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Explaining The Correlates of Child Mortality and Under-5 Survival in Nigeria

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ABSTRACT

Background: Survival of children under-5 is among the foremost public health concerns that has been pursued in the Sustainable Development Goals (SDGs). A proper understanding of the correlates of child survival is of paramount relevance to health policy formulation and development of interventions to promote child's health outcomes. This study therefore analysed the determinants of the number of recorded child mortality and survival in Nigeria.

Methods: The data were the Malaria Indicator Survey (MIS) that were collected in Nigeria in 2021. The samples were drawn with multi-stage sampling method following the 2023 Population and Housing Census sampling frame. A total of 14185 housing units were randomly selected of which 13887 were occupied and 13727 were successfully interviewed. In each household, all women belonging to the reproductive ages of 15-49 years were interviewed. A total of 14647 women were eligible, of which 14476 were successfully interviewed (Demographic and Health Survey (DHS), 2021). The data were analyzed using the Negative Binomial regression and logistic regression models.

Results: The logs of the number of dead children were significantly higher ($p<0.05$) for mothers from North West and North East Nigeria, while children from these regions also had a significantly lower probability of surviving. The mothers from urban areas had significantly lower log of dead children while urban children had significantly higher probability of surviving. Mothers with secondary and tertiary education had significantly lower log of dead children, while birth in the past five years and total children born reduced child's survival. Twin children also had a significantly lower probability of surviving while mother's maturity promoted child's survival.

Conclusion: Promotion of child survival in Nigeria requires a concerted effort that disaggregates interventions across Nigerian zones with preferences for those in the north and rural dwellers. In addition, there is the need to promote interventions to assist women with multiple births, promote girl child education and discourage teenage pregnancies.

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Introduction

Substantial progress in some basic indicators of child's health remains a globally authentic parameter for measuring socioeconomic development. Notable among these indicators is under-5 mortality rate, which measures the probability of a neonate dying before the age of five.[1] More importantly, the Human Development Index (HDI), which is a composite index computed from life expectancy, education, and Gross Net Income (GNI) are associated with child's health outcomes. However, based on HDI and other economic development parameters, sub-Saharan Africa (SSA) countries are among the poorly rated in the world. Some statistics have shown that in 2021, SSA recorded the least HDI (0.547), while Europe and Central Asia had the highest value (0.796). Therefore, the survival battle of an average child in SSA is significantly complicated by the region's low life expectancy (60.1 years), low education coverage, and very low GNI (US$3699).[2] More importantly, many SSA children are not fully vaccinated, although national coverages can be widely different with some statistics indicating that 24% for Guinea and 93% Rwanda.[3]

A reflection on recent global child mortality statistics reveals a significant improvement, given a 59% decline between 1990 and 2021, when child mortality rates were one death per eleven live births and one death per twenty-six live births, respectively.[1] However, a consensus exists among policy makers that more integrated effort should be applied in the fight against under-5 mortality for a better outcome. Specifically, in 2021, about 5 million under-5 children died in the world[1] due to some medical complications from preventable diseases. Moreover, under-5 mortality in SSA is disproportionately high with 3,323,165 and 2,902,961 deaths in 2011 and 2021, respectively.[4] Moreover, in 2021, SSA remains the hotspot of child mortality with one out of every fourteen children likely to die before reaching the age of five.[5] This figure is about fifteen times higher than what is obtainable in some high-income countries, and regrettably places SSA some twenty years behind the tick of time in the global fight against child mortality.[5]

Currently, Nigeria is among the SSA countries with the highest under-5 mortality rates. In 2021, estimates showed that under-5 mortality in the country reduced to 111 per 1000 live births, from 133 in 2011. Accordingly, there was a decline in under-5 deaths from 886,075 in 2011 to 852,298 in 2021.[4] The development implications of these statistics beg for more policy engagements on the identification of effective pathways for ensuring drastic reduction in under-5 mortality. This cannot be over-emphasized because majority of these deaths could have been prevented, should there be some improvements in the efficiency of healthcare service delivery, along with better utilization.[6] Although the Nigerian government is signatory to the Sustainable Development Goals (SDGs), the possibility of achieving the SDG 3, which seeks to reduce child mortality to 25 per 1000 live births in 2030 is perplexingly doubtful.

Moreover, a proper understanding of the correlates of child survival from the maternal and household perspectives can assist healthcare policy makers in their quests towards reduction in child mortality. The bedrock of such analyses has been the conceptual framework that was proposed by Mosley and Chen[7], which integrates some

economic, social, biological, and environmental factors into a set of proximate determinants that influence child survival through some exogenously defined maternal, paternal, health system and child factors. In Nigeria, there are rural-urban differences in households' access to orthodox healthcare services, with significant impacts on the timeliness of seeking medical care and sickness treatment outcomes. Child survival is promoted by timeliness of healthcare service utilization,[8-10] and engagement of competent nurses and doctors during child's delivery.[11-12] It had been reported that residence in urban are as improves survival of child.[8,13,14] Similarly, some regional variables can influence child survival through some peculiar geographical and environmental features. More specifically, in Nigeria, northern zones had been found to have a higher level.[15-16] Some authors have also integrated religion as a factor influencing child mortality,[13] while maternal and paternal education will reduce child mortality and redefine the magnitude of the contributions of other socioeconomic factors to child's survival.[17-19]

Maternal age and the age at first birth are concrete reflections of the extent of mother's physical, emotional, psychological, and financial maturity. These attributes are essential for the promotion of child's survival.[20-21] Moreover, teenage mothers are often inexperienced in child-raising matters, thereby increasing their likelihood of recording preventable child mortality. Other studies have found that households' wealth index,[21-23] income, waste disposal methods, sources of drinking water [20,24] and the type of sanitation practices,[20,23-25] are key determinants of child survival. The wealth of the households and associated housing attributes are essential for raising a child. Therefore, children that are raised in poor homes are likely to be deprived in some essential nutritious foods and health promoting facilities like clean water, improved sanitation, and clean environment.

Furthermore, some inherent child's factors have been found to influence child survival. These include the order of birth,[26] child's age,[27] gender[26] and being a singleton or twins. Some authors have reported that a higher birth order increases the probability of child survival.[26] However, others found male child to have a lower chance of surviving,[28-29] although female child was reported to have a lower surviving chance by other authors.[30] Twin child had been found to have a lower probability of surviving, when compared to singleton. This can be traced to resource constraints and the tendency of some twins to have low weights. In some other studies, altitude increased the probability of child's survival.[27] It had been noted that mortality in high altitude areas may be promoted by a high risk of hypoxaemia at infancy and when the child suffers from acute lower respiratory infections.[31]

The objective of this paper is to analyse the maternal and other socioeconomic variables that influence child mortality and under-5 survival. It was hypothesized that maternal and child's characteristics do not significantly explain child mortality and under-5 survival. The paper is a robust contribution to the growing body of knowledge on child survival by utilizing the most recent dataset to articulate the correlates of these vital health outcomes in one of Africa's hotspots for child mortality. The study approached the analyses at the maternal level with consideration of the determinants total child's deaths and at child's level, with the analysis of the determinants of child's survival.

Methods

1. The data and sampling procedures

This study used the dataset for the 2021 Malaria Indicator Survey (MIS). Although the survey's main objective is to evaluate progress in some basic malaria indicators, being an offshoot of the conventional Demographic and Health Survey (DHS), it integrates some conventional health indicators like child's survival, mortality, and other health outcomes. The 2021 survey was the third MIS to be conducted in Nigeria, since 2010 when the first data were collected. The survey was based on the proposed 2023 Population and Housing Census sampling frame. The multi-stage sampling method was adopted. The first stage comprised of a random selection of 568 clusters with 373 rural areas and 195 from urban areas. The second stage involved listing of all the households in each of the selected clusters, from where 25 households were randomly selected for interview. Therefore, across the country, a total of 14185 housing units were randomly selected of which 13887 were occupied and 13727 were successfully interviewed. In each household, all women belonging to the reproductive ages of 15-49 years were interviewed. A total of 14647 women were eligible, of which 14476 were successfully interviewed.[32]

The MIS comprised of four questionnaires which were for households, women, biomarkers, and fieldworkers. The data were collected after being pre-tested during some training sections that were conducted for 31 participants between 6-18 September 2021. The main survey trainings were conducted for 214 enumerators, 47 medical laboratory scientists, and 37 nurses between 20 September and 7 October 2021. The MIS data were collected between 12 October and 4 December 2021 in every Nigerian state and the Federal Capital Territory (FCT) by a survey team comprising a supervisor, a medical laboratory scientist, a nurse and two interviewers. The questionnaire, which was originally designed in English was translated into Nigeria's three predominant languages - Hausa, Yoruba, and Igbo. Data from the respondents were entered on phone tablets, registered, verified, and transmitted to the National Population Commission's (NPC) central office. Editing and processing of data were done by CSPro software. Compliance with essential ethical procedures for questionnaire administration was observed and the survey protocols were evaluated and approved by "the National Health Research Ethics Committee of Nigeria (NHREC) and the ICF Institutional Review Board".[32]

2. Estimated models

The negative binomial regression

The correlates of child mortality were analysed with negative binomial regression, which is a hybrid form of the Poisson regression. This model was used to analyse the determinants of the number of dead children reported by each interviewed woman. Following Lord and Park,[33] this model is specified for a random variable Yi that follows Poisson distribution as:

$$g(Y_i, \mu_i) = \frac{e^{-\mu}\mu_i}{Y_i!} \qquad .1$$

Where Y_i is a count of the deceased children 0, 1, 2,3, 4, …..k, and μ_i is the mean of the Poisson distribution. The basic assumption of the specification in equation 1 is that the conditional mean and variance are equal. When this is violated, the model is said to be over-dispersed, and an alternative model like negative binomial regression should be considered. The estimated Poisson regression model using the STATA 17 software is

to be subjected to goodness-of-fit test. If this is statistically significant, the model fails the basic assumption of Poisson model and an alternative model, such as the negative binomial regression model should be used. The estimated model is specified as:

$\mu_i = \exp(\beta_0 + \sum_{i=1}^{k} \beta_i X_i + \mu_i)$ .2

In equation 2, X_i are the explanatory variables,β_0 andβ_i are the estimated parameters and u_i is the random error.

Logistic Regression Model

Logistic regression was used to analyse determinants of child survival. The dependent variable was specified as 1 for surviving children and 0 otherwise. The model is specified as:

$log\left(\frac{\pi}{1-\pi}\right) = \gamma_0 + \gamma_i \sum_{i=1}^{d} X_i + e_i$ .3

In equation 3, π denotes the probability of child being alive andγ_0 and $\gamma_i$are the parameters to be estimated, and e_i is the stochastic error term.

Results

The results in Table 1 show the mean of selected demographic variables for the sampled children and mothers. It reveals that 96.38% of all the children born by selected women were alive, while average number of dead children was 0.456. Across the regions, 37.37% of the children and 32.96% of the mothers were from the North West zone. Although South East recorded the lowest percentage of the under-5 children (7.75%), South West reported the lowest percentage for eligible women (8.34%). In addition, urban areas accounted for 27.87% of eligible children and 29.45% of eligible women. Average age of eligible women was 29.30 years, while that for eligible children was 30.03 months. Of all the eligible children, 65.53% and 57.15% had access to improved water sources and sanitation, respectively. Also, among the eligible women, 67.57% and 60.17% had access to improved water sources and sanitation, respectively. Males accounted for 51.38% of the eligible children and only 5.71% were twins. The average altitudes for children and mothers were 325.13 m and 300.58 m, respectively. Also, while 43.62% of the eligible mothers had no formal education, 31.48% and 10.66% had secondary and tertiary education, respectively. Mobile phones were owned by 57.48% of the mothers. Average birth in the past five years was 1.526 and average total children were 3.973.

Table 1 Mean of the selected demographic variables across sampled respondents

Variables	**Coding format**	**Means across the children (n=10988)**	**Means across the mothers (n= 7222**
Alive children	Alive =1, 0 otherwise	.9637557	
Total dead	Number of dead children		.4564808
Regions			
North Central	Yes=1, 0 otherwise	.164444	.1960078
North East	Yes=1, 0 otherwise	.1791391	.1592662
North West	Yes=1, 0 otherwise	.3736697	.3295553
South East	Yes=1, 0 otherwise	.077536	.1357121
South South	Yes=1, 0 otherwise	.1029472	.0960926

South West	Yes=1, 0 otherwise	.102264	.083366
Urban resident	Yes=1, 0 otherwise	.2786649	.2945252
Household head gender	Male=1, 0 otherwise	.9344174	.9214733
Mother's age	Years	29.14311	29.29617
Improved water sources	Yes=1, 0 otherwise	.6553359	.6757395
Improved sanitation practices	Yes=1, 0 otherwise	.5715477	.6017022
Gender of the child	Male=1, 0 otherwise	.5138611	.5216076
Altitude of place of residence	Meters	325.1275	300.5842
Usage of mosquito nets	Yes=1, 0 otherwise	.6652138	.6322549
Age of the child	Years	30.0257	29.89384
Child is a twin	Yes=1, 0 otherwise	.0570783	.0241331
Mother's educational levels			
None	Yes=1, 0 otherwise	.4611254	.4362461
Primary	Yes=1, 0 otherwise	.1545751	.1423092
Secondary	Yes=1, 0 otherwise	.2868196	.314801
Tertiary	Yes=1, 0 otherwise	.0974798	.1066437
Births in the past 5 years	Number	1.791658	1.526023
Own a mobile phone	Yes=1, 0 otherwise	.5394846	.5748197
Total children	Number	4.262147	3.973311
Household's head age	Years	43.11179	43.13773
Wealth index	Composite indicator	-26349.88	-20467.72

Table 2 Mean of child mortality and survival across selected demographic variables

Variables	Average Dead Children	Percentage Alive Children
North Central	.2315634	.9810863
North East	.4773414	.9620438
North West	.8215136	.9465008
South East	.2083333	.994863
South South	.2397408	.9803371
South West	.1391941	.981203
Rural	.5077258	.9646465
Urban	.2713891	.9785671
No Education	.666996	.9580242
Primary	.5085066	.966932
Secondary	.2121993	.9801667
Tertiary	.1200000	.9810181
All	.4365827	.9687841

Table 2 further shows the distributions of child mortality and survival across selected demographic variables. It reveals that average number of dead children was highest in the North West zone with 0.822, while South West had the lowest value of 0.139. Women who were resident in rural areas had a higher average number of dead children with 0.507, as against 0.271 for urban residents. The women with no education had a higher average mortality of 0.667, as against 0.120 for those with tertiary education. Similarly, North West zone had the lowest child survival rate of 94.65%, while South East had the highest (99.49%). The children from rural areas had 96.46% survival rate, while those from urban areas had 97.86%. Child's survival rate among children whose mothers had no formal education was the lowest (96.69%), as against 98.10% for those with mothers who attained tertiary education.

Table 3 Determinants of child mortality (negative binomial regression) and survival (logit regression)

	Child Mortality (NBREG)		**Child Survival (Logit)**		
Variables	Coeff	z-stat	Coeff	Odds ratio	z-stat
Dwelling Characteristics& Wealth					
North East	.4296908***	3.50	-.8441968***	.4299025***	-3.83
North West	1.066941***	9.51	-.8339873***	.4343141***	-3.96
South East	-.0180727	-0.10	1.420923***	4.140939	2.74

South South	.0349559	0.24	-.2877871	.7499212	-0.91
South West	-.214499	-1.27	.1469957	1.158349	0.43
Urban residence	-.3625935***	-4.25	.607531***	1.835893***	3.17
Improved drinking water	.107572	1.61	-.0885613	.915247	-0.63
Improved sanitation	-.0471624	-0.66	-.1772003	.837612	-1.19
Altitude of residence	-.000371**	-2.30	.0003824	1.000382	1.14
Mosquito net usage	.1715777**	2.36	.0355724	1.036213	0.25
Mothers' Characteristics					
Head gender	.0553766	0.38	.0375186	1.038231	0.11
Mothers' age	.0679007***	15.06	.0500485***	1.051322***	4.07
Mother born twins	.6076846***	3.02	-	-	-
Education level of Mother					
Primary	.0453676	0.55	-.1005889	.9043048	-0.52
Secondary	-.4086559***	-3.95	.1156973	1.122656	0.51
Tertiary	-.7763053***	-4.50	-.0890547	.9147955	-0.25
Births in the past five years	.032957	0.69	-.4483745***	.6386655***	-4.46
Ownership of mobile phone	.0097721	0.14	-.4437012***	.6416571***	-2.75
Head age	-.0008999	-0.39	-.0037	.9265841	-0.78
Total child born	-	-	-.0762504**	.9963069**	-2.58
Child's characteristics					
Sex of the child	.0585781	0.87	-.3102565**	.7332588**	-2.46
Age of child	-.0003643	-0.16	.0018021	1.001804	0.53
Child is Twins	-	-	-.6750176***	.5091474***	-5.63
Wealth of households					
Wealth index	-2.44e-06***	-4.45	1.11e-06	1.000001	0.98
Constant	-3.450194***	-13.75	4.043795***	57.0424***	6.94
Lnalpha	.4836562				
Alpha	1.621994				
Number of observations	7222		10988		
Wald chi2(22)	1011.28***		203.90***		

Note: *** - statistically significant at 1 percent level; ** - statistically significant at 5 percent level

Table 3 shows the results of negative binomial regression (NBREG) and logit regression. The explanatory variables were examined for multicollinearity using the Variance Inflation Factor (VIF). These values were generally low (<2.00) for the two models, showing that multicollinearity was not a problem. The computed Wald Chi-Square statistics revealed that the stated hypotheses of no significant association between the selected characteristics of the mothers and the children in relation with child mortality and child survival cannot be accepted. The models therefore produced good fits for the data. Two of the regional dummy parameters – North East and North West – showed statistical significance in the child mortality model ($p<0.01$). In addition to these, South East region dummy parameter showed statistical significance in the child survival model ($p<0.01$). The NBREG results indicate that holding other variables constant, and when compared with mothers from the North Central region, the respondents from North East and North West had their logs of dead children increased by 0.4297 and 1.0669, respectively. In addition, the logit results showed that if other variables are held constant, and when compared with the children who resided in North Central region, the children from the North East and North West regions were 57.01% and 56.56% less likely to survive. In addition, those from the South East region are 314.09% more likely to survive, when compared with their counterparts from the North Central region.

The dummy parameters of urban residence in the two models also showed statistical significance ($p<0.01$). When compared with their rural counterparts, the log of dead children reduced by 0.363 for mothers from urban areas. Similarly, the children who were residing in urban areas had 83.59% more likelihood of surviving, when compared with their counterparts from rural areas. The altitude parameters in the NBREG model showed statistical significance ($p<0.05$). This implies that as altitude of place of mothers' residence increases by one meter, the log of dead children decreased by 0.0004. However, contrary to expectation, the mothers who were using mosquito nets had their log of dead children significantly increased by 0.1716 ($p<0.05$), when compared with those who were not using nets.

The parameters of mothers' age variable showed statistical significance ($p<0.01$) in the two models. In the NBREG, it implies that as the mothers' age increased by one year, the log of dead children increased by 0.0679. Also, the logit results indicate that as mothers' age increases by one year, the likelihood of child survival increases by 5.13%. The results further revealed that the mothers who gave birth to twins had their log of dead children significantly increased by 0.6077 ($p<0.01$), when compared with women with singletons.

Among the variables that captured some characteristics possessed by the children, gender dummy parameters show statistical significance ($p<0.05$) in the logit model. Male children were 26.67% less likely to survive, when compared with their female counterparts. Twin children were 49.09% less likely to survive than their counterparts who were not of multiple births.

Discussion

The results have shown the magnitude of child mortality, and determinants of child survival in Nigeria. The children who were born in the North-West and North-East regions had a lower probability of surviving. This agrees with the

findings from some previous studies.[23,34,35] Low child survival in northern Nigeria can be attributed to several factors, among which poverty is notable. Specifically, under-5 children are the foremost recipients of persistent economic deprivations in Nigeria, where northern regions disproportionately account for about 87% of poor households.[36] Economic situation in northern Nigeria has been adversely affected by growing insecurity that has subsumed many households into chronic poverty.[37] Similarly, urban children had a higher probability of surviving than their rural counterparts. This is in consonant with the findings of some previous studies.[34,35,38] Survival of urban children may have been promoted from biasness in the distribution of some basic health and social infrastructures and services that often favours urban centres.

The altitude of mother's residence reduced the total recorded deaths among children. This is contrary to the findings in some previous studies but in line with finding of Oyekale.[37] Literature emphasizes some pathways through which child's growth may be adversely influenced by their residences' altitudes. These are possibility of chronic hypoxia in high altitudes, soil fertility and nutrient depletion and exposure to some disease-causing pathogens.[39] Mohammed et al.[40] found that children in high altitudes had higher incidence of stunting, as compared with their lowland counterparts. Contrary to expectation, child mortality was higher in households that indicated under-5 children slept under mosquito net in the previous night. However, with mosquito being one of the major ways to prevent malaria among children, it is also important to note that children can be exposed to mosquito bites in other places within the household. More importantly, the use of mosquito net has been found to reduce malaria-related child mortality in rural Tanzania[41] and promote overall survival of children.[42] It should also be emphasized that child mortality may have resulted from other causes besides malaria, and the use of mosquito net as captured in the data did not probe into long-term compliance.

The results further showed that the number of dead children from a mother increased with their ages. This may be due to expected correlation between mothers' age and the number children born. However, as the age of the mothers increased, the chance of surviving increased. This is expected because children born to under-aged mothers are often with low birth weights, thereby reducing their chances of surviving. The finding is contrary to those of Friede et al.[43] and Tesema et al.[44], but in agreement with those of Noori et al.,45 Finlay et al.[46]and Finlay et al.[47] Emphases have been placed on some factors that promote child mortality among young mothers. These include physical and biological unpreparedness for pregnancy, complications, inadequate access to antenatal care (ANC), stigmatization, poverty and increased economic vulnerability.[48-50]

As expected, attainment of secondary and tertiary education by the mothers reduced the number of dead children. Educated mothers are expected to have the requisite money and expertise to properly take of children. They are also expected to understand the essence of timely utilisation of some healthcare services when the child is sick, and the role of adequate nutrition and vaccination in promoting child's health.[51] The results are in accordance with those of Adewusi and Nwokocha,[52] Oyekale and Maselwa,[30] Andriano and Monden,[53] Gakidou et al.,[54] Yaya et al.,[21] Balaj et al.,[17]Murarkar et al.[18], and Fenta and Fenta.[19] The role of maternal fertility and child's spacing in

explaining child's mortality was also evaluated. These results indicate that the number of births within past five years of data collection and total children born reduced the chance of child's survival. These findings are expected because short preceding birth intervals and high maternal fertility have been reported to promote child mortality.[30,55]

Finally, the role of multiple births in explaining child's survival was explored and the results revealed that mother who gave birth to twins recorded a higher number of dead children. Similarly, the children who were born as twins also recorded a lower probability of surviving. These findings are expected and in accordance with those of Jahn et al.[56], Dejene and Girma[57] and Stock and Norman.[58] Mortality among twins can be promoted by a higher probability of being born with low weight due to a very high tendency of preterm delivery, resource constraints from parent and limitations from mothers to effectively breastfeed two children.

Conclusion

A proper understanding of the correlates of the rate of child mortality and survival is of fundamental importance in promoting achievement of some SDGs. This remains a pressing concern for many countries in SSA due to their notoriously high rate of child mortality, despite some drastic reduction in global incidences. In this study, focusing on the most populous country in Africa, some correlates of child's survival were analyzed and the results have highlighted some vital issues for policy interventions. Specifically, some regional differences exist in child mortality and survival in Nigeria. This emphasizes the need for region-differentiated and integrated approaches to address child's health outcomes in Nigeria. Specifically, there is the need to intensify efforts in reducing child mortality in the states in northern Nigeria and among residents in rural areas. Revitalization of rural health care facilities with functioning emergency response preparedness promises to address progress inequity in child survival among rural children and their urban counterparts. In addition, promotion of maternal education promises to reduce child mortality. There is the need for interventions to facilitate enrolment of girl child in education facilities and concerted efforts in promoting information on the dangers of teenage pregnancy and high fertility. Proper creation of awareness on the use of family planning can assist in reducing maternal fertility, which will impact on child survival. Finally, there is the need for public health interventions at the local, state, and national levels to assist economically vulnerable women with multiple foetuses right from the time of being detected. Such interventions can target enhancement of their access to medical services, counselling, and post-delivery financial assistances.

Conflict of Interest

No conflict of interest in this study.

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