -0.1. This indicates a clustered distribution pattern with similar characteristics in the locations of adjacent sub-districts

Bivariate analysis using the LISA test was conducted to identify spatial autocorrelation between the variables of knowledge factor, behavior factor, sanitation facility factor, and environmental condition factor on the incidence of tuberculosis in Padang City. The results of this analysis can be seen in Table 1 below.

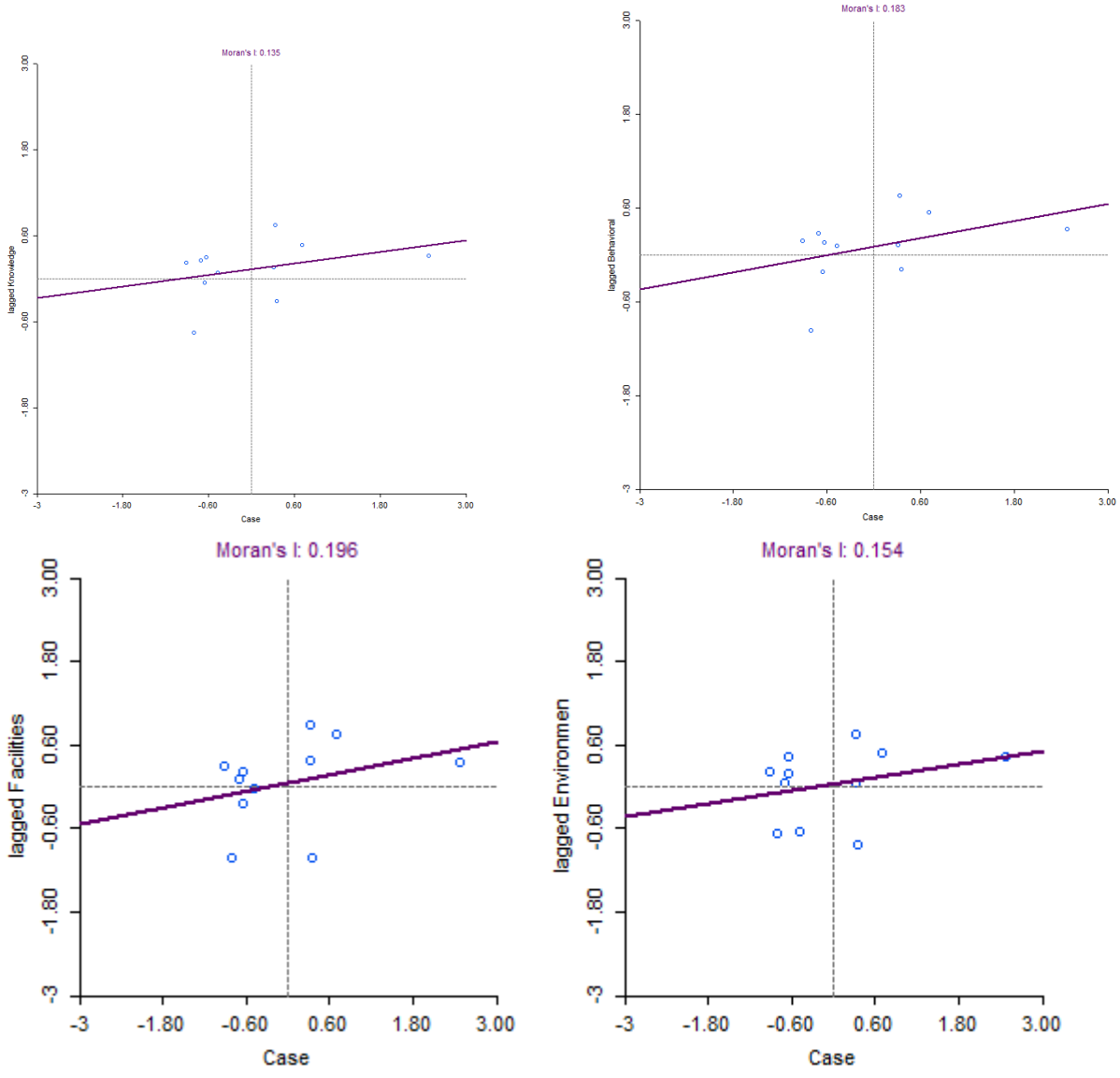
Table 1. Bivariate Analysis of Tuberculosis Incidence LISA

Variables	Morans'I	E[I]	SD	Sig
Knowledge Factor	0.1352	-0.1	0.1223	0.14
Behavioral Factors	0.1828	-0.1	0.1212	0.1
Sanitation Facility Factor	0.1963	-0.1	0.115	0.04
Environmental Condition Factor	0.1544	-0.1	0.1158	0.07

In Table 1, the results of the LISA bivariate test show a significance value (<0.05) for one variable, the sanitation facility factor (0.04), indicating spatial autocorrelation between the sanitation facility factor and the incidence of tuberculosis. The sanitation facility factor shows positive spatial autocorrelation with TB incidence because it has a Moran I index >0. There was no spatial autocorrelation between the knowledge factor, behavior factor and environmental condition factor with the incidence of tuberculosis among subdistricts because the knowledge factor had a p value = 0.14, the behavior factor had a p value = 0.1 and the environmental condition factor had a p value = 0.07 which means the significant value is greater than 0.05 (p>0.05).

Based on Table 1, the Moran index value of the knowledge factor, behavior factor, sanitation facility factor and environmental condition factor is greater than E [I] = -0.1, meaning that the pattern of association with the incidence of tuberculosis between sub-districts is clustered.

The results of the LISA bivariate test showed that out of 11 sub-districts in Padang City, there were 5 (five) sub-districts that were spatially significant between knowledge factors, behavioral factors, sanitation facility factors, and environmental condition factors with the incidence of tuberculosis (pv<0.05). The significant sub-districts can be seen in the following Moran clustermap:



Clustermap of Knowledge Factor, Behavior Factor, Sanitation Facility Factor and Environmental Condition Factor in Padang City

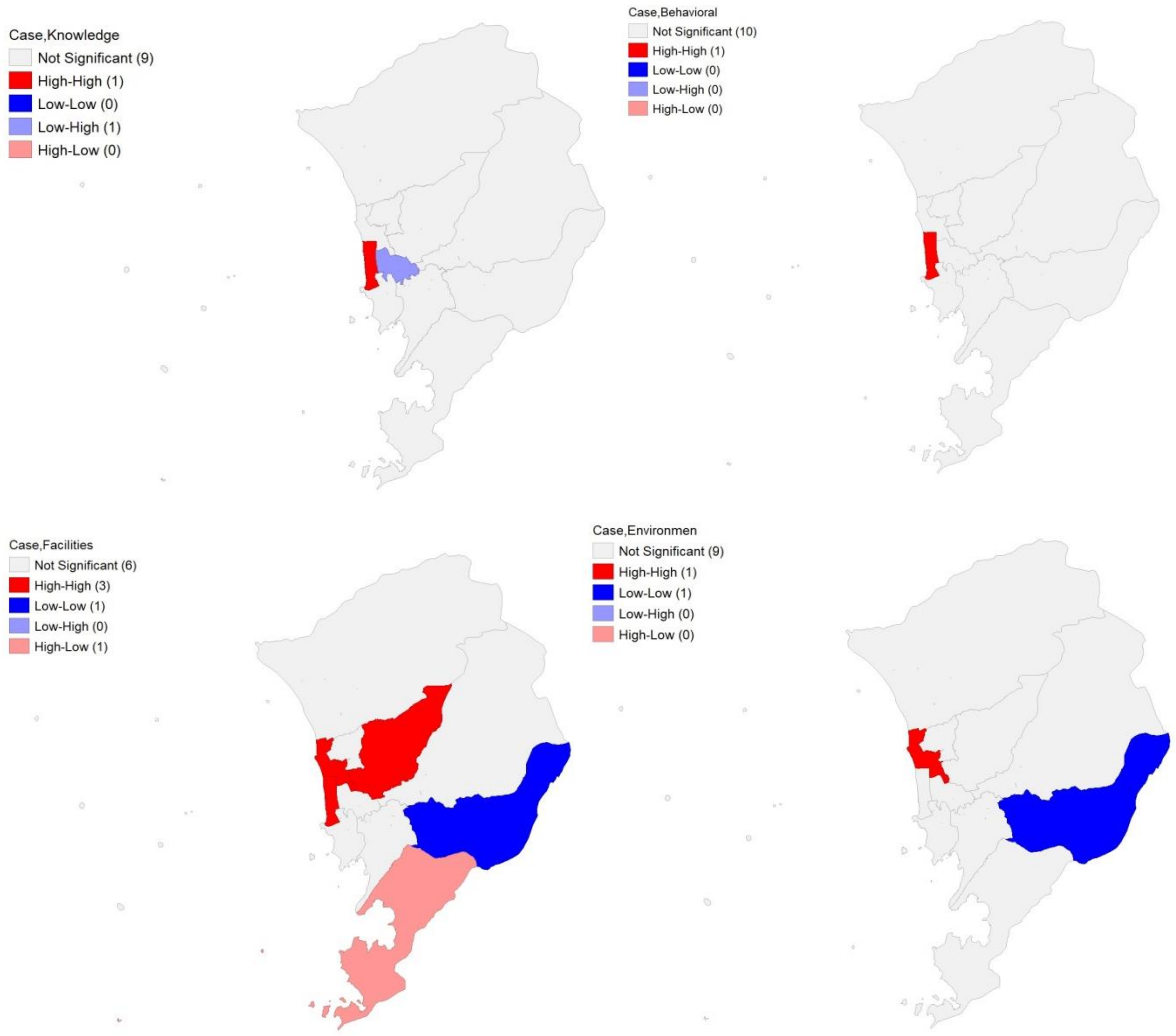


Figure 1. Moran's I Sacatterplot of Knowledge Factor, Behavior Factor, Sanitation Facility Factor, and Environmental Condition Factor Variables

a. Moran Clustermap of Knowledge Relationship with Tuberculosis Incidence

The results of the Moran clustermap showing the relationship between knowledge and TB incidence in Figure 2 (a) reveal that in quadrant I (High-High) there is one sub-district, namely Kecamatan Padang Barat, which means that sub-districts with high observation values are surrounded by sub-districts with high observation values, which are referred to as hotspot areas. Meanwhile, in quadrant II (Low-High) there is one sub-district, namely Kecamatan Padang Timur, which means that sub-districts with low observation values are surrounded by sub-districts with high observation values.

b. Moran Clustermap of Behavioral Associations with Tuberculosis Incidence

The result of the Moran cluster map showing the relationship between behavior and TB incidence in Figure 2 (b) shows that in quadrant I there is one sub-district, namely Kecamatan Padang Barat. This indicates that sub-districts with high observation rates are surrounded by other sub-districts that also have high observation rates, known as hotspot areas.

c. Moran Clustermap Relationship between Sanitation Facilities and Tuberculosis Incidence

The result of Moran's cluster map describing the relationship between sanitation facilities and tuberculosis incidence in Figure 2 (c) shows that in quadrant I, there are three sub-districts, namely West Padang, North Padang, and Kuranji sub-districts. In quadrant III (Low-Low), there is one sub-district, namely Kecamatan Lubuk Kilangan, which indicates that sub-districts with low observation values are surrounded by sub-districts with low observation values, known as hotspot areas. Meanwhile, in quadrant IV (High-Low), there is one sub-district, namely Kecamatan Bungus Teluk Kabung, which means that sub-districts with high observation values are surrounded by sub-districts with low observation values

d. Moran Clustermap Relationship between Environmental Conditions and Tuberculosis Incidence

The results of the Moran clustermap depicting the relationship between environmental conditions and tuberculosis incidence in Figure 2(d) show that in quadrant I (High-High) there is one subdistrict, namely Kecamatan Padang Utara, which indicates that subdistricts with high observation values are surrounded by subdistricts with high observation values, known as hotspot areas. Meanwhile, in quadrant III, there is one subdistrict, namely Kecamatan Lubuk Kilangan, which indicates that subdistricts with low observation values are surrounded by subdistricts with low observation values, known as coldspots.

DISCUSSION

Knowledge is the result of humans knowing something or all human actions to understand a particular object. Behavior based on knowledge will be better than behavior that is not based on knowledge. The knowledge seen here includes symptoms and prevention of TB. Knowledge is important so that the incidence of tuberculosis in an area does not increase.

The bivariate results of LISA found no spatial autocorrelation between knowledge and the incidence of tuberculosis. According to Fat'ha in 2020 said that the absence of spatial autocorrelation can be caused by randomly distributed data without systematic patterns that can produce autocorrelation values close to zero but according to Saputro in 2018 said that the absence of autocorrelation can also be caused by high variation between regions that can reduce the possibility of autocorrelation.(4,5)

This result is certainly not in line with the research conducted by Ramadhan in 2021 which says that there is a relationship between knowledge and the incidence of tuberculosis.(6) In a study conducted by Munawarah in 2022 even said that respondents who had poor knowledge had 5.923 times the risk of tuberculosis compared to respondents who had good knowledge.(7) In a different study conducted by Avy in 2024, it was also mentioned that respondents with low knowledge had a 3 times risk of suffering from tuberculosis compared to respondents with good knowledge. (8)

From the above results, it is expected that the Padang City Health Office can coordinate with the Puskesmas in order to educate the public regarding tuberculosis disease so that public knowledge related to tuberculosis disease becomes better.

Next is the behavioral factor. Behavior is the overall scope of attitudes and actions of respondents. The Healt Belief Model (HBM) theory says that individual perceptions of vulnerability and seriousness affect preventive behavior. In the research conducted by Ramadhani in 2022, in line with this theory, it was said that respondents who had poor tuberculosis transmission prevention behavior were susceptible to tuberculosis.

The bivariate results of LISA found that there was no spatial relationship between behavior and the incidence of tuberculosis. This is not in line with research conducted by Ramadhan in 2021, which states that there is a relationship between respondent behavior and the incidence of tuberculosis. Although it was found that there was no spatial relationship, behavior is important so that tuberculosis cases can be resolved.(6) According to Ramadhani, respondents who have bad behavior are 2.31 times more likely than respondents who have good behavior to have tuberculosis.

Behaviors such as not smoking, opening windows every morning, drying sleeping equipment such as mattresses, covering the mouth when coughing and sneezing, washing hands after coughing and sneezing, not disposing of phlegm carelessly and always keeping the house clean are important steps to prevent tuberculosis disease from spreading to other family members. Therefore, it is expected that the Padang City Health Office can coordinate with the Puskesmas to educate the community regarding tuberculosis disease so that public knowledge related to tuberculosis disease becomes better.

In addition to the above, sanitation facilities are also an important factor in the occurrence of tuberculosis. Sanitation are physical buildings and equipment used to maintain physical quality or control environmental factors that can be detrimental to public health. Good sanitation plays an important role in preventing the spread of disease, especially tuberculosis. By reducing environmental risk factors such as this can reduce the transmission of the disease.

The bivariate results of LISA showed that there was no positive spatial autocorrelation between the sanitation facility factor and the incidence of tuberculosis, meaning that the worse the sanitation facility factor, the higher the incidence of tuberculosis. This is in line with research conducted by Butarbutar in 2018 which said that there was a relationship between sanitation facilities and the incidence of tuberculosis.(9) Research conducted by Nirwana in 2022 also said the same thing, namely that there was a relationship between sanitation and the incidence of tuberculosis. (10)

Sanitary facilities consisting of room temperature, lighting, occupancy density and ventilation are one of the points that need to be considered so that tuberculosis disease can be overcome because if these sanitation facilities do not meet the requirements, it can cause tuberculosis disease to spread to family members. Therefore, the community is expected to always maintain the cleanliness of the home area so that tuberculosis does not spread to other family members.

Then there is the factor of environmental conditions. Environmental conditions are all the physical and social factors surrounding an individual or group that can affect a person's life and development. Some environmental factors that influence the spread of TB include air quality, population density, sanitation, and access to adequate health facilities. An unfavorable environment, such as areas with poor ventilation, high population density, and poor sanitation, can increase the risk of TB disease transmission, as the bacteria that cause TB can be spread through the air when an infected person coughs or sneezes.

The bivariate results of LISA showed that there was no spatial autocorrelation between environmental conditions and the incidence of tuberculosis. This is not in line with research conducted by Nur'aini in 2022 which said that there was a relationship between environmental conditions and the incidence of tuberculosis.(11) Research conducted by Sabila in 2024 also stated that there was a relationship between environmental conditions and the incidence of tuberculosis. (12)

Although the results show that there is no spatial relationship, environmental conditions are one of the important things that can prevent tuberculosis. If the environmental conditions are not

considered properly, then tuberculosis can easily infect someone. Even in a study conducted by Sabila in 2024 said that respondents who had poor environmental conditions had a risk of 3.4 times compared to respondents who had good environmental conditions.(12) Therefore, it is expected that the community can always maintain the cleanliness of the home area so that tuberculosis can be overcome.

CONCLUSIONS

Based on the results of the above analysis, it can be concluded that out of 11 sub-districts in Padang City, there are 5 sub-districts that have spatial interactions between knowledge factors, behavioral factors, sanitation facility factors and environmental condition factors with the incidence of tuberculosis. There was positive spatial autocorrelation between sanitation facility factors and TB incidence (clustering pattern) and no spatial autocorrelation between knowledge, behavior, and environmental conditions with TB incidence. Prevention of tuberculosis (TB) by the community requires integrated measures involving individuals, communities, health facilities, and the government. The following is an explanation of the efforts that can be made: Improving community knowledge about TB, its symptoms, modes of transmission, and the importance of early detection, BCG (Bacillus Calmette-Guérin) Vaccination, Improving Environmental Conditions, Clean and Healthy Living (PHBS). TB treatment according to the DOTS protocol (Directly Observed Treatment, Short-course), conducting counseling and routine examinations in high-risk areas to find active TB patients who have not been diagnosed, temporary isolation, monitoring and evaluation of treatment.

Recommendations suggested by researchers to the government regarding the incidence of Tuberculosis (TB): Increased Access to Health Services, Implementation of the DOTS (Directly Observed Treatment, Short-course) Program, Counseling and Education to the Community, Increased Early Detection, Control and Management of Multidrug-Resistant TB (MDR-TB), Strengthening Health Infrastructure.

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