Cancer survival analysis using population-based data

Granada, 27-28 March 2017

Age-standardised Net Survival
&
Cohort and Period Net Survival Estimates

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PART ONE
ASNS

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Outline

1. Age-standardised Net Survival.

2. Cohort and Period Estimation of Age-standardised Net Survival.

3. Practical implementation.

Introduction

1. **Net Survival** deals with Competing Risk.
2. Different estimators, but
3. **Pohar Perme estimator deals with censoring (IPCW): because the probability of death is increased for the majority of cancer sites during the first years of follow-up.**
4. **OK, great. But …**
5. The **excess risk of death** from cancer is itself often **dependent from the structure of AGE of the Background POPULATION**.

Why Age-Standardised Net Survival?

So, the Comparison of **all-ages survival** between **two or more populations** (regions or countries), or when analysing survival **trends over time** can be **misleading** if the **age structure** of the cancer patient populations is very **different**.

Imaging a Net Survival comparison between **JAPAN** and **GUATEMALA**

We need to control for the different **STRUCTURE OF AGE** when comparing Net Survival between populations

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What can we do about it?

1. Compare **age-specific survival** (not convenient if there are too many strata)

2. **Direct age-standardisation**

is one such approach (a classic in 101-Epi)

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Direct age-standardisation

Produces an **overall summary measure** for each population whilst **removing the effect of differences in age structure** of cancer patients that may compromise the **comparison of un-standardised survival**

Constraints of the direct age standardisation method

1. Requires estimation of **Net Survival for each age group**

2. Requires at least **one patient at risk within each age group** for each time interval of follow-up, unless all patients died before the end of the study

3. May not be feasible when data are sparse

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Interpretation

1. Age-standardised survival **does not reflect** the actual experience of the population being examined.

2. **It is an artificial (hypothetical) survival** estimate that allow comparisons across populations while “adjusting” for age.

3. It is **interpretable as** the overall survival that would have occurred if the age distribution of the patient group under study had been the same as that of the standard population.

4. Age-standardised survival estimates should be compared to each other **only if they have been calculated using the same reference population**.

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Examples of (external) standard cancer patient populations

3. International cancer survival standard (ICSS)

Recommended standard population

3 standards for 3 types of cancer derived from the EUROCARE-2 dataset

- **Type 1:** increasing with age (91% of cases)
- **Type 2:** constant with age (7% of cases)
- **Type 3:** mainly young adults (<2%)
    - Minimise difference between raw and standardised
    - Smallest number of standards
    - Not arbitrary (specific to one study)
    - Males and females combined

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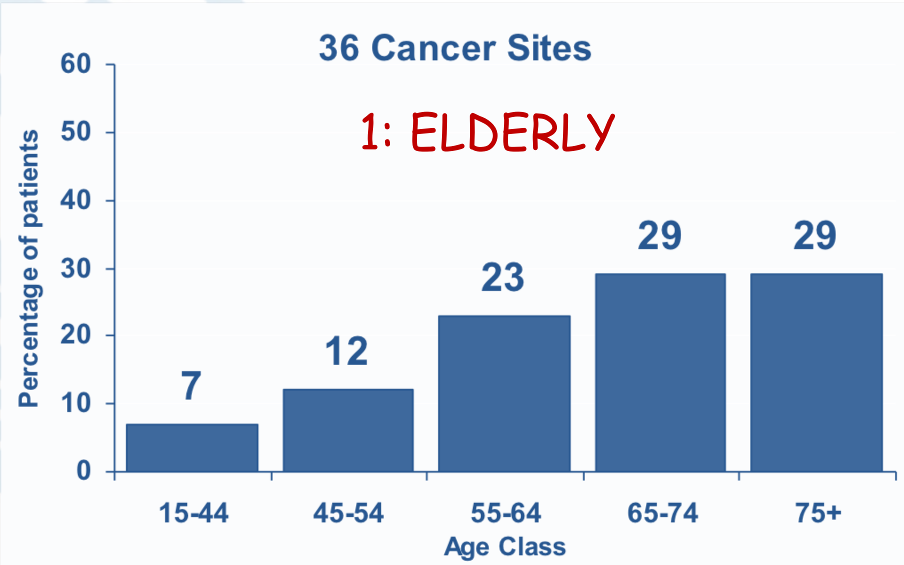
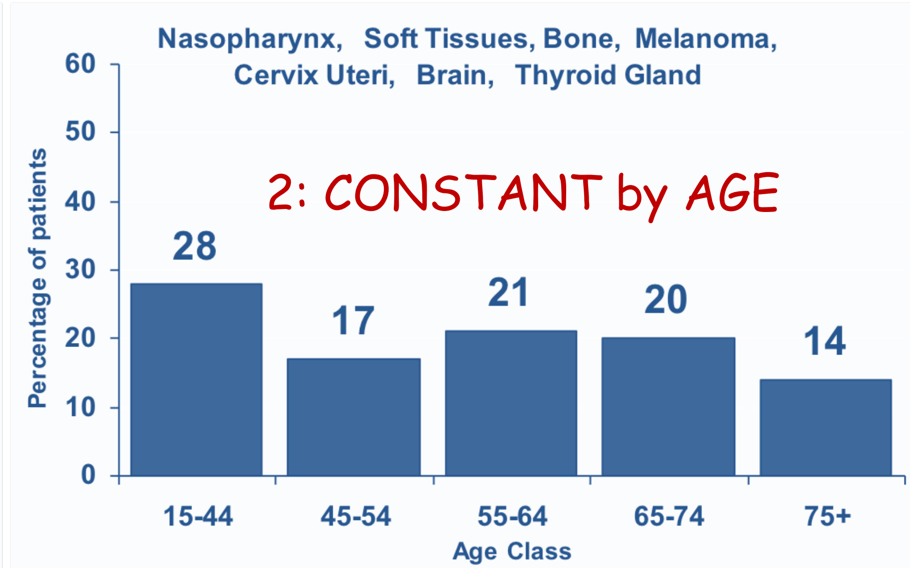
Corazziari et al., 2004

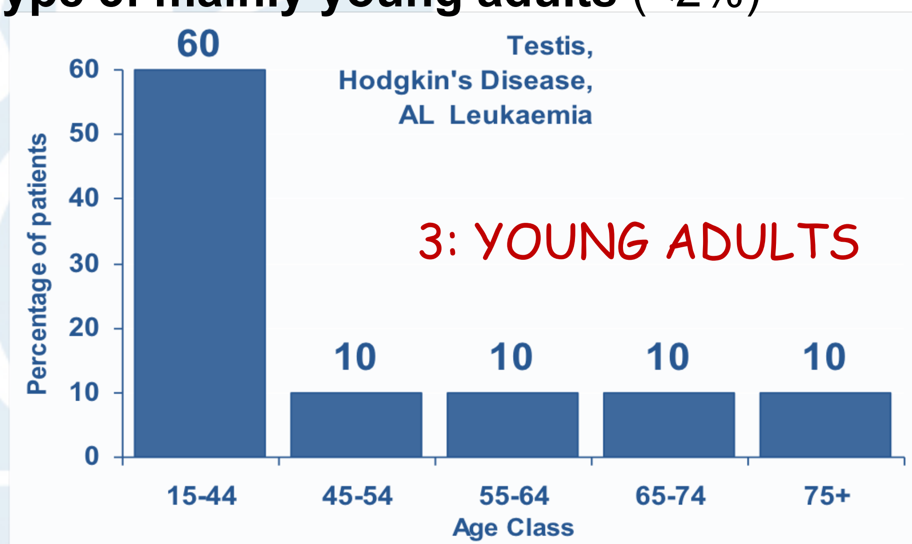
Type 1: increasing with age (91% of cases)



Type 2: constant with age (7% of cases)



Type 3: mainly young adults (<2%)



From Corazziari et al., 2004

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Calculation: age-standardised survival

1. Estimate **age-specific Net Survival** for each age-group

2. Combine these estimates in a **weighted average**

Age-standardised Net survival (AS) $= S_1.w_1 + S_2.w_2 + ... + S_n.w_n =$

$$= \sum_{i=1}^{n} S_{i.} w_i$$

Sum weights: $w_1+w_2+...w_n=1$

where

S_i = Net survival estimate for age group i

w_i = proportion of patients in age group i in the standard population

Calculation: standard error for age-standardised survival

$$SE(AS) = \sqrt{\sum_{i=1}^{n} w^2{}_i \cdot SE(S_i)^2}$$

where,

$SE(S_i)$= standard error for the survival estimate in age group i

w_i = proportion of patients in age group i in the standard population

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Example: Age-standardised cancer survival (salivary gland cancer)

Unstandardised Survival Estimates at 5 years:

	1971-75	1976-80	1981-85	1986-90
All ages	67.3	63.1	60.7	58.6

ICSS Population Standard

Age Group	weight	proportion
15-44	7	0.07
45-54	12	0.12
55-64	23	0.23
65-74	29	0.29
75+	29	0.29
All ages	100	1.00

Age Specific Survival Estimates at 5 years:

Age Group	1971-75	1976-80	1981-85	1986-90
15-44	91.3	86.8	84.4	84.7
45-54	72.1	76.8	65.1	67.3
55-64	61.9	55.6	57.9	51.2
65-74	45.8	53.4	48.7	51.4
75+	29.2	33.9	37.7	32.3

Using other standards

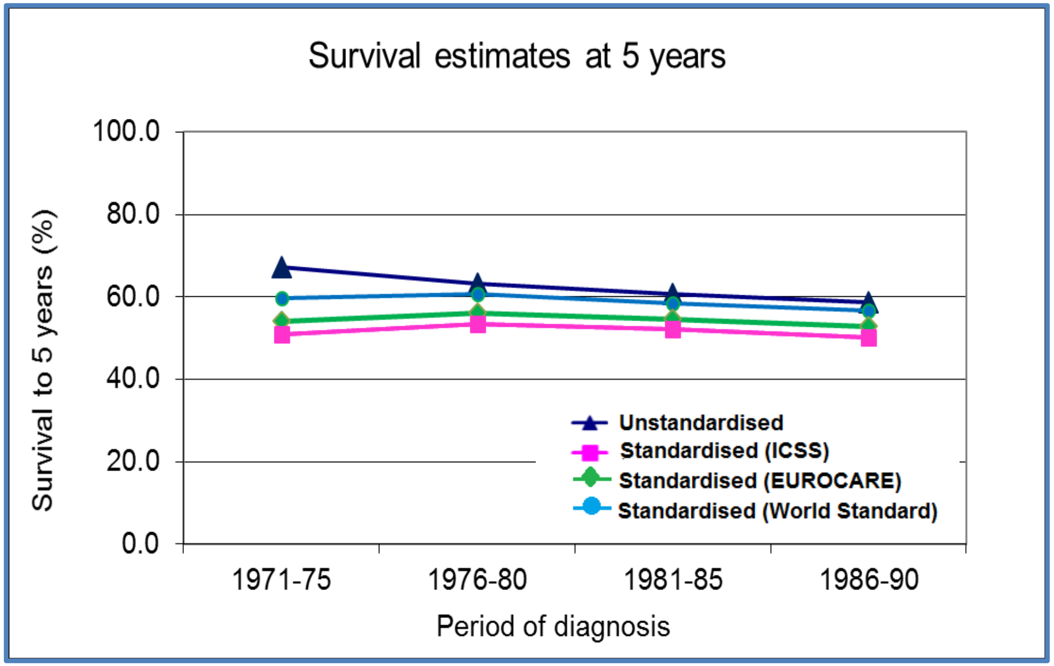
	EUROCARE		World Standard	
Age Group	weight	proportion	weight	proportion
15-44	515	0.15	18.7	0.19
45-54	452	0.13	19.1	0.19
55-64	674	0.19	23.1	0.23
65-74	905	0.26	18.9	0.19
75+	992	0.28	20.2	0.20
All ages	3539	1	100	1.0

Standardised Survival Estimates at 5 years

Age Group	1971-75	1976-80	1981-85	1986-90
15-44	6.4	6.1	5.9	5.9
45-54	8.6	9.2	7.8	8.1
55-64	14.2	12.8	13.3	11.8
65-74	13.3	15.5	14.1	14.9
75+	8.5	9.8	10.9	9.4
Age standardised	51.0	53.4	52.1	50.1

51.0=6.4+8.6+14.2+13.3+8.5

5.9 = 84.7*0.07
8.1 = 67.3*0.12
11.8 = 51.2*0.23
14.9 = 51.4*0.29
9.4 = 32.3*0.29



Calculation: 95% confidence interval for age standardised survival

$$\text{Lower Limit} = AS / \exp[1.96 * SE(AS) / AS]$$

$$\text{Upper limit} = AS * \exp[1.96 * SE(AS) / AS]$$

Based on a logarithmic transformation of the survival function and the **DELTA METHOD**

Remember: H(t) = -ln(S(t)) ==> exp(-H(t)) = S(t)

It’s your time

https://github.com/migariane/EASP_NET_SURV

ASNS/**Age_tandardisation_FOR_DEMO.xlsx**

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Conclusions

1. When comparing Net Survival estimates between groups there is still a residual impact of the **structure of age of the cancer incident population** on the estimates.

2. This can be remedied by **age-standardisation** of the Net Survival estimates.

3. Confidence intervals can be generated for age-standardised estimates, allowing inference (comparisons between them).

4. The reference population can be chosen to maximise:
    1. Comparability with other studies
    2. Maximum agreement between un-standardised and standardised estimates
    3. Computational ease

5. ICSS reference population is a very good choice for all these… though you may be required to use another one!

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PART TWO
Study Designs

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Learning objectives

- To **estimate net survival** using **cohort** and **period** approaches, and to **compare the results.**

Stata: stset

Setting the structure of your survival data

stset(end of follow-up: date), **fail**(dead==1) **origin**(time date) **enter**(time date) **exit**(time date) **scale**(value)

Scale: scale(30) = monthly data; scale(365.25) = yearly data

$$t = \frac{time - origin()}{scale()}; \text{ by default: } t = \frac{time - origin(0)}{scale(1)}$$

enter: When the subject enter the study (date)

origin: When the subject becomes at risk and needed if you have only **calendar dates** in your dataset

exit: When the subject leaves the study (date)

_t0 and **_t:** Record the **time span**, in analysis time t. _t0= start and _t= end

_d: Record the outcome at the end of the span.

_st: Record whether the observation is going to be used in the current analysis

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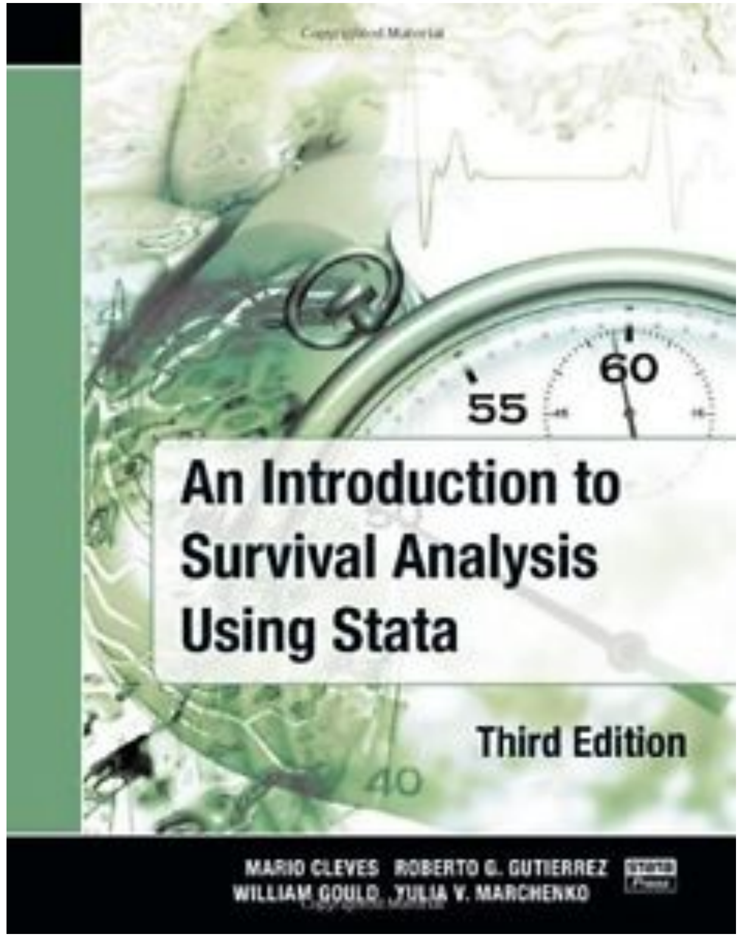

Chapters
4, 5, 6

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Breast_stns.dta

Calendar year of follow-up

Calendar year of diagnosis	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Calendar year of diagnosis
1971	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	1971
1972		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1972
1973			0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	1973
1974				0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	1974
1975					0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	1975
1976						0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	1976
1977							0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	1977
1978								0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	1978
1979									0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	1979
1980										0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	1980
1981											0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	1981
1982												0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	1982
1983													0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	1983
1984														0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	1984
1985															0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	1985
1986																0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	1986
1987																	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	1987
1988																		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	1988
1989																			0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	1989
1990																				0	1	2	3	4	5	6	7	8	9	10	11	12	13	1990
1991																					0	1	2	3	4	5	6	7	8	9	10	11	12	1991
1992																						0	1	2	3	4	5	6	7	8	9	10	11	1992
1993																							0	1	2	3	4	5	6	7	8	9	10	1993
1994																								0	1	2	3	4	5	6	7	8	9	1994
1995																									0	1	2	3	4	5	6	7	8	1995
1996																										0	1	2	3	4	5	6	7	1996
1997																											0	1	2	3	4	5	6	1997
1998																												0	1	2	3	4	5	1998
1999																													0	1	2	3	4	1999
2000																														0	1	2	3	2000
2001																															0	1	2	2001

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```
. stset finmdy, fail(dead==1) origin(time diagmdy) enter(time diagmdy)

     failure event:  dead == 1
obs. time interval:  (origin, finmdy]
 enter on or after:  time diagmdy
 exit on or before:  failure
    t for analysis:  (time-origin)
            origin:  time diagmdy

------------------------------------------------------------------------------
     355801  total observations
          0  exclusions
------------------------------------------------------------------------------
     355801  observations remaining, representing
     212121  failures in single-record/single-failure data
  920269050  total analysis time at risk and under observation
                                                at risk from t =         0
                                     earliest observed entry t =         0
                                          last observed exit t =     12052
```

Stata: stset

stset finmdy, fail(dead==1) origin(time diagmdy) enter(time diagmdy) **scale(365.25)**

list diagmdy finmdy _t0 _t _d _st in 1/10

```
     +------------------------------------------------------+
     |   diagmdy      finmdy   _t0          _t   _d   _st |
     |------------------------------------------------------|
  1. | 01jan2000   31dec2003     0   3.9972621    1     1 |
  2. | 29jul1998   31dec2003     0   5.4236824    0     1 |
  3. | 30jan1998   31dec2003     0   5.9164956    0     1 |
  4. | 09jul1998   31dec2003     0   5.4784394    0     1 |
  5. | 22dec1998   31dec2003     0   5.0239562    0     1 |
     |------------------------------------------------------|
  6. | 23jan1998   31dec2003     0   5.9356605    0     1 |
  7. | 16jul1998   31dec2003     0   5.4592745    0     1 |
  8. | 07jul1999   31dec2003     0   4.4845996    0     1 |
  9. | 18aug1998   31dec2003     0   5.3689254    0     1 |
 10. | 01sep1999   01oct2003     0   4.0821355    1     1 |
     +------------------------------------------------------+
```

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Net Survival Estimates

Hypothetical Scenario:

9 Cohorts from 1971 to 1979
5 incident cases per year
Recursive survival pattern:

- 1 individual survives 15 years
- 1 individual survives 10 years
- 1 individual survives 7 years
- 1 individual survives 4 years
- 1 individual survives 2 years

Several options to estimate Net Survival answering different questions:

1. The complete data (considering the last update date)
2. From one particular cohort
3. From one or several aggregated calendar periods

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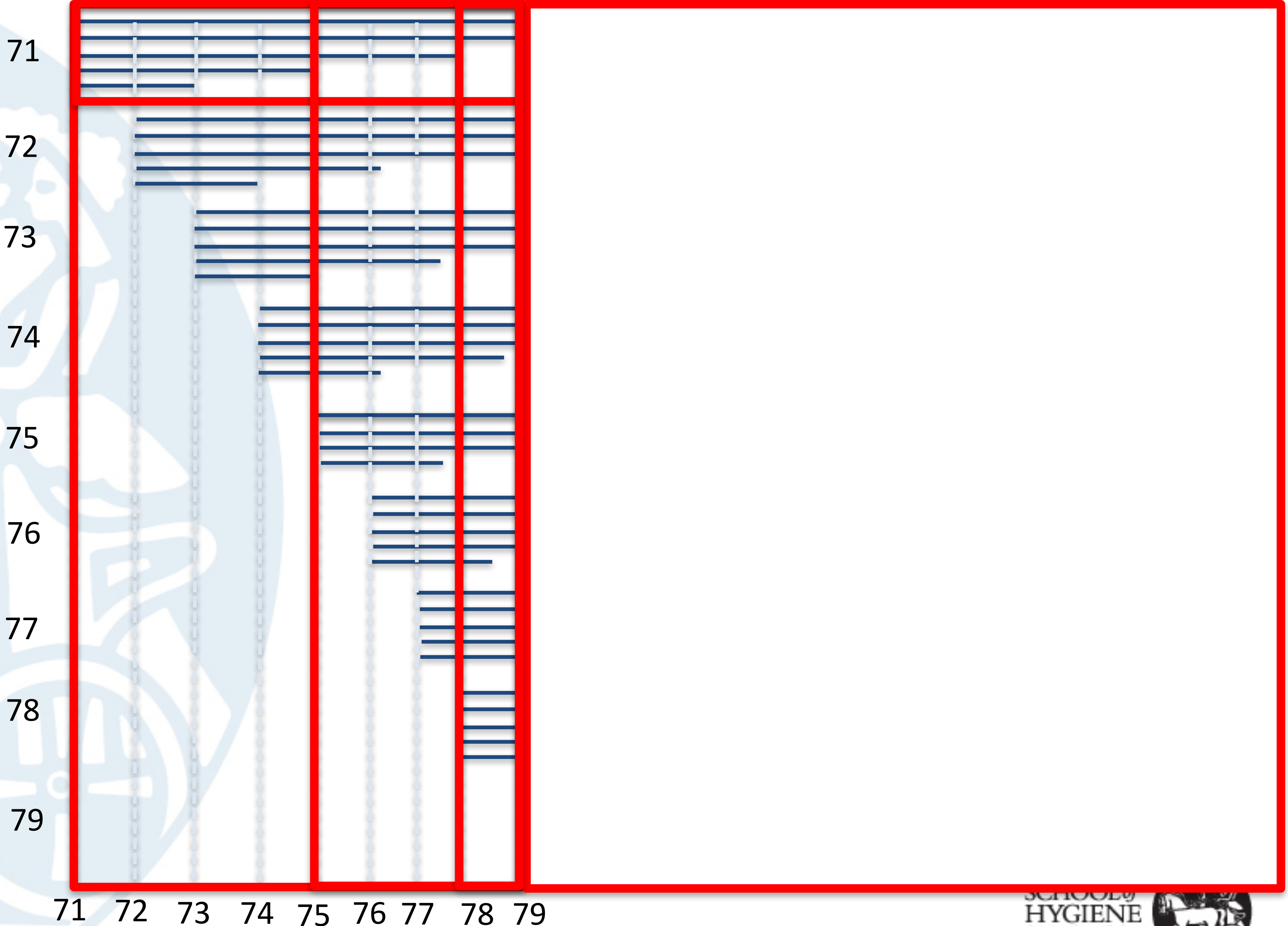

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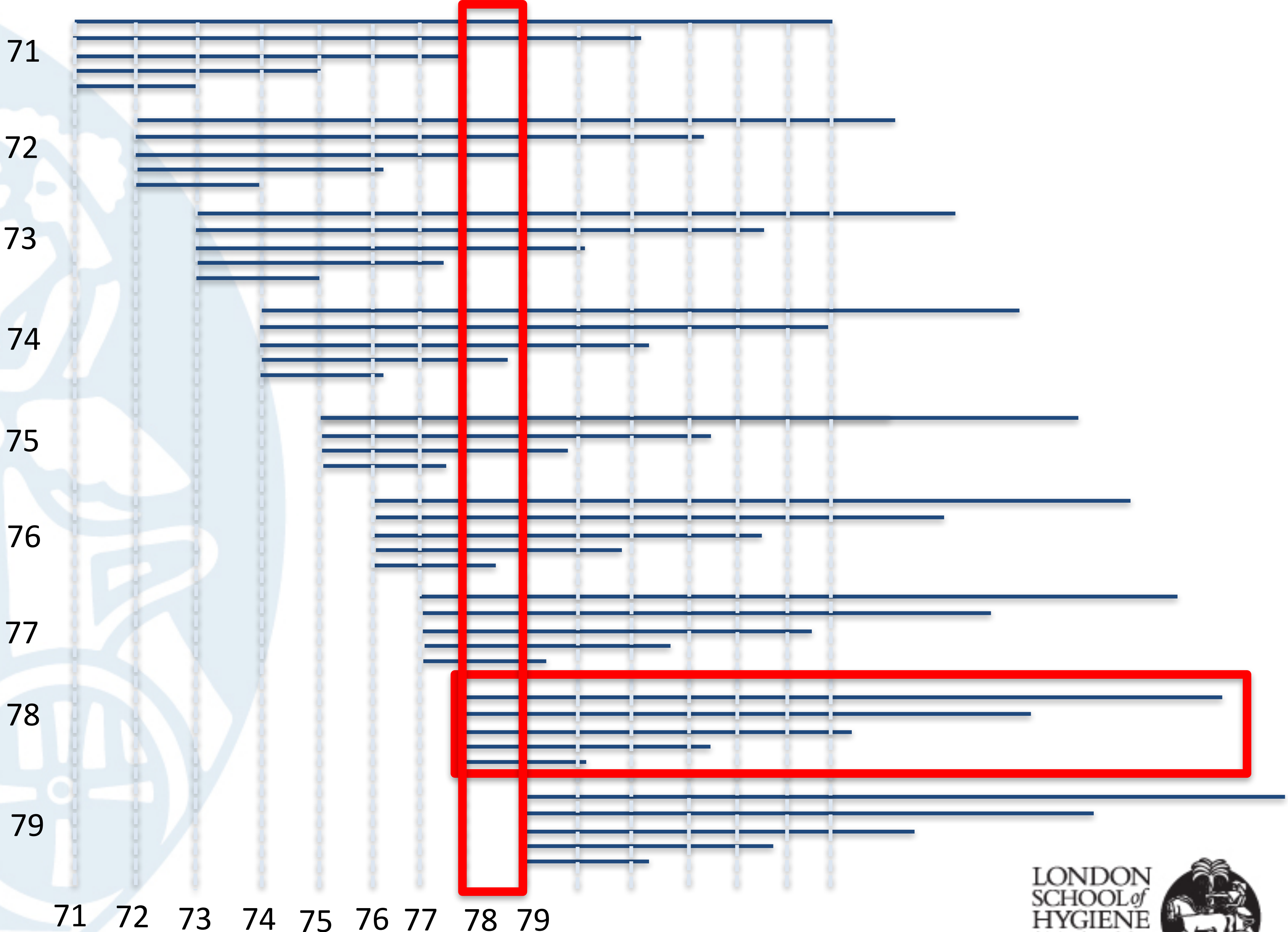

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Cohort and Period

Calendar year of follow-up

Calendar year of diagnosis	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Calendar year of diagnosis
1971	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15																		1971
1972		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14																		1972
1973			0	1	2	3	4	5	6	7	8	9	10	11	12	13																		1973
1974				0	1	2	3	4	5	6	7	8	9	10	11	12																		1974
1975					0	1	2	3	4	5	6	7	8	9	10	11																		1975
1976						0	1	2	3	4	5	6	7	8	9	10																		1976
1977							0	1	2	3	4	5	6	7	8	9																		1977
1978								0	1	2	3	4	5	6	7	8																		1978
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1980										0	1	2	3	4	5	6																		1980
1981											0	1	2	3	4	5																		1981
1982												0	1	2	3	4																		1982
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Cohort approach, 1971

***cohort approach 1971**

stset finmdy, fail(dead==1) origin(time diagmdy) enter(time diagmdy)

list diagmdy finmdy _t0 _t _d _st in 1/10

stns list using lifetable_stns.dta **if year(diagmdy)==1971**, ///
age(agediagindays=_age) period(diagmdy=yearindays) ///
strata(sex dep) rate(rate_day) ///
at(.5 1 5 10 15, scalefactor(365.25) unit(year)) ///
saving(cohort_1971, replace)

```
type of estimate: kaplan-meier
         failure _d:  dead == 1
   analysis time _t:  (finmdy-origin)
             origin:  time diagmdy
  enter on or after:  time diagmdy
```

Time (year)	Event Time	Beg. Total	Fail	Net Lost	Net Surv. Function	[95% Conf.	Int.]
.5	182	6061	838	0	0.8722	0.8634	0.8810
1	365	5223	480	1	0.8013	0.7906	0.8120
5	1826	4742	2056	7	0.4992	0.4844	0.5139
10	3646	2679	1024	1	0.3485	0.3306	0.3664
15	5467	1654	474	3	0.3126	0.2907	0.3345

Period approach, 1986

Calendar year of follow-up

Calendar year of diagnosis

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	
1971	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15																		1971
1972		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14																		1972
1973			0	1	2	3	4	5	6	7	8	9	10	11	12	13																		1973
1974				0	1	2	3	4	5	6	7	8	9	10	11	12																		1974
1975					0	1	2	3	4	5	6	7	8	9	10	11																		1975
1976						0	1	2	3	4	5	6	7	8	9	10																		1976
1977							0	1	2	3	4	5	6	7	8	9																		1977
1978								0	1	2	3	4	5	6	7	8																		1978
1979									0	1	2	3	4	5	6	7																		1979
1980										0	1	2	3	4	5	6																		1980
1981											0	1	2	3	4	5																		1981
1982												0	1	2	3	4																		1982
1983													0	1	2	3																		1983
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JUSTIFICATION:

Need of **UPDATED SURVIVAL estimates** that account for recent **improvements in treatment**

- All observations included in the analysis are **LEFT TRUNCATED and RIGHT CENSORED at 1986**
- Then from the survivors of the cohort of 1971 we will have **15 years of follow-up** (5480 days)
- **STNS account for the informative censoring**

  (cancer deaths that occurs during the first years following diagnosis)

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Period approach, 1986

Calendar year of follow-up

Calendar year of diagnosis	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Calendar year of diagnosis
1971	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15																		1971
1972		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14																		1972
1973			0	1	2	3	4	5	6	7	8	9	10	11	12	13																		1973
1974				0	1	2	3	4	5	6	7	8	9	10	11	12																		1974
1975					0	1	2	3	4	5	6	7	8	9	10	11																		1975
1976						0	1	2	3	4	5	6	7	8	9	10																		1976
1977							0	1	2	3	4	5	6	7	8	9																		1977
1978								0	1	2	3	4	5	6	7	8																		1978
1979									0	1	2	3	4	5	6	7																		1979
1980										0	1	2	3	4	5	6																		1980
1981											0	1	2	3	4	5																		1981
1982												0	1	2	3	4																		1982
1983													0	1	2	3																		1983
1984														0	1	2																		1984
1985															0	1																		1985
1986																0																		1986
1987																																		1987
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2001																																		2001

The **PERIOD** approach corresponds to the **survival which would be observed** amongst **NEWLY DIAGNOSED patients** if the currently observed conditional survival probabilities were to remain constant.

Period approach, 1986

Calendar year of follow-up

Calendar year of diagnosis	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Calendar year of diagnosis
1971	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15																		1971
1972		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14																		1972
1973			0	1	2	3	4	5	6	7	8	9	10	11	12	13																		1973
1974				0	1	2	3	4	5	6	7	8	9	10	11	12																		1974
1975					0	1	2	3	4	5	6	7	8	9	10	11																		1975
1976						0	1	2	3	4	5	6	7	8	9	10																		1976
1977							0	1	2	3	4	5	6	7	8	9																		1977
1978								0	1	2	3	4	5	6	7	8																		1978
1979									0	1	2	3	4	5	6	7																		1979
1980										0	1	2	3	4	5	6																		1980
1981											0	1	2	3	4	5																		1981
1982												0	1	2	3	4																		1982
1983													0	1	2	3																		1983
1984														0	1	2																		1984
1985															0	1																		1985
1986																0																		1986
1987																																		1987
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2001																																		2001

JUSTIFICATION:

Need of **update SURVIVAL estimates** that account for recent **improvements in treatment**

- All observations included in the analysis are **LEFT TRUNCATED and RIGHT CENSORED at 1986**

- **Begintime(origin): date of diagnosis:**
  STNS account for the informative censoring
  (cancer deaths that occurs during the first years following diagnosis)

LONDON SCHOOL of HYGIENE &TROPICAL MEDICINE

Period approach, 1986

Calendar year of follow-up

Calendar year of diagnosis	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Calendar year of diagnosis
1971	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15																		1971
1972		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14																		1972
1973			0	1	2	3	4	5	6	7	8	9	10	11	12	13																		1973
1974				0	1	2	3	4	5	6	7	8	9	10	11	12																		1974
1975					0	1	2	3	4	5	6	7	8	9	10	11																		1975
1976						0	1	2	3	4	5	6	7	8	9	10																		1976
1977							0	1	2	3	4	5	6	7	8	9																		1977
1978								0	1	2	3	4	5	6	7	8																		1978
1979									0	1	2	3	4	5	6	7																		1979
1980										0	1	2	3	4	5	6																		1980
1981											0	1	2	3	4	5																		1981
1982												0	1	2	3	4																		1982
1983													0	1	2	3																		1983
1984														0	1	2																		1984
1985															0	1																		1985
1986																0																		1986
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2000																																		2000
2001																																		2001

***Period approach 1986**

```
stset finmdy, fail(dead==1) origin(time diagmdy) ///
      enter(time mdy(1, 1, 1986)) exit(time mdy(12, 31, 1986))

stns list using lifetable_stns.dta, ///
      age(agediagindays=_age) period(diagmdy=yearindays) ///
      begintime(origin) strata(sex dep) rate(rate_day) ///
      at(.5 1 5 10 15, scalefactor(365.25) unit(year)) end_followup(5480) ///
      saving(period_1986, replace)
```

Phoar-Perme estimate:
Needs to account for
Informative censoring
from the date of diagnosis

LONDON SCHOOL of HYGIENE & TROPICAL MEDICINE

Cohort, 1971

The survival of **women diagnosed in 1971**, as computed with the **cohort approach**, was:

one-year survival:	0.80	(95% CI 0.79-0.81)
five-year survival:	0.50	(95% CI 0.48-0.51)
ten-year survival:	0.35	(95% CI 0.33-0.37)
fifteen-year survival:	0.31	(95% CI 0.31-0.33)

Period, 1986

In 1986, the predicted survival for women with breast cancer, obtained through **period analysis**:

one-year survival:	0.88	(95% CI 0.87-0.88)
five-year survival:	0.63	(95% CI 0.62-0.64)
ten-year survival:	0.48	(95% CI 0.46-0.50)
fifteen-year survival:	0.41	(95% CI 0.39-0.44)

LONDON SCHOOL of HYGIENE & TROPICAL MEDICINE

Period approach, 1986

Calendar year of follow-up

Calendar year of diagnosis	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Calendar year of diagnosis
1971	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15																		1971
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1973			0	1	2	3	4	5	6	7	8	9	10	11	12	13																		1973
1974				0	1	2	3	4	5	6	7	8	9	10	11	12																		1974
1975					0	1	2	3	4	5	6	7	8	9	10	11																		1975
1976						0	1	2	3	4	5	6	7	8	9	10																		1976
1977							0	1	2	3	4	5	6	7	8	9																		1977
1978								0	1	2	3	4	5	6	7	8																		1978
1979									0	1	2	3	4	5	6	7																		1979
1980										0	1	2	3	4	5	6																		1980
1981											0	1	2	3	4	5																		1981
1982												0	1	2	3	4																		1982
1983													0	1	2	3																		1983
1984														0	1	2																		1984
1985															0	1																		1985
1986																0																		1986
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2001																															0	1	2	2001

Just considering the survival experience **exclusively in recent years**

You can approach the estimate of the survival for the cohort of 1986 without having to wait to get the complete follow-up data for the the cohort of 1986

LONDON SCHOOL of HYGIENE &TROPICAL MEDICINE

Cohort and Period

Calendar year of follow-up

Calendar year of diagnosis	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Calendar year of diagnosis
1971	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14																			1971
1972		0	1	2	3	4	5	6	7	8	9	10	11	12	13																			1972
1973			0	1	2	3	4	5	6	7	8	9	10	11	12																			1973
1974				0	1	2	3	4	5	6	7	8	9	10	11																			1974
1975					0	1	2	3	4	5	6	7	8	9	10																			1975
1976						0	1	2	3	4	5	6	7	8	9																			1976
1977							0	1	2	3	4	5	6	7	8																			1977
1978								0	1	2	3	4	5	6	7																			1978
1979									0	1	2	3	4	5	6																			1979
1980										0	1	2	3	4	5																			1980
1981											0	1	2	3	4																			1981
1982												0	1	2	3																			1982
1983													0	1	2																			1983
1984														0	1																			1984
1985															0																			1985
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HOW?

Let’s prove it.

Imagine we can

Travel in the

FUTURE

LONDON SCHOOL of HYGIENE &TROPICAL MEDICINE

Cohort and Period

Calendar year of follow-up

Calendar year of diagnosis

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	
1971	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	1971
1972		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1972
1973			0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	1973
1974				0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	1974
1975					0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	1975
1976						0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	1976
1977							0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	1977
1978								0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	1978
1979									0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	1979
1980										0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	1980
1981											0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	1981
1982												0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	1982
1983													0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	1983
1984														0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	1984
1985															0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	1985
1986																0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	1986
1987																	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	1987
1988																		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	1988
1989																			0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	1989
1990																				0	1	2	3	4	5	6	7	8	9	10	11	12	13	1990
1991																					0	1	2	3	4	5	6	7	8	9	10	11	12	1991
1992																						0	1	2	3	4	5	6	7	8	9	10	11	1992
1993																							0	1	2	3	4	5	6	7	8	9	10	1993
1994																								0	1	2	3	4	5	6	7	8	9	1994
1995																									0	1	2	3	4	5	6	7	8	1995
1996																										0	1	2	3	4	5	6	7	1996
1997																											0	1	2	3	4	5	6	1997
1998																												0	1	2	3	4	5	1998
1999																													0	1	2	3	4	1999
2000																														0	1	2	3	2000
2001																															0	1	2	2001

Calendar year of diagnosis

Cohort approach, 1986

***cohort approach 1986**

```
stset finmdy, fail(dead==1) origin(time diagmdy) enter(time diagmdy) scale(365.25)

stns list using lifetable_stns.dta if year(diagmdy)==1986, ///
        age(agediagindays=_age) period(diagmdy=yearindays) ///
        strata(sex dep) rate(rate_day) ///
        at(.5 1 5 10 15, scalefactor(365.25) unit(year))  ///
        saving(cohort_1986, replace)
```

```
type of estimate: kaplan-meier

         failure _d:  dead == 1
   analysis time _t:  (finmdy-origin)
             origin:  time diagmdy
  enter on or after:  time diagmdy
```

Time (year)	Event Time	Beg. Total	Fail	Net Lost	Net Surv. Function	[95% Conf.	Int.]
.5	182	10801	973	0	0.9214	0.9159	0.9269
1	365	9828	568	0	0.8791	0.8722	0.8859
5	1826	9260	3166	4	0.6425	0.6312	0.6538
10	3649	6090	1801	3	0.5166	0.5011	0.5321
15	5475	4286	1005	7	0.4978	0.4753	0.5202

Your TURN (interpret it)

The survival of **women diagnosed in 1971**, as computed with the **cohort approach**, was:

one-year survival:	0.80	(95% CI 0.79-0.81)
five-year survival:	0.50	(95% CI 0.48-0.51)
ten-year survival:	0.35	(95% CI 0.33-0.37)
fifteen-year survival:	0.31	(95% CI 0.31-0.33)

In 1986, the predicted survival for women with breast cancer, obtained through **period analysis**:

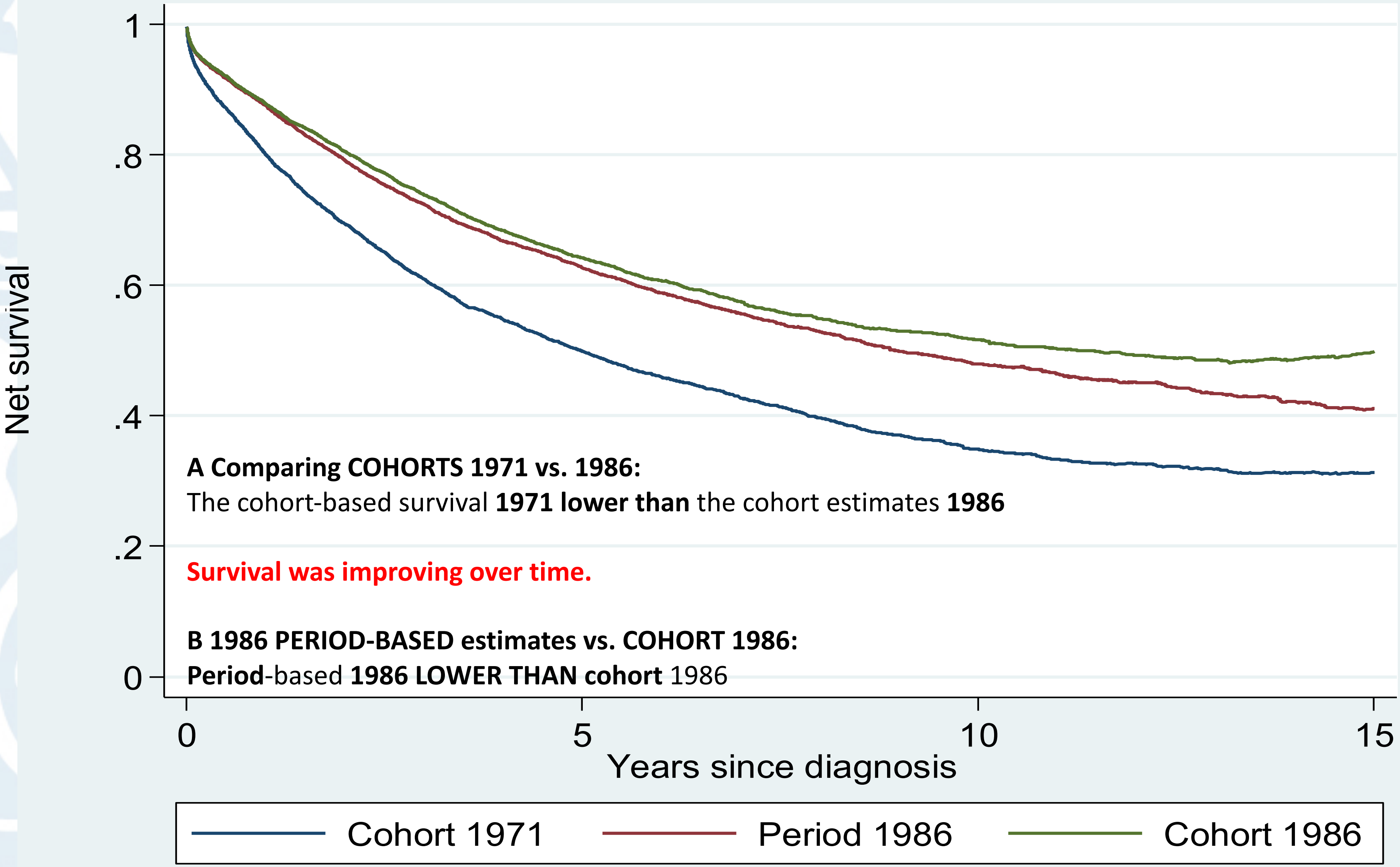
one-year survival:	0.88	(95% CI 0.87-0.88)
five-year survival:	0.63	(95% CI 0.62-0.64)
ten-year survival:	0.48	(95% CI 0.46-0.50)
fifteen-year survival:	0.41	(95% CI 0.39-0.44)

The actual survival of women diagnosed in 1986, as observed in due course, and by **the cohort approach**:

one-year survival:	0.88	(95% CI 0.87-0.89)
five-year survival:	0.64	(95% CI 0.63-0.65)
ten-year survival:	0.52	(95% CI 0.50-0.53)
fifteen-year survival:	0.50	(95% CI 0.48-0.52)

LONDON SCHOOL of HYGIENE & TROPICAL MEDICINE

Compare approaches



Period approach 1986

	Calendar year of follow-up																																	
Calendar year of diagnosis	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Calendar year of diagnosis
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1972		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14																		1972
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1975					0	1	2	3	4	5	6	7	8	9	10	11																		1975
1976						0	1	2	3	4	5	6	7	8	9	10																		1976
1977							0	1	2	3	4	5	6	7	8	9																		1977
1978								0	1	2	3	4	5	6	7	8																		1978
1979									0	1	2	3	4	5	6	7																		1979
1980										0	1	2	3	4	5	6																		1980
1981											0	1	2	3	4	5																		1981
1982												0	1	2	3	4																		1982
1983													0	1	2	3																		1983
1984														0	1	2																		1984
1985															0	1																		1985

Cohort 85

Biased: we do not have **INCIDENT** cases for the **YEAR 1986**

LONDON SCHOOL of HYGIENE &TROPICAL MEDICINE

Hybrid approach: 1986

Calendar year of follow-up

Calendar year of diagnosis	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Calendar year of diagnosis
1971	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15																		1971
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1979									0	1	2	3	4	5	6	7																		1979
1980										0	1	2	3	4	5	6																		1980
1981											0	1	2	3	4	5																		1981
1982												0	1	2	3	4																		1982
1983													0	1	2	3																		1983
1984														0	1	2																		1984
1985															0	1																		1985

Hybrid 1986

gen entermdy = cond(diagmdy>=mdy(1, 1, 1985), diagmdy, mdy(1, 1, 1986))

```
stset finmdy, fail(dead==1) origin(time diagmdy) enter(time entermdy) ///
      exit(time mdy(12, 31, 1986))
```

Cohort 85

```
stns list using lifetable_stns.dta, ///
      age(agediagindays=_age) period(diagmdy=yearindays) ///
      begintime(origin) strata(sex dep) rate(rate_day) end_followup(5480) ///
      at(.5 1 5 10 15, scalefactor(365.25) unit(year)) ///
      saving(hybrid_1986, replace)
```

Hybrid approach: 1986

Calendar year of follow-up

Calendar year of diagnosis	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Calendar year of diagnosis
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1973			0	1	2	3	4	5	6	7	8	9	10	11	12	13																		1973
1974				0	1	2	3	4	5	6	7	8	9	10	11	12																		1974
1975					0	1	2	3	4	5	6	7	8	9	10	11																		1975
1976						0	1	2	3	4	5	6	7	8	9	10																		1976
1977							0	1	2	3	4	5	6	7	8	9																		1977
1978								0	1	2	3	4	5	6	7	8																		1978
1979									0	1	2	3	4	5	6	7																		1979
1980										0	1	2	3	4	5	6																		1980
1981											0	1	2	3	4	5																		1981
1982												0	1	2	3	4																		1982
1983													0	1	2	3																		1983
1984														0	1	2																		1984
1985															0	1																		1985

Hybrid 1986

If date of diagnosis >=1985 (then) ➔ 1985

else date of diagnosis <1985 (then) ➔ 1,1,1986

Combined information:

Cohort 1985 + most updated information for other cohorts (**the most recent year**).

```
stset finmdy, fail(dead==1) origin(time diagmdy) ///
enter(time entermdy) exit(time mdy(12, 31, 1986))
```

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Hybrid approach: 1986

The **'biased' period estimates** using the modified dataset were:

▪ one-year survival:	0.84	(95% CI 0.80-0.87)
▪ five-year survival:	0.60	(95% CI 0.57-0.63)
▪ ten-year survival:	0.46	(95% CI 0.43-0.48)
▪ fifteen-year survival:	0.39	(95% CI 0.36-0.42)

The estimates obtained with **hybrid analysis** were:

▪ one-year survival:	0.88	(95% CI 0.88-0.89)
▪ five-year survival:	0.63	(95% CI 0.62-0.64)
▪ ten-year survival:	0.48	(95% CI 0.47-0.50)
▪ fifteen-year survival:	0.41	(95% CI 0.39-0.44)

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References and further reading

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