Survival Analysis approach in evaluating the efficacy of ARV treatment in HIV patients at the Dr GM Hospital in Tshwane, GP of S. Africa

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Background

- Survival analysis is aimed at estimating the probability of survival, relapse or death that occurs over time
- Relevant in clinical studies evaluating the efficacy of treatments in humans or animals
- Commonly deals with rates of mortality and morbidity

Problem statement

- The efficacy of ARV treatment at Dr G Mukhari hospital is favourable, but not clear as to the extend they are helpful to patients

- Survival analysis, a scientific statistical tool is conducted to-

  -model ARV treatment efficacy in HIV patients

  -confirm the association between survival or not of patients after ARV treatment

Data Analysis

- 2007-2011 raw data
- 318 HIV/AIDS cases
- 24 variables selected
- STATA (12), SAS (9.2) & SPSS(21)

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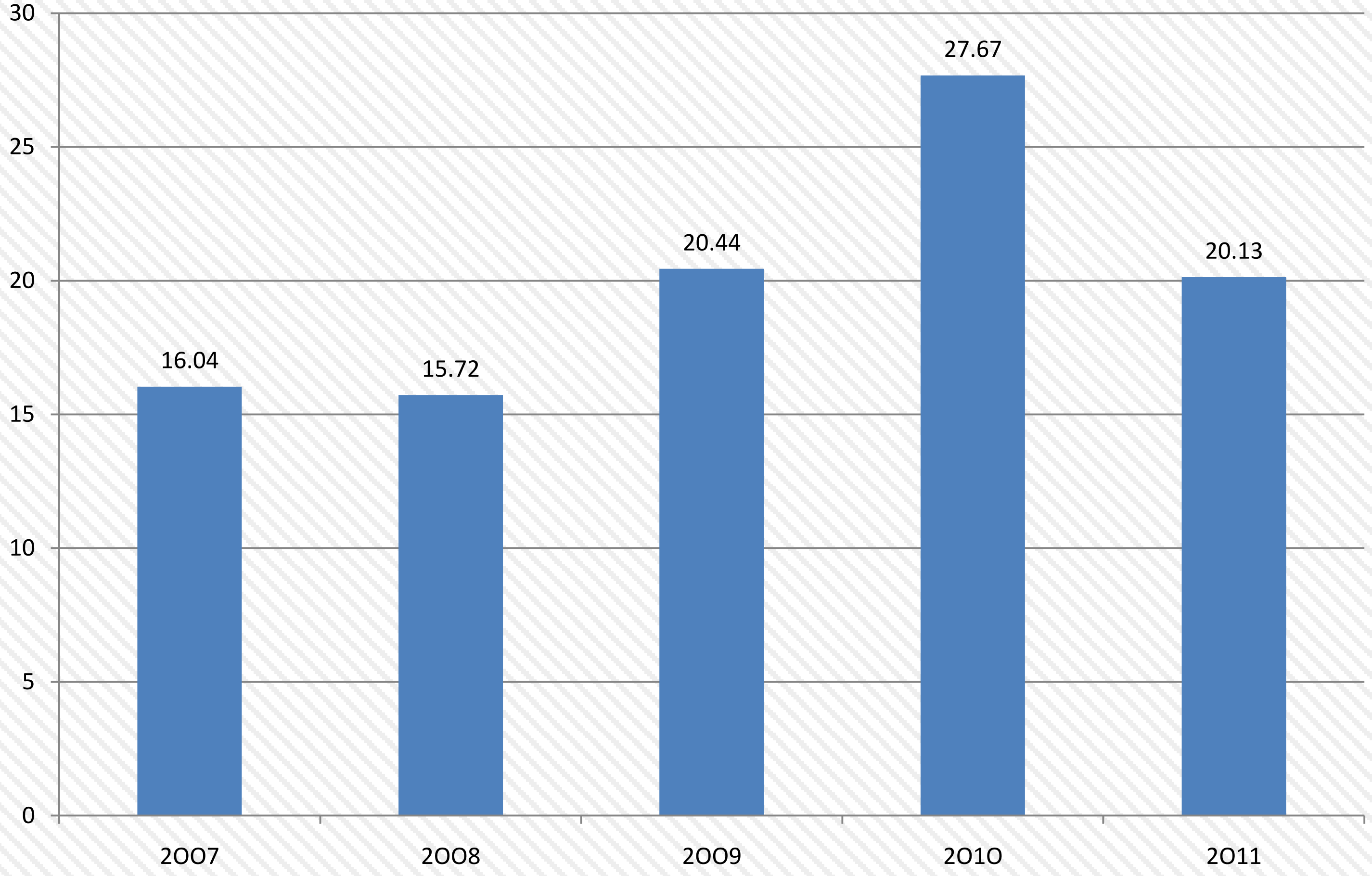
Year



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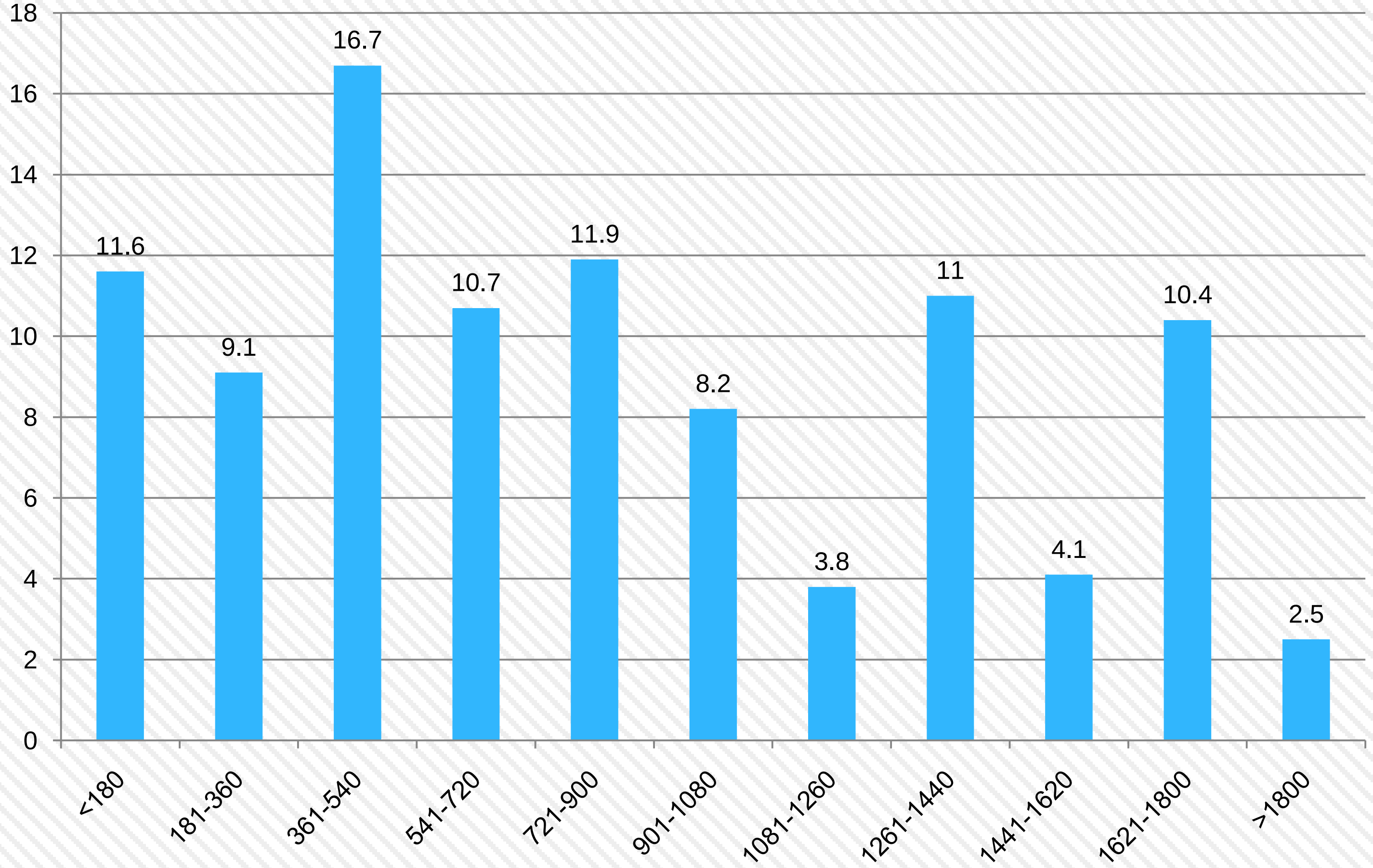
No. of days on ARV



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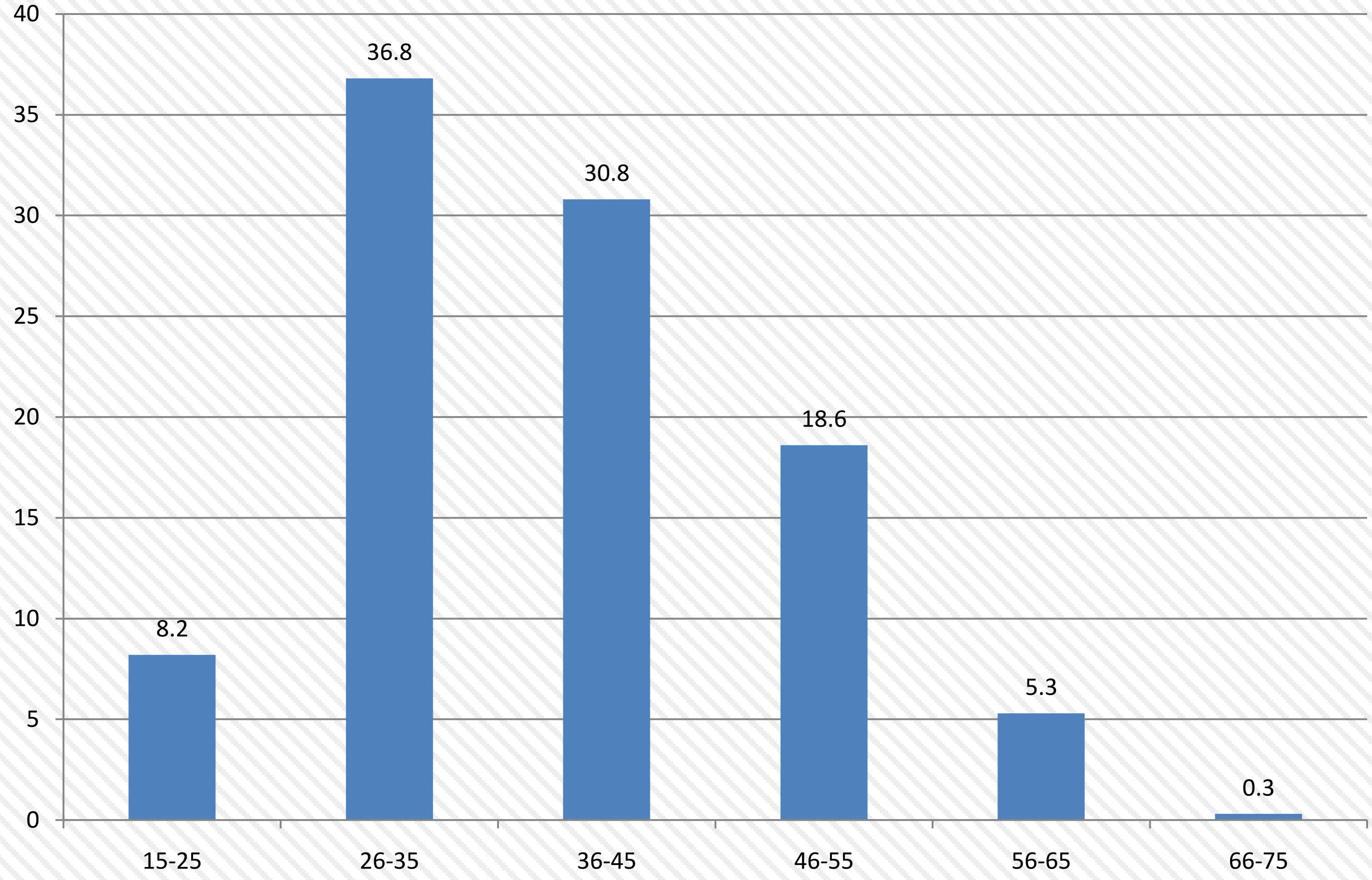
Age (Years)



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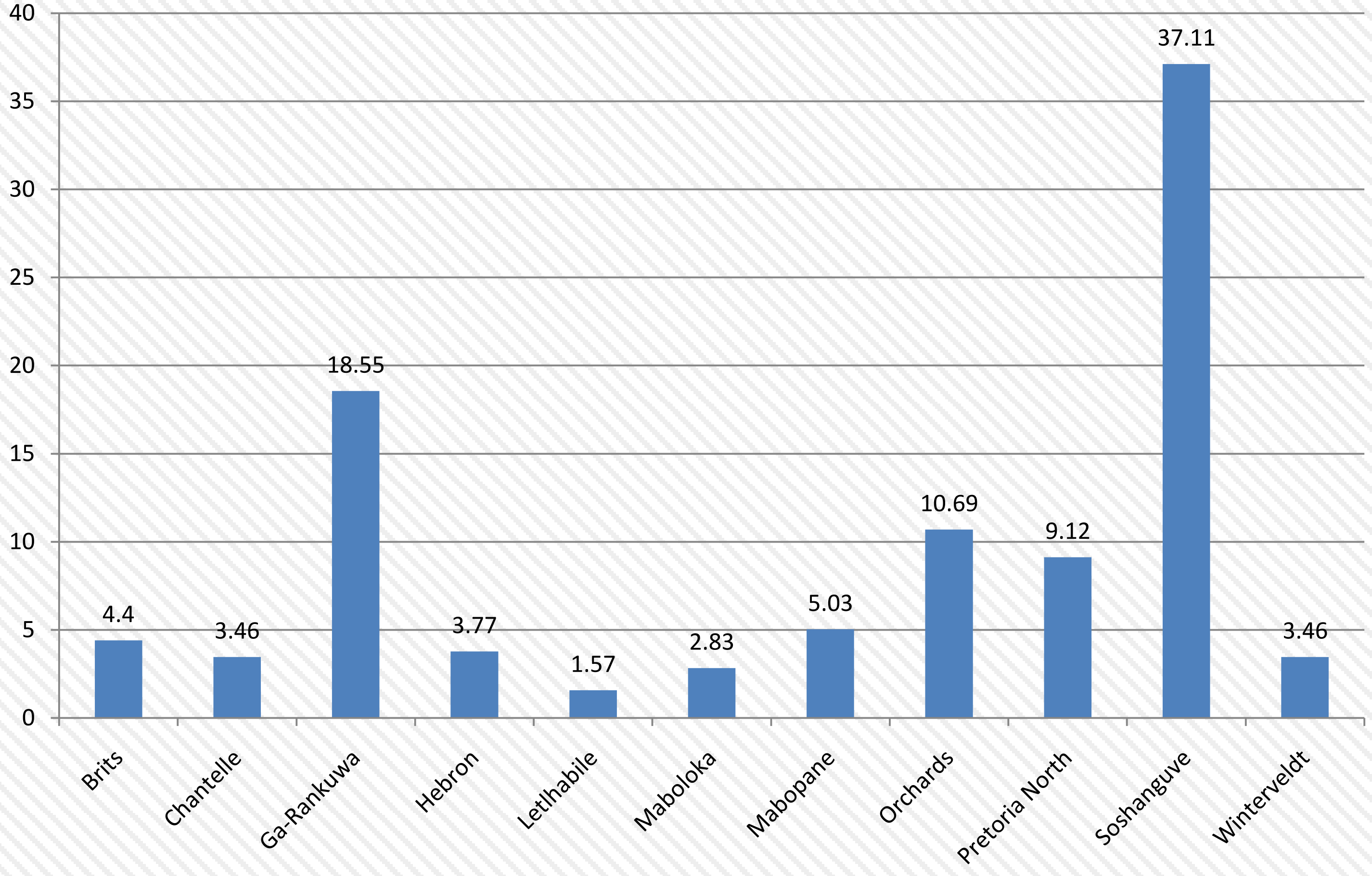
Residential Area



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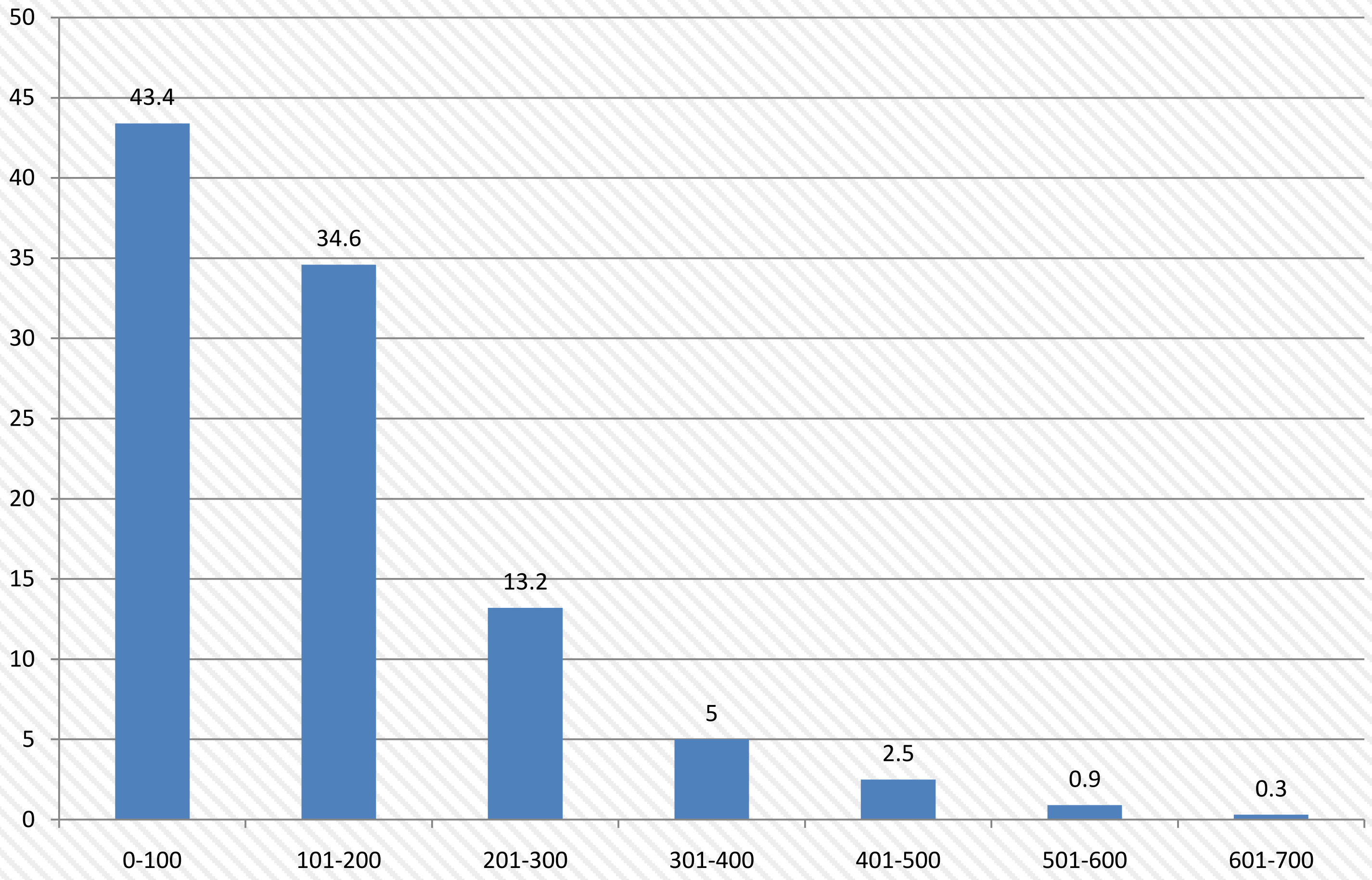
CD4 Count



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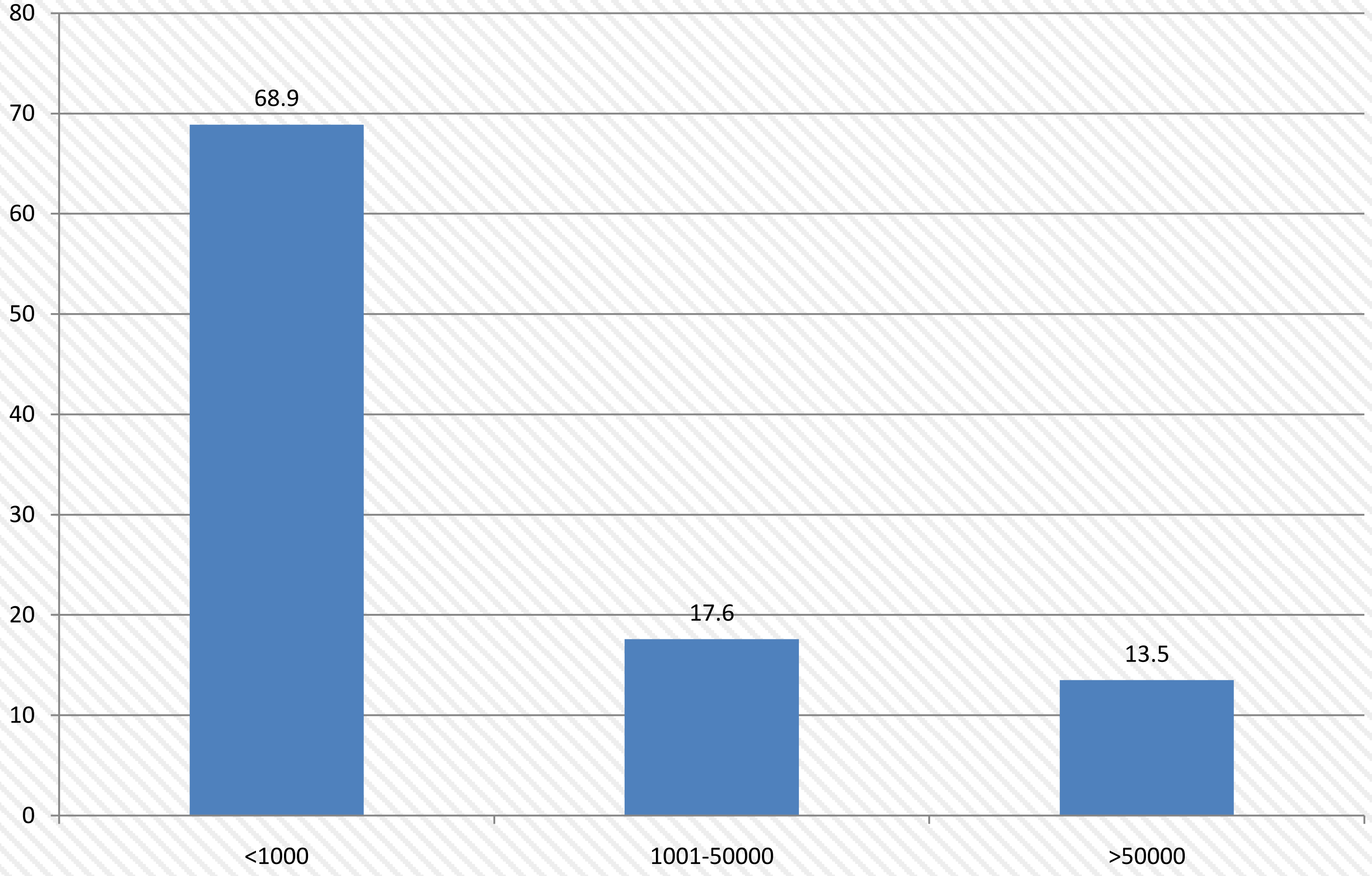
Viral Load



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Survival function

- Used to describe the time-to-event concept for all patients.
- This is the probability of an individual to survive beyond time "*x*"and is defined as :

$$S(x) = P(X > x)$$

- Is a non-increasing function with a value of 1 at the origin and *0* at infinity.
- This is the case here with 1 at four days (4) and zero at the end of (1781) days, meaning that there is conformity with the survival function.

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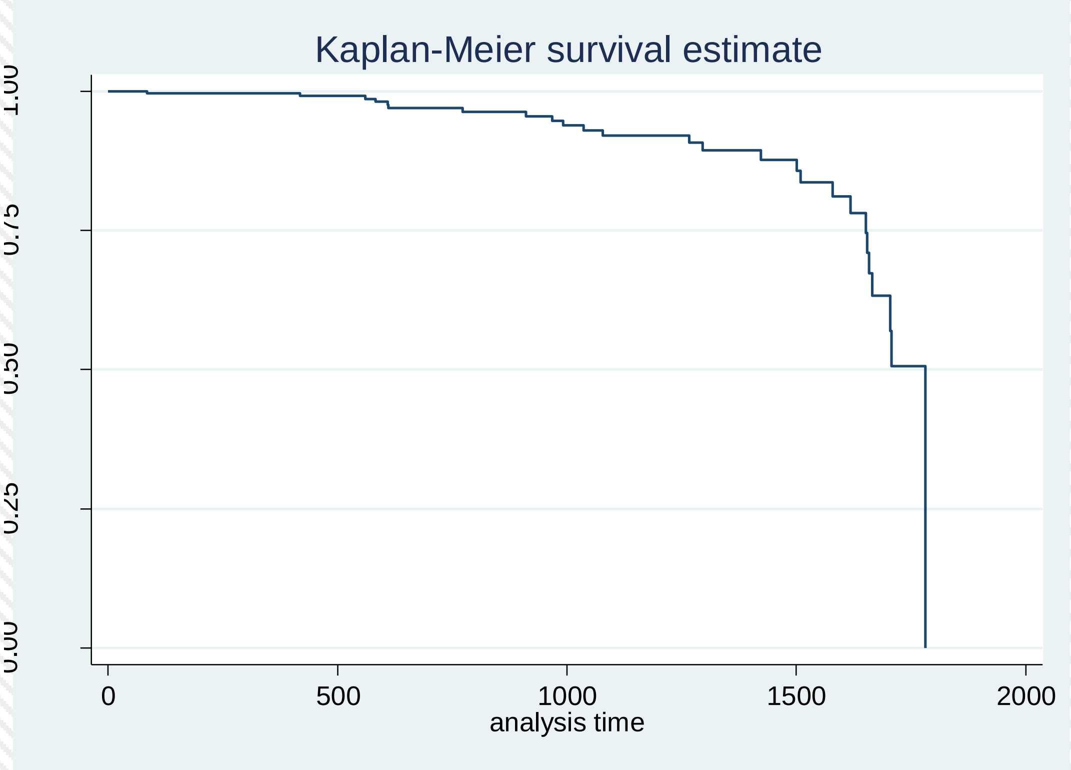
Kaplan-Meier Estimate



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Kaplan-Meier estimate (cont)

- It is an estimator of the survival function- also called the product limit estimator
- It is a function of the probability of survival plotted against time
- In the *ith* interval, the probability of death can be estimated by: $\frac{d_1}{n_1}$

Kaplan-Meier (cont)

- The estimated survival probability is:

$$\hat{S}(t) = \pi \left(\frac{n_1 - d_1}{n_1} \right)$$

Where,

- *"d"* = number of deaths observed at time "*t*"
- "n"=the number of patients at risk

Kaplan-Meier (cont)

- All patients were alive at time *t=o*
- They remained so until the first patient died after four (4) days.
- The estimate of the probability of surviving at zero is *1.0*
- *The estimate of the survival function is thus:* $\hat{S}(t) = 1.0$

  at t=o

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The log-rank test

Log-rank test for equality of survivor functions

```
      |   Events         Events
group |  observed       expected
------+-------------------------
0     |         0          20.09
1     |        26           5.91
------+-------------------------
Total |        26          26.00

            chi2(1) =     105.26
            Pr>chi2 =     0.0000
```

The log-rank test (cont)

- The observed values are different from the expected values
- Produce a highly significant chi-squared value ($P < 0.05$).
- The null hypothesis is rejected at the 5% level of significance
- Survivor functions of the two groups are not the same.

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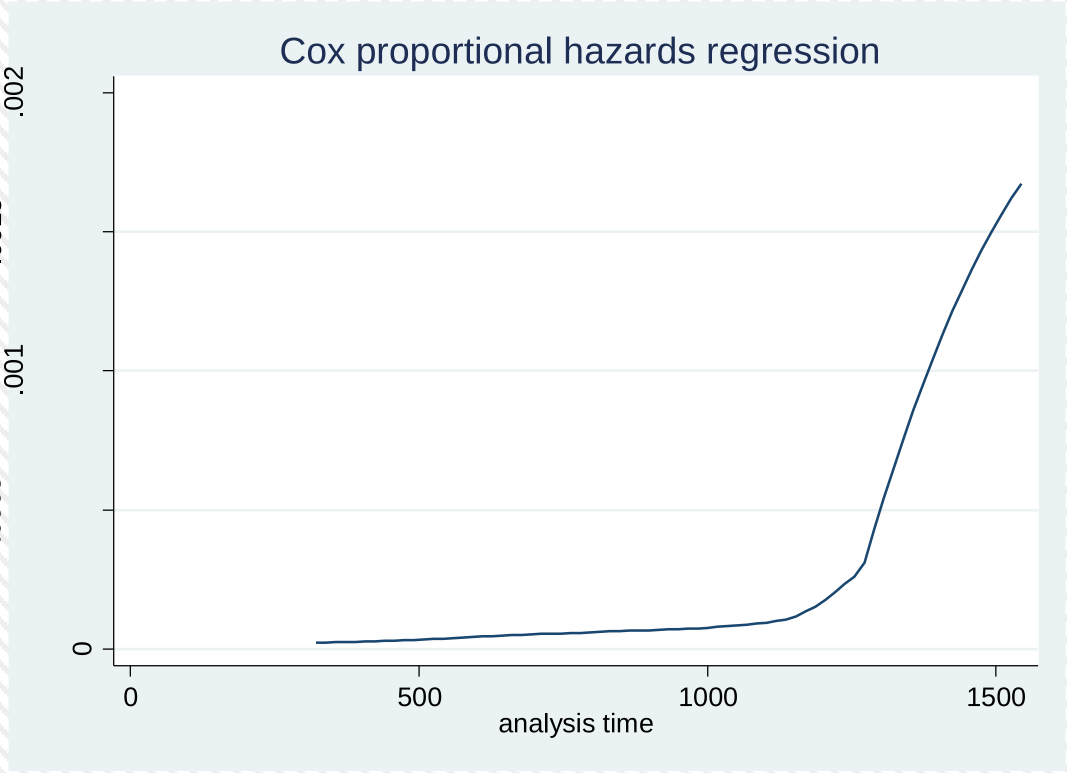
Hazard function



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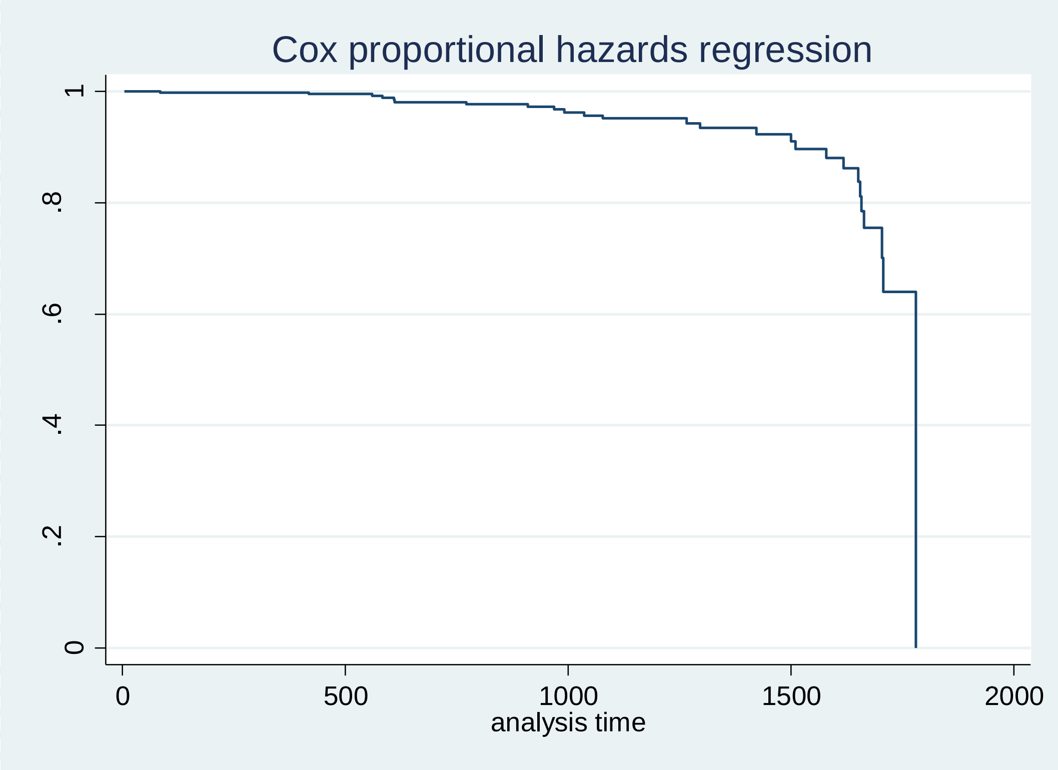
Hazard function

- It is the proportion of subjects dying or failing in an interval per unit of time
- As days pass, the number of patients dying also increases
- It is an increasing function as opposed to the non-increasing function of the Kaplan-Meier survival estimate.

Cox survival curve



Cox survival curve

- The graph of the estimated baseline survivor function
- The Cox approach is the most widely used regression model in survival analysis
- The probability of survival is 1 at time $t=0$
- Drops to “0” as the number of days elapses to maximum of 1781.

Cox regression model

```
No. of subjects =          312                   Number of obs   =        312
No. of failures =           26
Time at risk    =       249675
                                                 LR chi2(7)      =      13.54
Log likelihood  =   -96.694567                   Prob > chi2     =     0.0599

------------------------------------------------------------------------------
          _t | Haz. Ratio   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     gender2 |   .6791803   .2879292    -0.91   0.361     .2958897    1.558979
         age |   1.032749   .0259595     1.28   0.200     .9831025    1.084903
    marital2 |   .3615232   .1486429    -2.47   0.013     .1614947    .8093083
  education2 |   1.084283   .0966501     0.91   0.364     .9104767    1.291268
   township2 |   .8435348   .0977518    -1.47   0.142     .6721447    1.058628
         cd4 |   .9987908   .0023613    -0.51   0.609     .9941735     1.00343
       viral |          1   5.54e-08    -0.20   0.845     .9999999           1
------------------------------------------------------------------------------
```

Cox reg.model (cont)

- It asserts that the hazard rate for the *ith* subject in the data is

$$h(t \mid x_i) = h_0(t)\exp(x_i \beta_x)$$

- The model is thus:

$$h(t \mid ARV) = h_o(t)\exp(0.67gender + 1.03age + 0.36marriage + 1.08edu + 0.84township + 0.99cd4 + viral)$$

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Cox reg.model (cont)

- Since P> 0.05 for gender, age, education, township, cd4 count and viral load,
- No significant statistical difference amongst these variables with regard to the predictor variable, days ARV.

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Conclusion

- 92%(292/318) were alive after ARV treatment as compared to 8%(26/318) that died
- At the 5% level of significance, significant hazard ratios were characterised by hazard ratios that are significantly different from “1”, and 95% confidence interval (CI)

- ARV had a significant statistical impact on AIDS patients’ survival
- Overall mortality rates have decreased

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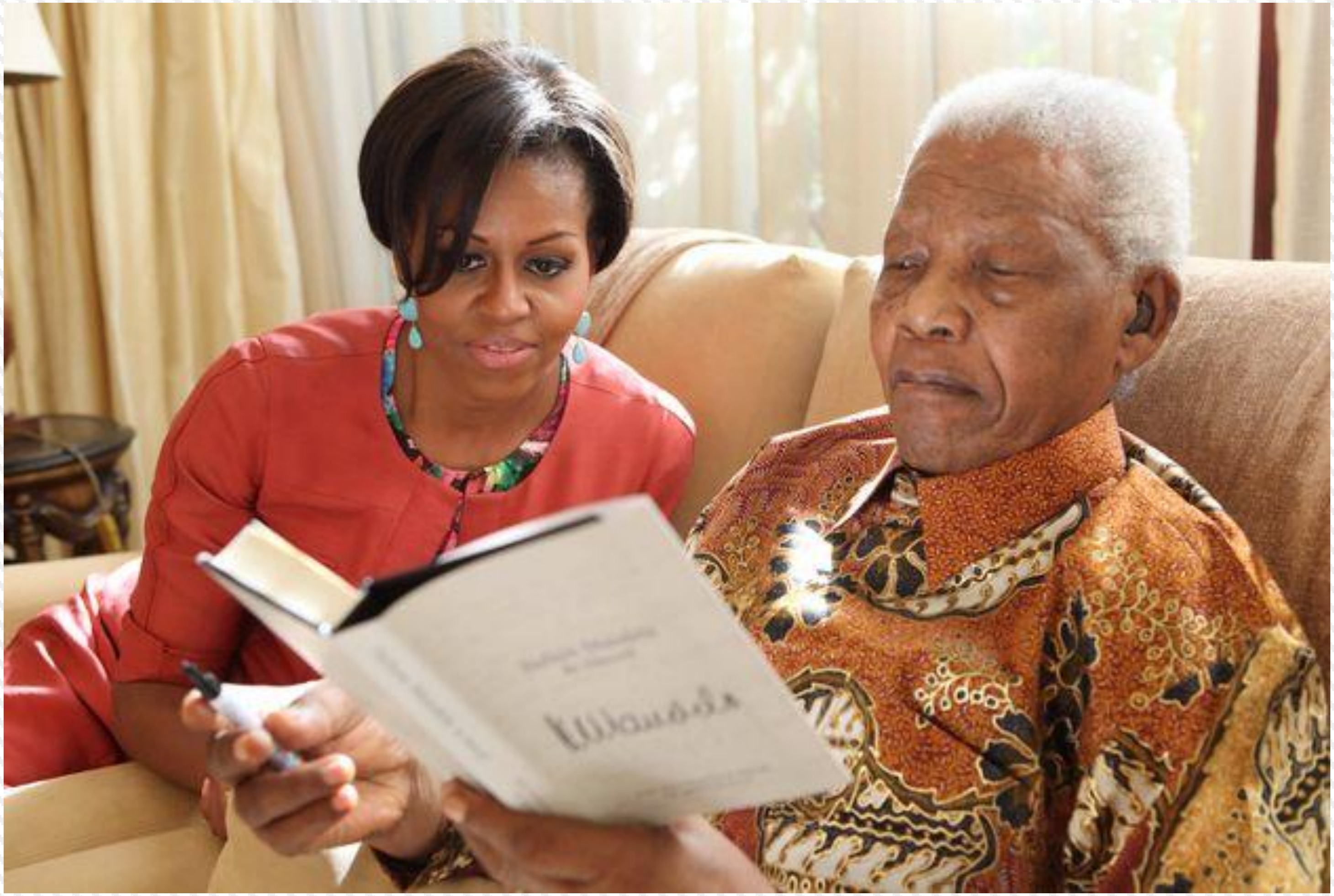
IN MEMORY

Mrs Obama



FINALLY

THANK YOU

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