

## Sub national mortality trajectory in Kenya: Examining the role of HIV and AIDS interventions

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### ABSTRACT

Kenya has witnessed significant drop in life expectancy since 1984. The decline coincided with the onset of HIV and AID epidemic. Regional variations in life expectancy at birth are also evident in Kenya with some counties exhibiting high life expectancy while infant and childhood mortality rates are low. Regional variation in HIV prevalence is also evident in Kenya. Counties with high HIV prevalence have recorded high infant and childhood mortality. Although mortality projections have been done in Kenya, the role of HIV and AIDS related interventions on county level mortality patterns has not attracted the attention of researchers. This study explores the contribution of HIV related programs on future mortality patterns at sub national level in Kenya. The study makes use of data drawn from the 2009 Kenya population and housing census, the 2012 Kenya AIDS indicator survey and the 2014 Kenya demographic and health survey. The cohort component approach to population projections and trend extrapolation methods are applied in this study. The results indicated that, HIV and AIDS related programs affect mortality at the county level in Kenya. If there was no HIV and AIDS in Kenya, all counties would experience steady increase in life expectancy. When HIV and AIDS prevalence were incorporated in mortality projections, the results indicated that life expectancy will be consistently lower than it would have been if there was no HIV and AIDS. When HIV and AIDS related programs were incorporated in mortality projections, life expectancy at birth was higher than it was in HIV/AIDS only scenario. Based on the finding of this study, it is recommended that future mortality projections should incorporate the effect of AIDS related programs since the study established that they affect mortality patterns.

**Keywords:** Mortality, HIV/AIDS, HIV/AIDS interventions, Projections, Life expectancy

### INTRODUCTION

Mortality situation in a country is a key indicator of the general well-being of its people. It can be measured using a number of indicators. However, the common indicators are: under five mortality rate (U5MR), maternal mortality rate and life expectancy at birth. If under five mortality rate (U5MR) is low, it indicates that there is wide coverage of initiatives targeting child survival. Low U5MR also implies that there is high level of socio economic development. Low maternal mortality rate indicates existence of strong health care facilities and extensive coverage of reproductive health programs. On the other hand, life expectancy at birth is a key indicator of health conditions of a population and the level of economic development of a nation. High life expectancy at birth generally denote a healthy nation (Rashidul et al., 2013). There has been a significant decrease in life expectancy in Kenya.

Wide disparities in life expectancy at birth also exist at the county level in Kenya. According to KNBS (2012), some counties especially those in former Eastern and Rift Valley region exhibit low childhood mortality and adult mortality. However, life expectancy in these regions is higher than the existing development indicators can support.

Existing research has linked change in life expectancy witnessed in Kenya over the years to HIV and AIDS (NCPD, 2013). Existing studies have also attempted to incorporate HIV prevalence in projecting life expectancy at birth in Kenya (CBS, 2002; KNBS, 2012). However, the effect of HIV and AIDS interventions on future mortality patterns in Kenya has not attracted the attention of researchers. Mortality in Kenya varies by counties. HIV and AIDS prevalence also varies by counties while the uptake of HIV and AIDS related interventions vary to a large extent by counties.

### OBJECTIVES OF THE STUDY

The objective of this study is to examine the effects of HIV and AIDS related interventions on future mortality patterns at sub national level in Kenya.

### Past Studies on the Relationship between HIV/AIDS and Mortality

Studies have shown that HIV and AIDS affect mortality in various ways. HIV positive adults experience substantially higher mortality than their counterparts who are HIV sero negative. Children born to HIV sero positive mothers experience higher infant mortality than those born to HIV sero negative mothers. (Nunn et al., 1997; Gray et al., 1998; Sewankambo et al., 1994; Todd et al., 1997; Wachter, Knodel, and Van Landingham, 2002; Carpenter et al., 1997; Hunter et al., 2003; Lewis et al., 2004; Timaeus and Jasseh, 2004; Zaba et al., 2007; Garenne et al., 2007; Clark et al., 2008; Gregson et al., 2007).

Empirical literature also point that, HIV and AIDS affect women more than men. Men and women infected with HIV have suppressed immune system and are more likely to suffer from opportunistic infections. This in turn increases their odds of death. In sub Saharan Africa, HIV is primarily transmitted through heterosexual union. In these regions HIV prevalence is consistently higher among the women than in men (PRB, 2006).

Studies have linked HIV and AIDS with increase in childhood mortality. In Kenya for example, the reversal in declining childhood mortality witnessed in the late 1980s and early 1990s was attributed to HIV and AIDS (Hill et al., 2001). However, according to data from the 2008/2009 Kenya demographic and health survey (KDHS), U5MR has started declining in Kenya. The declining U5MR has been attributed to upscale of government interventions programs especially immunization (KNBS, 2012). Although there has been a decline in childhood mortality in Kenya, there still exist wide regional disparities in childhood mortality. Data from the 2008/2009 KDHS reveal that holding all other factors constant, U5MR is higher in the regions with the highest HIV prevalence (KNBS, 2015).

Kenya has also witnessed a steady decline in life expectancy at birth since 1984 (NCPD, 2013). The decline in life expectancy was attributed to HIV and AIDS endemic. According to the KNBS (2012), life expectancy at birth varies

considerably by regions in Kenya. Some counties especially those in Rift Valley and Eastern region have high life expectancy which fail to match with the existing development indicators (KNBS, 2012)

Empirical studies have indicated that HIV related program interventions lower mortality in both developed and developing countries. HIV infected persons who have access to highly active anti-retroviral therapy (HAART) generally have higher survival chances when compared with their counterparts who don't have access to HAART (Martin et al., 2009; Andreas et al., 2008; Chan et al., 2006).

### DATA AND METHODS

The study makes use of the 2009 Kenya population and housing census data (2012), the 2012 Kenya AIDS indicator surveys (KAIS) and the 2014 Kenya demographic and health surveys (KDHS).

Although a number of indices can be computed to indicate the mortality situation in a country, this study focuses on projections of life expectancies at sub national level in Kenya. The projections begin in 2009, the year of the most current census in Kenya. The projections are then extended to the year 2030 which has been earmarked as Kenya's deadline for achieving a national long-term development blue print for creating a globally competitive and prosperous country with a high quality of life (GoK, 2007). The projections are anchored on the assumptions that, life expectancy should increase over the years since there has been an improvement in infant and child hood mortality rates. It is also assumed that since counties are nested within provinces, and provinces are nested within the country (Kenya), then the trajectory of life expectancy at birth for each sex in each county will follow that of the parent province. Besides, the trajectory of  $e(0)$  for each province will follow that of the country. Life tables generated from the 2009 Kenya population and housing census data for the country and for each of the provinces are used as input data. Trend extrapolation method is applied to the 2009 Kenya population and housing census data. Extrapolation method was deemed to be the most appropriate method because of limited data at county level. For each projection, the data required included; the base year, the upper asymptote of life expectancy at birth disaggregated by sex; national base year projections of life expectancy at birth and sex specific estimates of county life expectancies at

birth. This is followed by computation of County projections of life expectancy at birth. The procedure involves forming a ratio of the complement of the provincial life expectation at birth for a launch (base) year as well as that of a future year. The ratio formed represent the extent to which provincial life expectation at birth approaches the limit over a period between the launch year (2009) and the projected year (2030). According to Arriaga (1994) the difference between the two  $e(0)$ s at some time  $t$  is equal to the relative complement of an estimate of  $e(0)$  in relation to a limit  $e(0)$ .

Suppose:

$t_0$  is the Launch year

$t_{0+n}$  = future year

$k$ =limit ( $e(0)$ )

$k-e(0)$ = the complement of  $e(0)$

Then

The ratio=  $(K - National e(0)t + n)/(K - National e(0)t) \dots 1$

The computed ratio is then multiplied by the complement of county  $e(0)$  for year  $t$  to obtain

$$n_{a+1}, d = 2, t + 1 = n_{a,d=1,t} s_{a,d=1,t} i_{a,t} s_{a,d=2} \dots \dots \dots 2$$

$$n_{a+1}, d > 2, t + 1 = n_{a,d=1,t} s_{a,d=1,t} s_{a,d>2} \dots \dots \dots 3$$

Where  $S_{a,d>1} < 1$ ; survival in the HIV+ states is reduced compared to the HIV- state.

To determine the effect of HIV related interventions on mortality, the level of uptake of each HIV and AIDS intervention per county is included in the model. The following interventions are modeled: improvement in the treatment of sexually transmitted infections; information and education campaigns (IEC) and social marketing; voluntary counseling and testing (VCT); mother to child transmission prevention (MTCTP) and anti-retroviral treatment (ART).

**RESULTS AND DISCUSSIONS**

In order to establish whether HIV and AIDS related programs are affecting mortality, projections were first generated while holding constant the effect of HIV and the related programs on mortality. Because of limited data at county level in Kenya, provincial projections of life expectancy at birth were first computed to generate base data. Life tables for each province generated from the 2009 Kenya population and housing census data (KNBS, 2012) were used as input. The standard cohort

estimated reduction in the complement of county/province  $e(0)$  from  $t_0$  to  $t_{0+n}$ . then, the complement is subtracted from  $K$  to obtain an estimate of non  $e(0)$  for each county and province for the year  $t_{0+n}$

To estimate the effect of HIV and AIDS associated programs in mortality projections, HIV prevalence per county and the level of uptake of AIDS related programs like condom use and anti-retroviral therapy are introduced in each county. This is because; individuals infected by HIV may experience additional force of mortality that is different from those who are HIV negative.

Let the population be subdivided into 17 age groups such that  $a=1,2,3,\dots,17$  corresponding to the age groups 0-4,5-9,...,80+. Assume also that  $d$  represent affiliation of an individual to the HIV duration groups where  $1 < d < 5$  correspond to HIV-, HIV+ for 0-4 years,..., HIV+ for more than 15 years, then an individual sick with HIV( $d>1$ ) will experience extra force of mortality that is not experienced by those in the HIV- state ( $d=1$ ). The mortality differential due to HIV is projected as follows:

component approach to population projections was applied to the data to generate provincial projections of life expectancy at birth up to the year 2030. The output generated was then used to produce county specific projections of life expectancy. The procedure involved forming of a ratio of the complement of the provincial life expectation at birth for a launch year as well as that of a future year as illustrated in equation 1, 2 and 3. The results of the analysis are presented in Table 1.

Table 1 shows that if there was no HIV and AIDS in Kenya, life expectancy among the males in all counties is expected to increase though at a varying rate. Life expectancy at birth is projected to be highest in Isiolo County. The findings agree with those of KNBS (2012) which established that Isiolo County has the highest life expectancy. Siaya County is projected to have the lowest life expectancy at birth. All counties are expected to maintain their county ranking in terms of  $e(0)$  in 2030 if HIV/AIDS had no role to play in population

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dynamics. Throughout the projection period, male  $e(0)$  is expected to be highest in counties in former Eastern, Nairobi and Central provinces and lowest in counties in former, Nyanza, North Eastern and Western Provinces some of which

have high prevalence of HIV. The findings point that; there could be a possible link between life expectancy at birth among males in each county and HIV prevalence.

**Table1.** Projected Non HIV/AIDS  $e(0)$  per Province and County

	Projected Non HIV/AIDS $e(0)$ among the males		Projected Non HIV/AIDS $e(0)$ among the females	
	Base year $e(0)$	Projected $e(0)$	Base year $e(0)$	Projected $e(0)$
	2009	2030	2009	2030
Nairobi	62	67	63	70
<b>CENTRAL</b>	<b>61</b>	<b>66</b>	62	70
Kiambu	63	67	64	71
Kirinyaga	61	66	64	71
Muranga	60	65	62	70
Nyandarua	60	65	60	68
Nyeri	60	65	60	68
<b>COAST</b>	<b>56</b>	<b>62</b>	55	65
Kilifi	57	63	62	70
Tana River	56	62	56	66
Kwale	58	64	56	66
lamu	58	64	53	64
Mombasa	57	63	56	66
TaitaTaveta	53	60	51	63
<b>EASTERN</b>	62	67	67	73
Embu	59	64	65	71
Isiolo	65	69	70	75
Kitui	65	69	68	73
Makueni	65	69	69	74
Machakos	62	67	69	74
Marsabit	65	69	64	71
Meru	62	67	66	72
TharakaNithi	60	65	64	71
<b>NORTH EASTERN</b>	49	57	53	64
Garisa	56	62	65	71
Mandera	51	58	55	65
Wajir	42	51	44	58
<b>NYANZA</b>	<b>49</b>	<b>57</b>	54	65
Homabay	47	55	55	65
Kisii	57	63	59	68
Kisumu	48	56	51	63
Migori	50	57	54	65
Nyamira	58	64	60	68
Siaya	39	49	46	59
<b>RIFT VALLEY</b>	<b>57</b>	<b>63</b>	61	69
Baringo	54	60	59	68
Bomet	55	61	61	69
Kajiado	60	65	64	71
ElgeyoMarakwet	57	63	62	70
Kericho	54	60	59	68
Laikipia	53	60	57	66
Nakuru	52	59	55	65
Nandi	56	62	57	66
Narok	61	66	67	73
Samburu	54	60	65	71
Trans Nzoia	55	61	59	68
Turkana	50	57	55	65
UasinGishu	54	60	57	66

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West Pokot	54	60	64	71
<b>WESTERN</b>	<b>52</b>	<b>59</b>	54	65
Bungoma	57	63	58	67
Busia	51	58	54	65
Kakamega	53	60	55	65
Vihiga	49	57	49	61

*Source: Analysis of the 2009 KPHC*

Among the females, the findings indicated that; if there was no HIV and AIDS in Kenya, then by 2030, life expectancy at birth would be highest in Isiolo County. This is to be expected since according to the 2009 KPHC, Isiolo County has the highest  $e(0)$ . Wajir County is projected to record the lowest  $e(0)$ . This clearly indicates that huge disparities in life expectation at birth by counties among the female population in Kenya will continue to persist throughout the projection period. This scenario indicates that, there is huge disparity in access to health care across the counties. Just as it is with males  $e(0)$ , counties in the former Eastern province have remarkable high female  $e(0)$ .

### Mortality Projections under both HIV/AIDS and Interventions Scenarios

In populations where HIV prevalence is more than 1%, the United Nations recommend that mortality projections should incorporate the effect of HIV/AIDS (Shryock and Siegel, 2004). Consequently, the non HIV expectations of life presented in Table 1 are subjected to the prevailing county level HIV prevalence rates. Then a set of age specific parameters are applied to infect HIV negative people thus transitioning them to HIV positive category as soon as possible. The approach is presented in equation 2 and 3. To establish the effect of HIV related program interventions on future county level mortality patterns, the level of phase in of these interventions is included. The analysis is done using the ASSA2008 demographic model (Dorrington et al., 2010). The results of the analysis are presented in Table 2.

**Table 2.** County Mortality Projections under both HIV/AIDS and interventions scenario.

PROJECTED $e_0$ in 2030 incorporating HIV/AIDS					Projected $e_0$ in 2030 incorporating HIV/AIDS and effect of program intervention					
	a	b	c	d		e	f	g	h	i(f-b)
S/N	County	$e_0$ all	$e_0$ male	$e_0$ female	S/N	County	$e_0$ all	$e_0$ male	$e_0$ female	
1	Nairobi	62.2	61.7	62.7	1	Nairobi	66.1	64.9	67.4	3.9
2	Nyeri	57.9	58.0	57.8	2	Nyeri	65.4	64.3	66.5	7.5
3	Nyandarua	57.5	57.6	57.3	3	Nyandarua	65.2	64.2	66.3	7.7
4	Kiambu	60.6	60.3	60.8	4	Kiambu	65.9	64.7	67.1	5.3
5	Muranga	58.9	58.9	59.0	5	Muranga	65.3	64.2	66.4	6.3
6	Kirinyaga	57.1	57.3	56.9	6	Kirinyaga	64.7	63.7	65.8	7.7
7	Mombasa	58.9	58.9	59.0	7	Mombasa	65.6	64.5	66.7	6.6
8	Kwale	57.3	57.5	57.2	8	Kwale	65.4	64.3	66.5	8.0
9	Kilifi	59.4	59.3	59.5	9	Kilifi	65.7	64.6	66.8	6.3
10	Tana River	54.1	54.6	53.6	10	Tana River	64.4	63.6	65.3	10.4
11	Lamu	51.9	52.6	51.2	11	Lamu	63.2	62.6	63.9	11.3
12	TaitaTaveta	57.5	57.7	57.4	12	TaitaTaveta	64.5	63.7	65.4	7.0
13	Marsabit	57.4	57.5	57.2	13	Marsabit	64.6	63.7	65.5	7.3
14	Isiolo	55.2	55.6	54.8	14	Isiolo	63.7	63.0	64.5	8.5
15	Meru	61.8	61.4	62.3	15	Meru	65.8	64.6	67.0	4.0
16	TharakaNithi	58.4	58.4	58.3	16	TharakaNithi	62.9	61.7	64.2	4.6
17	Embu	59.4	59.3	59.5	17	Embu	65.1	64.1	66.1	5.7
18	Kitui	61.2	60.8	61.5	18	Kitui	65.6	64.5	66.8	4.5
19	Machakos	61.4	61.0	61.8	19	Machakos	65.7	64.5	66.8	4.3
20	Makueni	60.8	60.5	61.1	20	Makueni	65.6	64.5	66.7	4.7
21	Garisa	59.9	59.7	60.0	21	Garisa	64.1	63.3	65.0	4.3
22	Wajir	57.7	57.8	57.6	22	Wajir	64.2	63.4	65.1	6.5
23	Mandera	61.2	60.9	61.6	23	Mandera	64.7	63.8	65.7	3.5
24	Siaya	58.2	58.2	58.2	24	Siaya	64.5	63.6	65.4	6.3
25	Kisumu	58.6	58.6	58.7	25	Kisumu	64.7	63.7	65.6	6.0
26	Homabay	58.4	58.4	58.5	26	Homabay	64.6	63.7	65.6	6.2

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27	Migori	58.2	58.2	58.2	27	Migori	64.6	63.6	65.5	6.3
28	Kisii	59.3	59.2	59.4	28	Kisii	64.9	63.9	65.9	5.5
29	Nyamira	57.2	57.3	57.0	29	Nyamira	64.1	63.3	65.0	6.9
30	Kakamega	60.4	60.1	60.7	30	Kakamega	65.2	64.1	66.3	4.8
31	Vihiga	57.1	57.3	56.9	31	Vihiga	64.0	63.2	64.9	6.9
32	Bungoma	59.9	59.7	60.1	32	Bungoma	65.0	64.0	66.1	5.2
33	Busia	57.8	57.9	57.7	33	Busia	64.4	63.5	65.3	6.6
34	Turkana	58.4	58.5	58.4	34	Turkana	64.6	63.6	65.5	6.1
35	West Pokot	56.6	56.8	56.4	35	West Pokot	63.9	63.1	64.7	7.3
36	Samburu	53.4	53.9	52.8	36	Samburu	62.5	61.9	63.1	9.1
37	Tranzoia	58.3	58.4	58.3	37	Tranzoia	64.5	63.6	65.4	6.2
38	Baringo	57.0	57.2	56.8	38	Baringo	64.0	63.2	64.9	7.0
39	UasinGichu	58.5	58.5	58.6	39	UasinGichu	64.6	63.7	65.5	6.1
40	ElgeyoMarakwet	55.7	56.1	55.4	40	ElgeyoMarakwet	63.4	62.7	64.2	7.7
41	Nandi	57.9	58.0	57.8	41	Nandi	64.4	63.5	65.3	6.5
42	Laikipia	56.0	56.3	55.7	42	Laikipia	63.6	62.8	64.3	7.5
43	Nakuru	60.5	60.2	60.7	43	Nakuru	65.2	64.1	66.2	4.7
44	Narok	58.3	58.3	58.2	44	Narok	64.5	63.6	65.5	6.3
45	Kajiado	57.9	57.9	57.8	45	Kajiado	64.3	63.4	65.2	6.4
46	Kericho	58.0	58.1	57.9	46	Kericho	64.3	63.4	65.2	6.3
47	Bomet	57.9	58.0	57.8	47	Bomet	64.4	63.5	65.3	6.4

Source: Analysis of the 2009 KPHC data and 2014 KDHS data

The results indicate that except in the counties of Mandera, Wajir, Kisumu, Migori and Siaya, life expectancy at birth is projected to be consistently higher in the no HIV scenario than in the HIV/AIDS scenario. This implies that HIV/AIDS epidemic is playing a crucial role in influencing the mortality rates at the county level in Kenya. Among the males, when HIV/AIDS is incorporated in mortality projections, life expectancy at birth in Isiolo County is projected to be 13 years less in a HIV scenario than in no HIV/AIDS scenario by 2030 which implies that HIV/AIDS will lead to 13 years loss of life. Marsabit and Lamu Counties although they have low HIV prevalence take position two and three respectively as far as impact of HIV/AIDS is concerned in terms of affecting mortality at counties. Marsabit County by 2030 is projected to live 11 years less if the current HIV/AIDS prevalence rates were to continue than he would have lived if there was no HIV/AIDS. Similarly, a male child in 2030 at Lamu county is likely to live 10 years less if the current HIV prevalence were to prevail than he would have lived if there was no HIV/AIDS in the county. Surprisingly, all counties in former Western province except Bungoma would experience no change in life expectancy even after incorporating HIV prevalence in mortality projections. In addition, it is worthwhile to note that life expectancy at birth among males is projected to be higher in HIV/AIDS scenario than in no HIV/AIDS scenario in all counties in Luo Nyanza including Homabay county which has the highest reported

HIV prevalence rate. This scenario could be attributed to the high uptake PMTCT services and high uptake of high antenatal HIV test uptake (Kohler P.K et.al., 2014).

Among the females, life expectancy at birth is projected to be consistently higher in no aids scenario than it would be in a HIV/ AIDS scenario in all the counties except in Wajir County. The greatest effect of HIV/AIDS is projected to be witnessed in the counties characterised by high HIV prevalence and relatively low access to healthcare. Included in this list are the counties of Isiolo, Samburu, West Pokot, ElgeyoMarakwet, Lamu, Marsabit, TharakaNithi, and Kajiando. A female child born in Isiolo County is projected to live 20 years less that she would have lived if there was no HIV/AIDS. HIV/AIDS is projected not to have any effect on life expectancy at birth in Wajir County perhaps because the county has low HIV prevalence.

When HIV/AIDS interventions are introduced in mortality projections, the results indicated that, HIV and AIDS related programs are effective in reducing mortality levels at sub national level in Kenya. Life expectancy at birth will be consistently higher in "HIV/AIDS and intervention scenario" than in a "HIV/AIDS only scenario" for both males and females across all the counties. However, the effectiveness of these interventions varies considerably by counties and by gender. Among the males for example, in presence of government interventions at county level, a

child born in LamuCounty in 2030 is projected to live 10 years more than he would have lived if such interventions were not put in place. Similarly, among the females, a child born in LamuCounty in 2030 would be expected to live approximately 13 years more than she would have lived if the current HIV/AIDS prevalence were to continue. Generally, the effect of interventions on life expectancy tend to be more profound in those counties which are rather marginalized and less profound in counties with good infrastructure and low HIV prevalence. This is to be expected since marginalised counties lack good infrastructure, have low development index, high poverty levels and high illiterate rates. These factors suppress high uptake of AIDS interventions. As the HIV and AIDS interventions become widespread in these counties due to adoption of devolved system of governance, it is expected that the affected counties will experience tremendous increase in life expectancy as a result of behaviour change.

### CONCLUSIONS AND POLICY IMPLICATIONS

The findings of this study revealed that HIV and AIDS related program interventions will continue to shape future mortality patterns in Kenya. If there was no HIV and AIDS in Kenya, life expectancy would continue to increase over the years. When HIV and AIDS were incorporated in mortality projections, the finding revealed that HIV/AIDS will lead to substantial reduction in life expectancy across all the counties. However, the effect of HIV/AIDS on mortality varied across the counties of Kenya depending on HIV prevalence and the level of socio economic development. The impact of HIV and AIDS tend to be more pronounced in counties with high HIV prevalence and low socio economic development. When HIV and AIDS related interventions were included in mortality projections, the findings revealed that, the interventions are indeed effective in controlling mortality patterns in Kenya. However, effectiveness of the HIV related programs in controlling mortality in Kenya varied across the counties. Based on the findings of this study, it is recommended that future projections of mortality in Kenya should incorporate uptake of HIV related programs since the study established that they play a crucial role in mortality levels.

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