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Investigating maternal mortality cases in Wukari, Taraba state, Nigeria

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Abstract
Maternal mortality in Nigeria has been one of the fundamental topics of peculiar interest to public health workers and the authorities. This difficulty is due to the alarming charge at which ladies who are pregnant or some weeks after childbirth die. These reasons are; a result of negative scientific facilities and employees and many others. The goal of this examination is to apply statistical tools to research the maternal mortality ratio. Data were sourced from General Hospital Wukari spanning a duration of 14 years. The techniques of locating the maternal mortality study were used to estimate the Maternal Mortality Rate and Ratio, to explain the fashion, and to make the forecast, the method of time series evaluation was applied. 12,459 instances concerning maternity have been considered from the facts. The consequences obtained from the analysis showed the anticipated MM Ratio to be 0.005 (that is 500) maternal deaths for every 100,000 maternal-related instances. Also, the MM Rate was positioned to be 0.009 (this is 900) maternal deaths for every 100 thousand maternal births in the populace. Also from the forecast, it was discovered that the trend for maternal mortality is lowering as determined in the study of the trend.

Keywords: Maternal mortality rate, Pregnant, Number of live births, Women of reproductive age, Smoothing parameters

1. Introduction

1.1 Background of the Study

The maternal mortality ratio (MMR) is defined as the number of maternal deaths during a given period, per 100,000 live births. This death can occur from any cause related to or aggravated by pregnancy or its management (excluding accidental or incidental causes). The MMR includes deaths during pregnancy, childbirth, or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, for a specified year. As defined by Ronsmans-Graham (2006) [2], it is the death of a woman during pregnancy or within 42 days after birth. In recent times, this problem has been on the increase instead. For example, in a study by Sharma *et al.* (2017) [3], it was observed that in 2013 alone, about 293,000 maternal deaths occurred worldwide, with a whopping 99% of these occurrences being among countries with meager income. The African continent happened to be the most affected worldwide. For instance, Africa is seen as being close to 17 out of every 20 countries with the alarming rate of maternal mortality index in the world.

Nigeria as one of the African countries is not an exception to the alarming rate of maternal mortality as observed in other countries. Studies have shown that Nigeria is one of the six countries that contributed to over 50% of the total maternal deaths globally. The reductions in the maternal mortality ratio (MMR) have been conflicting (Sharma *et al.* 2017) [3].

In another report by Index Mundi (2018), the maternal mortality index of Nigeria is not only the fourth highest globally, but it is estimated to be 814 for every 100,000 which appears to be on the increase when compared with 576 by the Demographic and Health Survey in 2013.

The rate at which maternal mortality is increasing in Nigeria is alarming. This constitutes one of the major problems of public health. In an attempt to address this situation, experts in public health-related issues made some recommendations, and Nigeria's Federal Ministry of Health in 2013 granted those recommendations, that all maternal health institutions across the country should from time to time conduct a maternal death review, surveillance and response using the technical guidance document as recommended by the World Health Organization, (WHO 2013) [4].

The prevention of maternal mortality and consequent improvement within the maternal fitness of Nigerian ladies is an all-encompassing venture, which even though tedious; is possible through concerted efforts of health care vendors, participants of the society, and authorities as an entire. There is a cutting-edge inter-relationship between those above-stated elements which is plain in poor authorities' fitness and socio-economic charges required to ensure the fitness and well-being of a population whose health in search of behaviors are poor either because of poverty, cultural beliefs, and so on. (Ogu and Ephraim, 2018) [1].

According to Ogu and Ephraim, (2018) [1], In Nigeria, without regard to the administration of an expansion of maternal fitness carrier strategies which comprises free antenatal care, education of professional beginning attendants, etc.; in addition to the availability of sources, the scenario of maternal fitness stays one of the worst in Africa as evidenced through winning maternal mortality ratios. Nigeria contributes more than 10% of maternal deaths globally. (Yar'zever 2014) [5]. A joint document (Trends in Maternal Mortality: 1990 to 2015 by WHO, UNICEF, World Bank, and United Nations Population Fund) estimates that Nigeria has approximately fifty-eight,000 maternal deaths, accounting for 19% globally. Put otherwise, at least 800 women die in every one hundred,000 stay births. Northeast has the very best maternal mortality fee, compared to different areas, with 1,549 deaths in step with one hundred,000 stay births. To cope with the excessive maternal mortality quotes, in 2017 the inauguration of a 34-member Task Force to accelerate the reduction of maternal mortality in Nigeria, (WHO, 2018).

2. Methodology

2.1 Introduction

Here, we are interested in the strategies and strategies employed in sporting out the studies. This consists of the research layout, having a look at the populace, pattern size, and records accumulating techniques, the methods employed for records evaluation and of the look at, and the vicinity in which the research may be completed.

2.2 Measures of Maternal Mortality

There are vital factors influencing a woman's lifetime hazard of maternal death.

The hazard of lack of life at some point of a single being pregnant and (b) how regularly a female faces this danger (i.e., her fertility level). The maternal mortality ratio (MMR) presentations

Only; it is calculated as the range of maternal deaths in a given term divided by using the manner of the number of stay births during the identical period.

$$\text{MMR} = \frac{\text{Number of maternal deaths}}{\text{Number of live births}} \quad (1)$$

The maternal mortality rate (MMR) reflects both (a) and (b). It is defined as the number of maternal deaths divided by person-years lived by women of reproductive age in a population.

$$\text{MMRate} = \frac{\text{Number of maternal deaths}}{\text{Woman - years lived at ages } 15\text{ - }49} \quad (2)$$

The MMR is generally, the preferred measure of maternal mortality as it describes the frequency of maternal demise relative to its threat pool, as measured (imperfectly, however no longer badly) by way of the number of stay births. In practice, the MMR is at risk of dimension bias because facts for the numerator and denominator are often accrued through special methods. As a result, for estimation functions it miles frequently better first to data on the proportion of maternal deaths (PM) among girls of reproductive age.

$$\text{PM} = \frac{\text{Number of maternal deaths}}{\text{All female deaths at ages } 15\text{ - }49} \quad (3)$$

Even if a given records source yields an underestimation of the number of maternal deaths (as takes area pretty frequently due to below-reporting of events), it's far capacity that the mentioned percent of maternal deaths is greater dependable (Hill *et al*., 2007).

Given the best records, the MMR and MM Rates can be derived from the PM by way of connection with the subsequent relationships.

$$\text{MMR} = \text{PM} \times \frac{\text{All female deaths at ages } 15\text{ - }49}{\text{Number of live births}} \quad (4)$$

$$\text{MMRate} = PM \times \frac{\text{All female deaths at ages } 15\text{ - }49}{\text{Woman - years lived at ages } 15\text{ - }49} \quad (5)$$

The following relationship linking the MMR and MM Rate can be derived easily using equations (1) and (2).

$$\text{MMRate} = MMR \times GFR \quad (6)$$

Where the general fertility rate (GFR) equals the number of live births per woman year lived at ages 15-49. Equation (6) illustrates clearly that the MM Rate reflects both the risk of maternal death per live birth (MMR) and the level of fertility (GFR).

In building regression models of these or different indicators of maternal mortality, the above courting means that models of the MMR and the MM Rate are closely related. Specifically, whilst log (GFR) is blanketed as an explanatory variable, regression models of log (MMR) and log (MM Rate) differ only within the coefficient for log (GFR), which changes employing exactly one. The identical is proper, approximately, while the use of every other measure of fertility is especially correlated with the GFR, consisting of the overall fertility rate (TFR).

2.3 Sources of Data

Data for this work are gotten from the medical records of General Hospital Wukari.

2.4 Holt Winters Exponential Smoothing and Forecasting

Additive Model: The additive model is.

- $L_t = \alpha (Y_t - S_{t-p}) + (1 - \alpha) [L_{t-1} + T_{t-1}]$
- $T_t = \gamma [L_t - L_{t-1}] + (1 - \gamma) T_{t-1}$ (7)
- $S_t = \delta (Y_t - L_t) + (1 - \delta) S_{t-p}$
- $\hat{Y}_t = L_{t-1} + T_{t-1} + S_{t-p}$

Notation

Term	Description
L_t	level at time t, α is the weight for the level
T_t	trend at time t,
Γ	weight for the trend
S_t	seasonal component at time t
Δ	weight for the seasonal component
P	seasonal period
Y_t	data value at time t
$\hat{Y}_t$	fitted value, or one-period-ahead forecast, at time t

2.5 Model Fitting

Winters' approach employs a level element, a trend element, and a seasonal aspect at each length. It makes use of 3 weights, or smoothing parameters, to replace the additives at each duration. Initial values for the extent and trend additives are acquired from a linear regression on time. Initial values for the seasonal issue are acquired from a dummy-variable regression.

2.6 Forecasting

Winters' Method uses the level, trend, and seasonal components to generate forecasts. Winters' Method also uses data up to the forecast origin time to generate the forecasts.

Formula

The forecast for m periods ahead from a point at time t is:

Additive method: $L_t + mT_t + S_t + m - p$ (8)

Notation

Term	Description
L_t	Level
T_t	trend at time t

Term	Description
$S_t + m - p$	seasonal component for the same period from the previous year

2.8 Data Presentation

Table 1: Showing the Data

Year	MM	TNB	TNLB
2004	6	916	910
2005	6	1083	1077
2006	5	1099	1094
2007	6	1088	1082
2008	7	1201	1194
2009	7	912	905
2010	7	1101	1094
2011	2	1024	1022
2012	0	1179	1179
2013	1	735	734
2014	3	364	361
2015	2	440	438
2016	4	751	747
2017	0	566	566
Total	56	12459	12403

Source: General Hospital Wukari

Where
MM = Maternal Mortality,
TNB = Total Number of Birth
MMR = Maternal Mortality Ratio
TNLB = Total Number of Live Birth

3. Analysis and the results

3.1 Preliminary Tests for the Data Set

For the validity of the results obtained through the methodology used in this research, it is essential that the data met the preliminary assumptions. These assumptions are; normality and stationery. The table below presents the results of the test for normality using the Shapiro statistic (W) and the p-value.

Table 2: Showing the Shapiro Test for Normality

	W	P-value
Maternal death	0.8867	0.07245
Total birth	0.88873	0.07751
Maternal mortality Ratio	0.9049	0.1329

From Table 2, 'it is seen that the p-values for the test of normality are 0.07245 for maternal death, 0.07751 for the total birth observed, and 0.1329 for the maternal mortality ratio calculated for the collected data. Comparing these values to the alpha value of 0.05, we see that for all the computed values are greater than 0.05. We are sure that the data set is not normally distributed in the case of Maternal death and total birth while for the maternal mortality ratio, we are 13% sure that the data is not normally distributed. To remedy this, we used the logarithmic transformation on the data.

Table 3: Showing the Results for the Stationary Test

	Dickey-Fuller	p-value
Maternal death	-3.3925	0.07882
Total birth	-2.2057	0.494
Maternal mortality Ratio	-4.4381	0.01

From Table 3, we observed that the value for the Dickey-Fuller statistic is -3.3925 for maternal death, -2.2057 for the total birth, and -4.4381 for the maternal mortality ratio. Also, the p-value is observed to have a value of 0.07882 for maternal death, 0.494 for the total birth, and 0.01 for the maternal mortality ratio. This therefore means that the series is not stationary except in the case of the maternal mortality ratio with a p-value of 0.01 which is less than the alpha of 0.05. The method of differencing was used to remedy the unit root problem and stationery was attained at first differencing.

3.2 Data Analysis

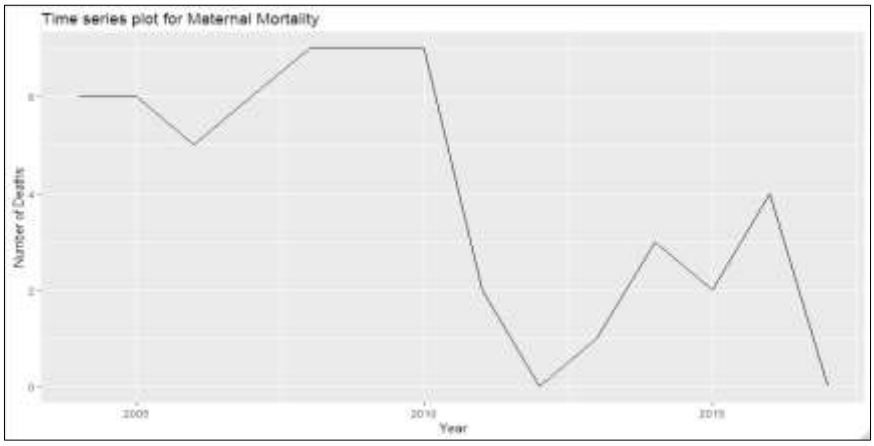

Fig 1: The plot of the maternal mortality

Figure 1 shows the plot of the maternal mortality. We can observe that from 2004, there was a gradual increase in maternal mortality with peak values of 7 in 2008, 2009, and 2010. However, it is also observed that there is a sharp decrease in the trend as we move from 2010 to 2018. This sharp decrease in maternal mortality might be the result of the reduction in the population of Wukari during those years or possibly as a result of the improvement in the state health and medical care services in Wukari.

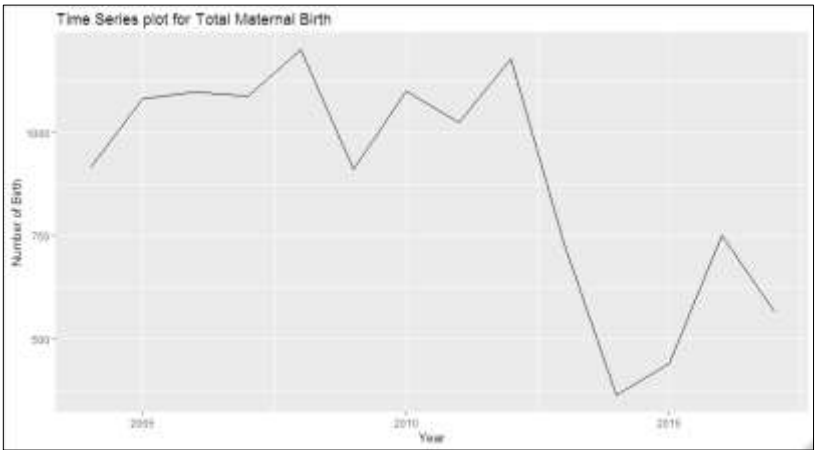

Fig 2: Time Series plot for total maternal Birth

The number of total annual births as observed in the medical records of General Hospital Wukari is presented in Table 3 above. From Table 3, we can observe that there was an increase in the number of births observed in Wukari. Several fluctuations were observed over time but from 2012 to 2017, we observed a sharp decrease in the number of births which coincides with a corresponding decrease in maternal mortality occurrences as seen earlier. Factors responsible for this might be a decrease in the population density of Wukari at those periods.

3.3 Estimation of Maternal Mortality Ratio

The maternal mortality ratio is given by the expression;

$$MMR = \frac{NMD}{NLB} \times 100000 \quad (9)$$

Table 4: Showing the Calculations for the Maternal Mortality Ratio

Year	MM	TND	TNLB	MMR
2004	6	916	910	659.3407
2005	6	1083	1077	557.1031
2006	5	1099	1094	457.0384
2007	6	1088	1082	554.5287
2008	7	1201	1194	586.2647
2009	7	912	905	773.4807
2010	7	1101	1094	639.8537
2011	2	1024	1022	195.6947
2012	0	1179	1179	0.0000
2013	1	735	734	136.2398
2014	3	364	361	831.0249
2015	2	440	438	456.6210
2016	4	751	747	535.4752
2017	0	566	566	0
Total	56	12459	12403	6382.666

3.4 The Average MMR = the total MMR/the number of years: For every 100,000 births in Wukari, the Average Maternal Mortality ratio is 456.

$$Av.MMR = \frac{6382.666}{14} = 455.9047$$

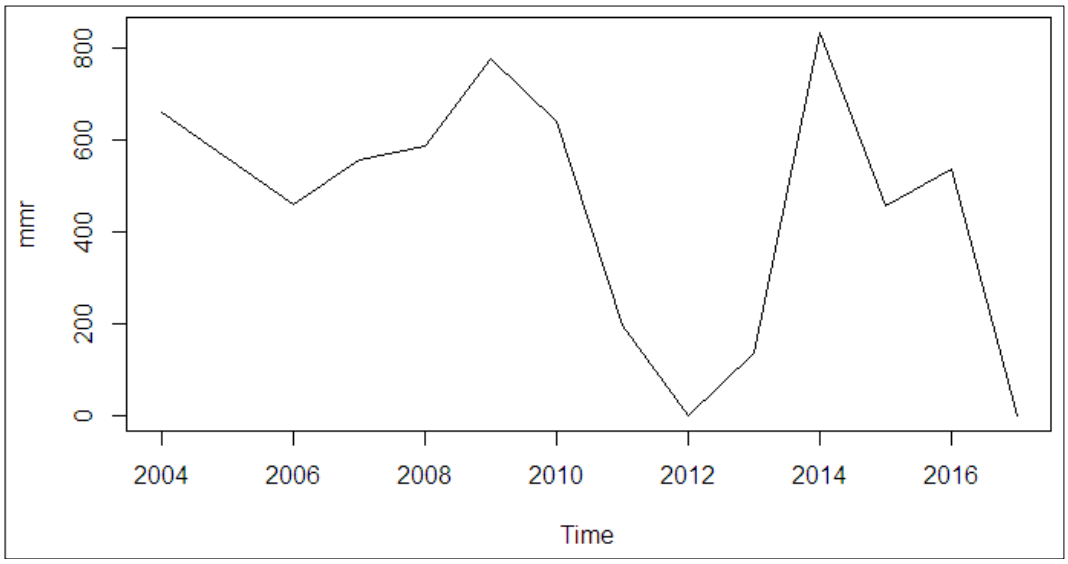

Fig 3: Series Plot for MMR

The table above presents the maternal mortality ratio as calculated for the respective years for which data was collected. From Table 4, we observed that the maternal mortality ratio was lowest in 2012 and 2017 with values of 0.00 and was at its peak in 2014 with a value of about 800 and after that year, there was a sharp decrease in the ratio.

3.5 Forecasting

To forecast for the MMR, we first made the series stationary and that was achieved at first dereferencing. This is to ensure that the prediction made will be as accurate as possible within the limit of experimental error (5%). The method used for the forecast and smoothing of the series is the Holt-Winters. The result of the forecasting is presented in Figure 4.

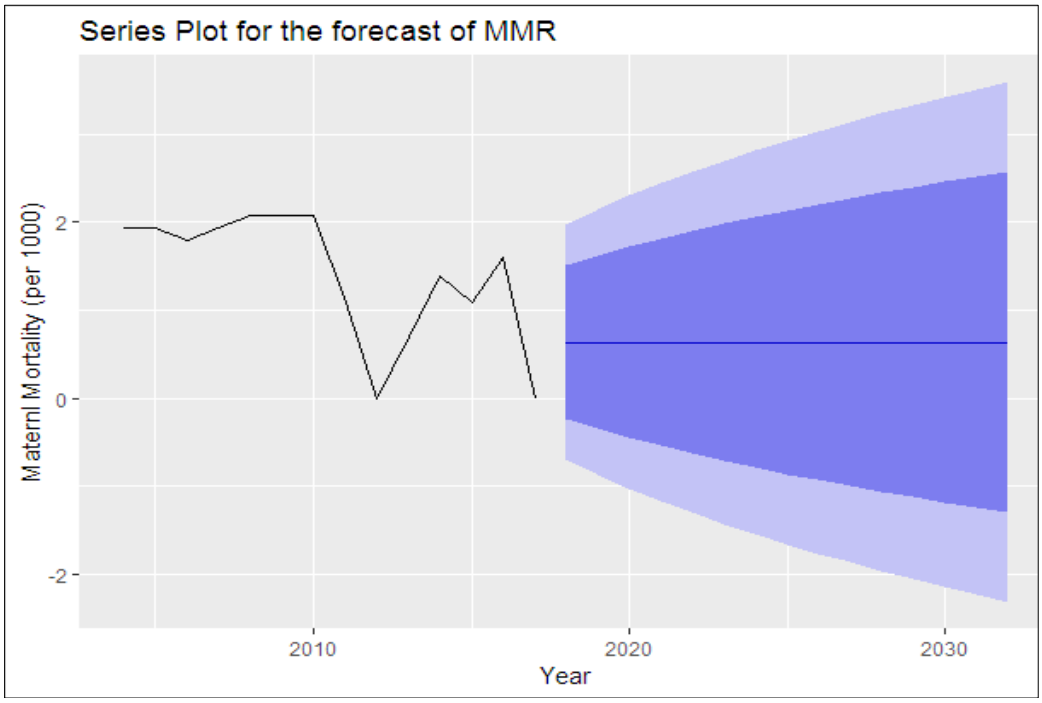

Fig 4: Series plot for the forecast of MMR

A forecast for the maternal mortality ratio for the period of 14 years shows that the MMR continues to reduce in magnitude as indicated in the trend in figure 4. To test for the adequacy of the fitted model and the appropriateness of the forecast made, we plotted the series and the fitted model. This is presented in the figure 5 below;

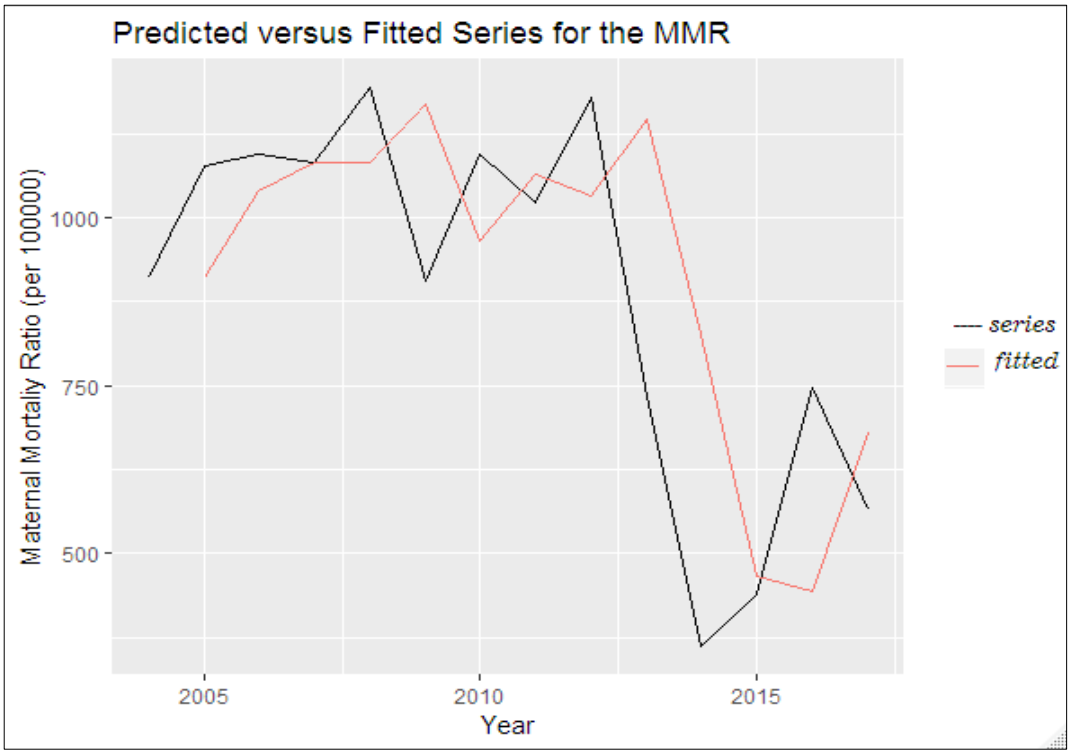

Fig 5: Predicted versus fitted series for the MMR

From figure 5, we observed that the fitted model is almost the same as the actual series. This however shows that the forecast shown to be decreasing in terms of trend as observed in figure 5 is statistically adequate.

4. Conclusion

This study examined maternal mortality in Nigeria which has been one of the major subjects of peculiar interest to public health workers and the government. This concern is a result of the alarming rate at which women that is pregnant or a few weeks after childbirth die due to one reason or another, such as complications resulting from poor medical facilities and personnel.

The results obtained from the analysis showed the estimated MM Ratio to be 0.005 (That is 500) maternal deaths for every 100000 maternal-related cases. Also, the MM Rate was found to be 0.009 (That is 900) maternal deaths for every 100000 maternal births in the population. Also, from the forecast, it was found that the trend for maternal mortality is decreasing as found in the trend. This could be a result of improvement in health sectors.

5. Acknowledgment

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