

Interpolated Markov Chain Model to estimate Health Expectancies from Cross- longitudinal surveys

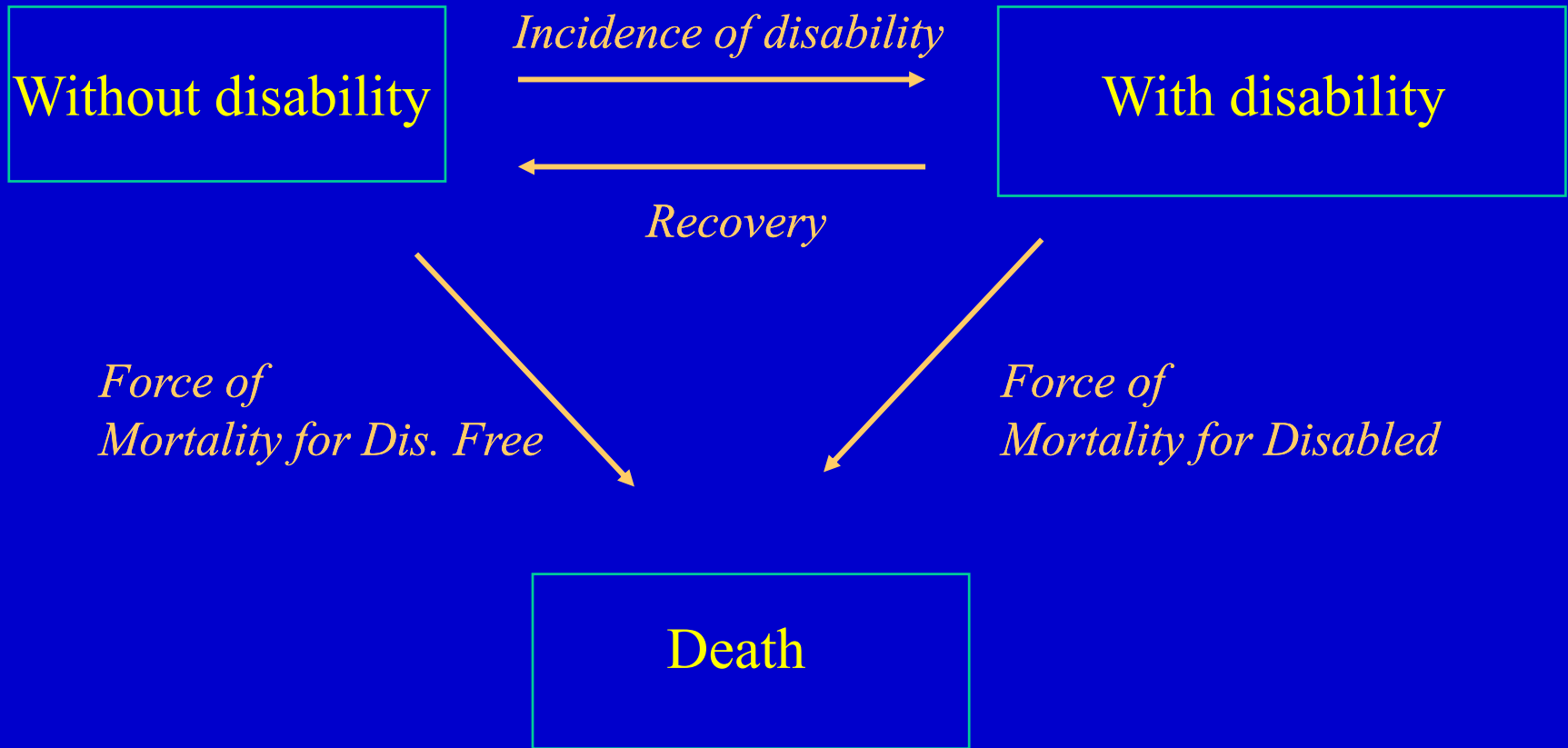
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Leicester, Yasuhiko Saito (Nihon University).**

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Transitions between health states and death



Interpolated Markov Chain (IMaCh)

- Simplest model of a Period Life Table with heterogeneity: i.e at least 2 Health Statuses which implies 4 incidences: incidence of disability, incidence of recovery, incidences of mortality from disability state and from disability-free state.
- Cross-longitudinal survey (CL) data, ie at least 2 waves and wider age range than time elapsed between waves: [70+] vs 2, 3 or 5 years.
- Simplification of incidence profiles by age, currently by logistics:
$$\text{Logit}(\text{incidence}) = a + b \text{ age}$$
- Inclusion of covariates: $a + b \text{ age} + c \text{ sexe} + d \text{ education}$
- Use of interpolated Markov chain to set the Likelihood of the sample taking into account precise date of interview (month usually). Maximisation of Likelihood gives parameters estimates with standard errors as for all outputs (DFLE, period prevalence etc.).

Biases of cross-sectional surveys related to disability and mortality

- Cross-sectional surveys are usually designed or weighted to reflect national « alive » population according to age, sex etc.
- But non-responses, refusals may/introduce biases in disability measurement.
- If the Cross-sectional survey has also a follow-up study (CL) with at least a second survey, we can use the information on deaths occurring between waves to measure mortality (Life Expectancy) and estimate the bias.

Why using IMaCh (v.97b) to estimate Period Life Table from a Cross-longitudinal Survey

Difficulties for estimating LE from a CL survey

- Small sample size (in comparison to National Vital Statistics).
- Large age range (use of a constant mortality isn't realistic).

Advantages of using IMaCh for LE

- Standard deviations are computed from Likelihood.
- Use of covariates to analyse the biases or to simply to describe mortality differentials. Same dataset

Use of a model life table (currently only Gompertz)

Gnu Scientific Library (GSL) to replace Numerical Recipes in C (NRC)

- IMACh code sources can't be « openly » and « widely » available because of copyrighted routines (NRC).
- GPL (Gnu Public Licence) and other Open source licences: Mozilla Firefox, Mozilla Thunderbird, GIMP are good examples.
- Advantages of GPL/Open source licence:
 - Sources can be recompiled for security reasons (many computer centres don't accept « executable » (.exe) anymore (viruses) or at least « Open/PGP signed » binary files (IMaCh will be signed).
 - Software can be modified, fixed, improved (CVS).
 - Software (or part of it) could be merged in other softwares like « R » (GPL).
- Gnuplot (grapher used by IMACh) is GPL too.

Access to CVS, not only to binaries

- CVS (concurrent version system) was only available to people having the NRC licence. Will be freely available (probably)
<http://sauvy.ined.fr/cgi-bin/cvsweb.cgi>

IMaCh CVS

imach/src/

Click on a directory to enter that directory. Click on a file to display its revision history and to get a chance to display diffs between revisions.

Current directory: [local] / imach / src

File	Rev.	Age	Author	Last log entry
[TXT] Makefile Wine for Inno Setup Compi...	1.11	2 weeks	brouard	Cross compiling from Linux with i586-mingw32-gcc Using
[TXT] README.htm	1.2	3 years	lievre	Some changes
[TXT] euroeves2.gif	1.1.1.1	4 years	brouard	Import de imach064
[TXT] imach.c	1.102	8 months	brouard	Add the possibility to read data file including tab characters.
[TXT] imach.exe need of computing ...	1.7	11 months	brouard	Agnes added a direct estimation of mortality (without the
[TXT] imach.htm	1.1.1.1	4 years	brouard	Import de imach064
[TXT] imach.ico	1.1	3 years	lievre	Windows IMaCh icon added!!!
[TXT] imach.iss	1.6	2 weeks	brouard	*** empty log message ***
[TXT] imach097b-noreg.iss registries	1.1	10 months	brouard	Inno setup for users without privilege to access Windows
[TXT] setup.iss setup.iss can be comp...	1.1	2 weeks	brouard	Output of make setup.iss using setup.iss.in as a template.
[TXT] setup.iss.in	1.3	2 weeks	brouard	Set version
[TXT] timeval.h gettimeofday working...	1.1	23 months	brouard	* timeval.h (Module): Added included file to make use of
[TXT] wgnuplot38i.zip	1.1	23 months	brouard	*** empty log message ***

Difficulties to move to GSL

- IMaCh/GSL (imachg or gimach) is not only simple « calls » to library function.
See Matrices declaration for example (pointers to pointers of pointers).
- Probable newer instability (IMaCh core was stable since version 0.8)...

Matrix of Matrices pointers

```
/****** ma3x *****/
double ***ma3x(long nrl, long nrh, long ncl, long nch, long nll, long nlh)
{
    long i, j, nrow=nrh-nrl+1, ncol=nch-ncl+1, nlay=nlh-nll+1;
    double ***m;

    m=(double ***) malloc((size_t)((nrow+NR_END)*sizeof(double*)));
    if (!m) nrerror("allocation failure 1 in matrix()");
    m += NR_END;
    m -= nrl;
    .. ..
    /*  gdb: p *(m+1) <=> p m[1] and p (m+1) <=> p (m+1) <=> p &(m[1])
        &(m[i][j][k]) <=> *((*(m+i) + j)+k)
    */
}
```

Availability of current IMaCh

- Version 0.97b (October 2004) available for Windows (installer), MaC OS X (dmg), Linux (rpm but sources needed for a wide distribution).
- Written in C, can be compiled with gcc (GPL) on Windows (cygwin or Mingw32 at least), Mac and Linux.
- Cross-compiled on Linux using Mingw32 to build Windows executable (imach.exe)
- Windows installer is setup by Inno Setup 4 (GPL). We will move to NSIS (GPL) in order for the installer to be crosscompiled from Linux (instead of using Wine under Linux).

Official Documentation of IMaCh

- <http://euroreves.ined.fr/imach> (Nicolas Brouard updated the documentation in October 2004).
- Carol Jagger fixed (will fix) some English.
- Saito is collecting former documentation on IMaCh (unfortunately Mathematical Population Studies article is copyrighted...)

IMaCh WIKI proposals

Wiki is probably the best way for a documentation « closer » to users. Will be available on the IMaCh web soon (wikipedia style)

- Howto, FAQ on « initial values »
- Inclusion of SAS, stata macro to output IMaCh data files.



article discussion **edit this page** history

Disability

From Wikipedia, the free encyclopedia.

The term "**disability**", as it is applied to [humans](#), refers to any condition that impedes the completion of daily tasks using traditional methods. National [governments](#) and global [humanitarian](#) agencies have narrowed this definition for their own purposes, only pledging aid to those with specific disabilities of a certain severity.

Contents [\[hide\]](#)

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- [2 The evolution of a movement](#)
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- [4 Well-known people with disabilities](#)
- [5 See also](#)
- [6 External links](#)

- Main Page
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- Donations

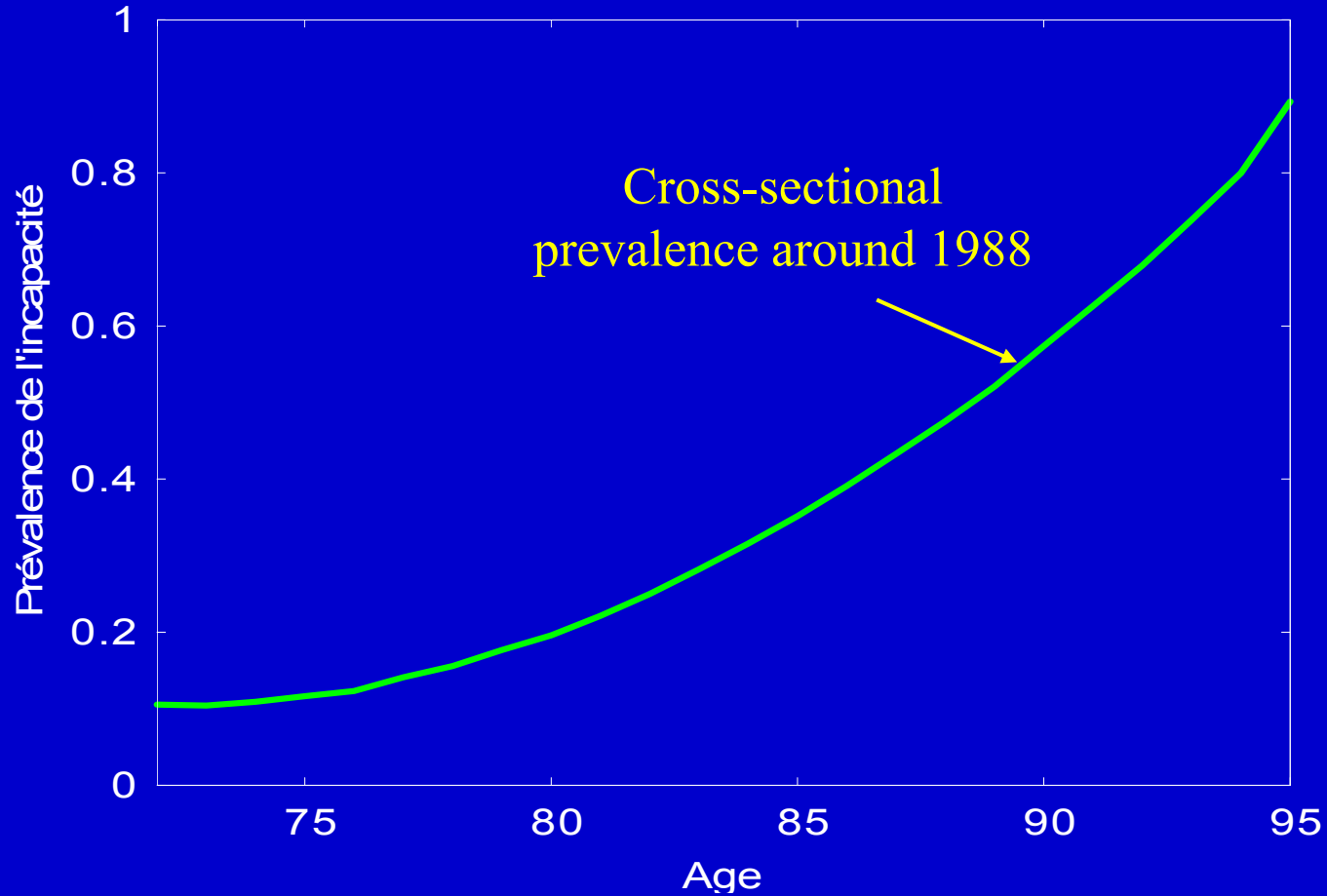
search

Go Search

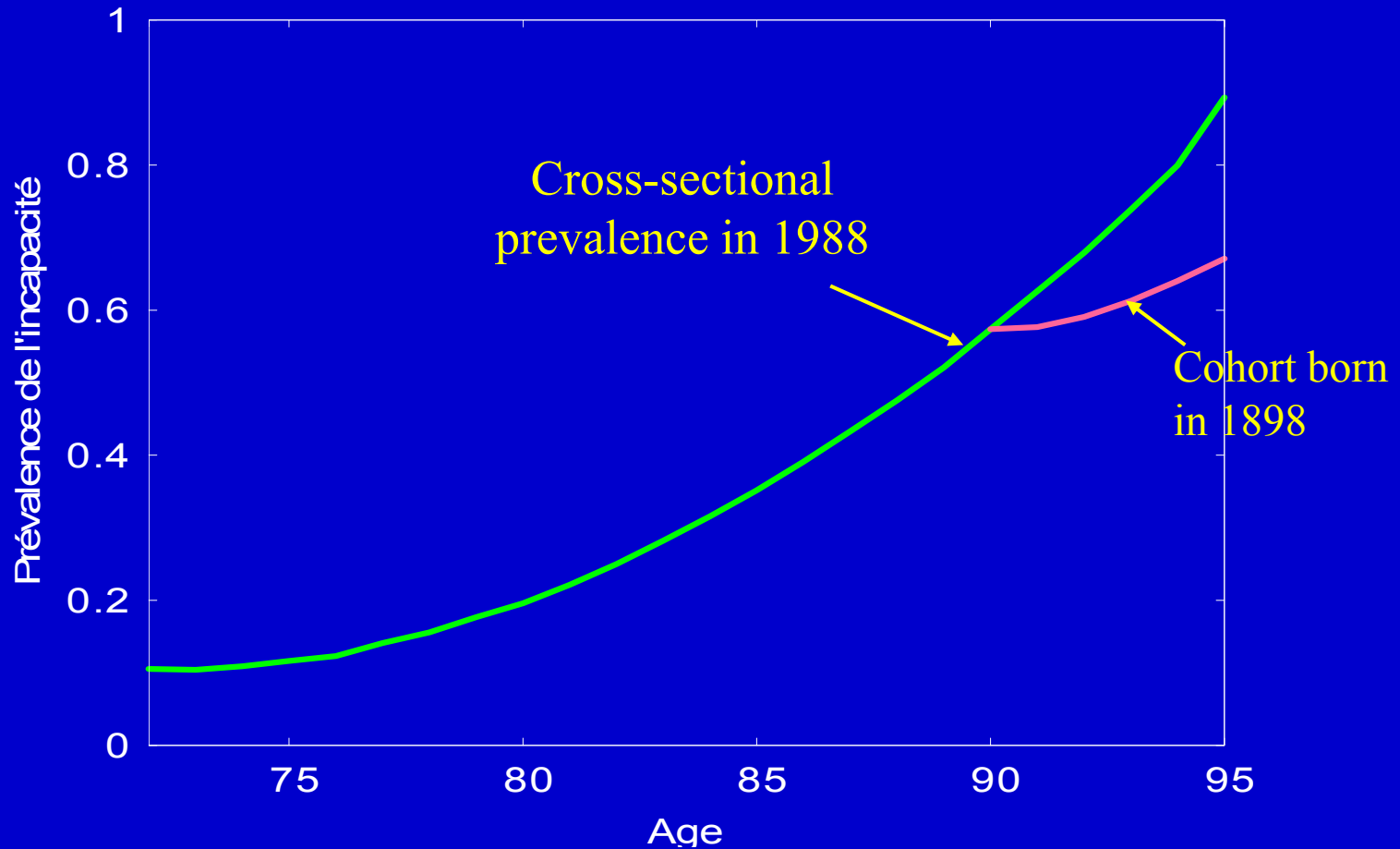
Types of disability

[\[edit\]](#)

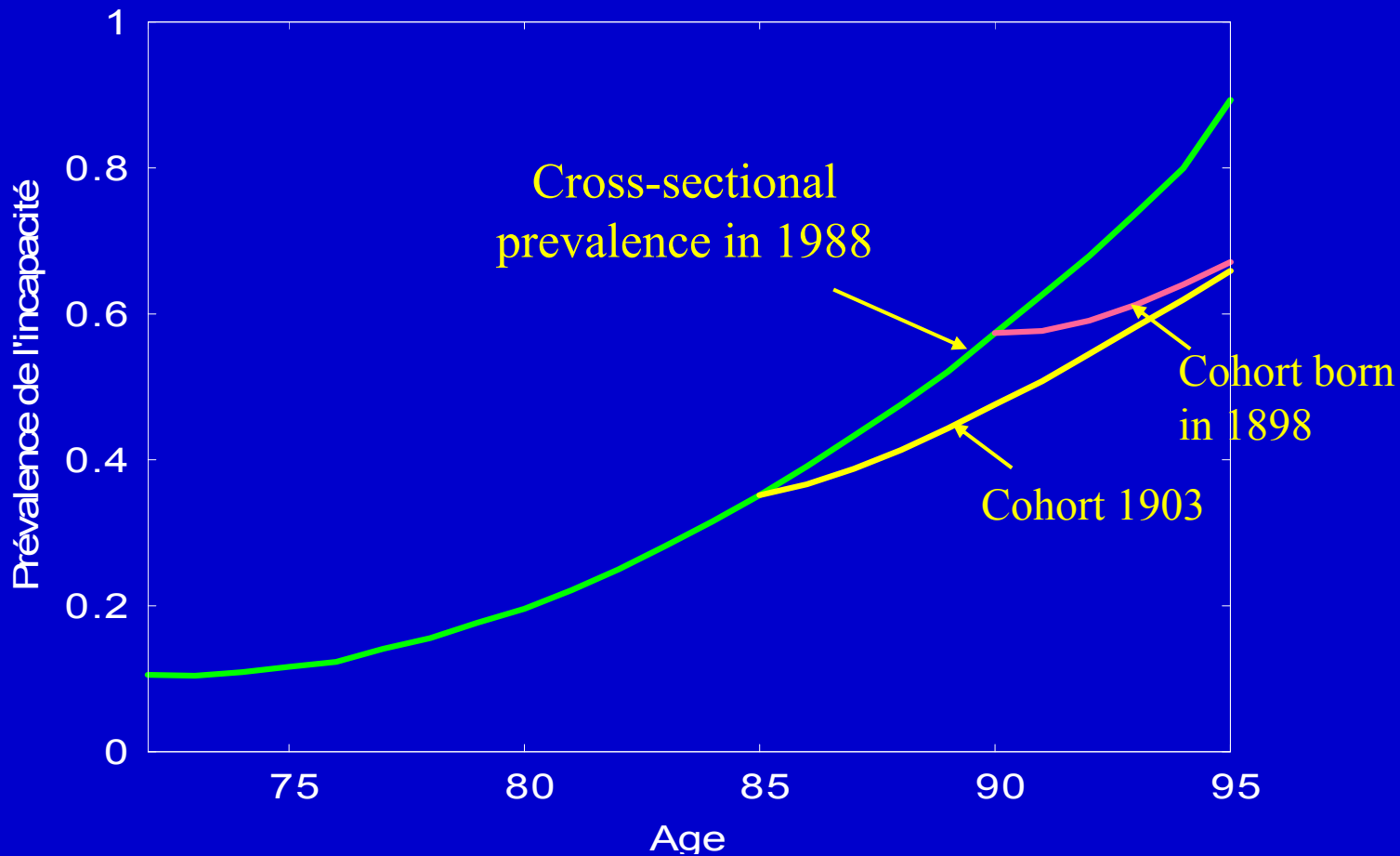
Cross-sectional prevalence of disability



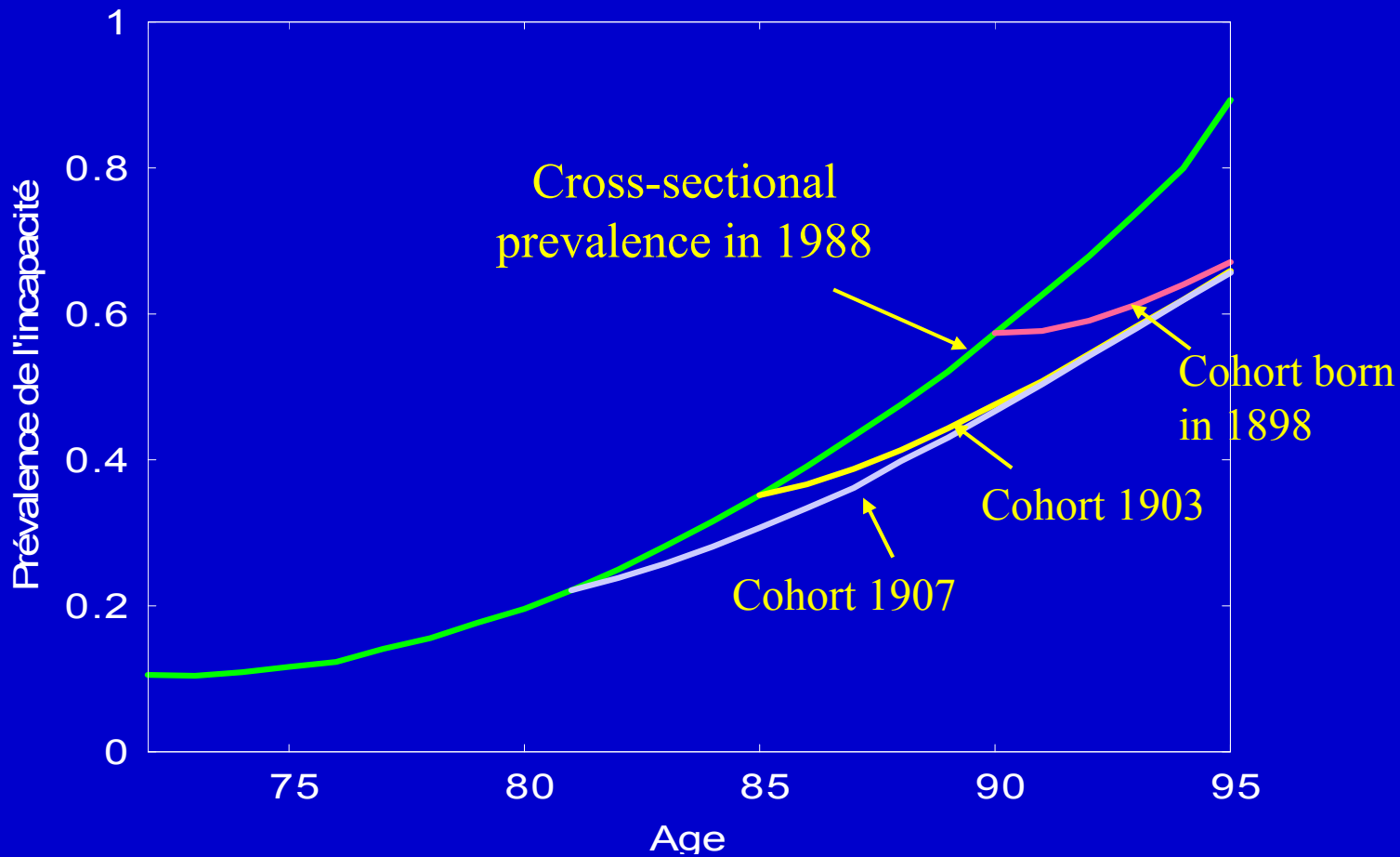
Projecting disability of cohort born in 1898 under the hypothesis of constant incidences



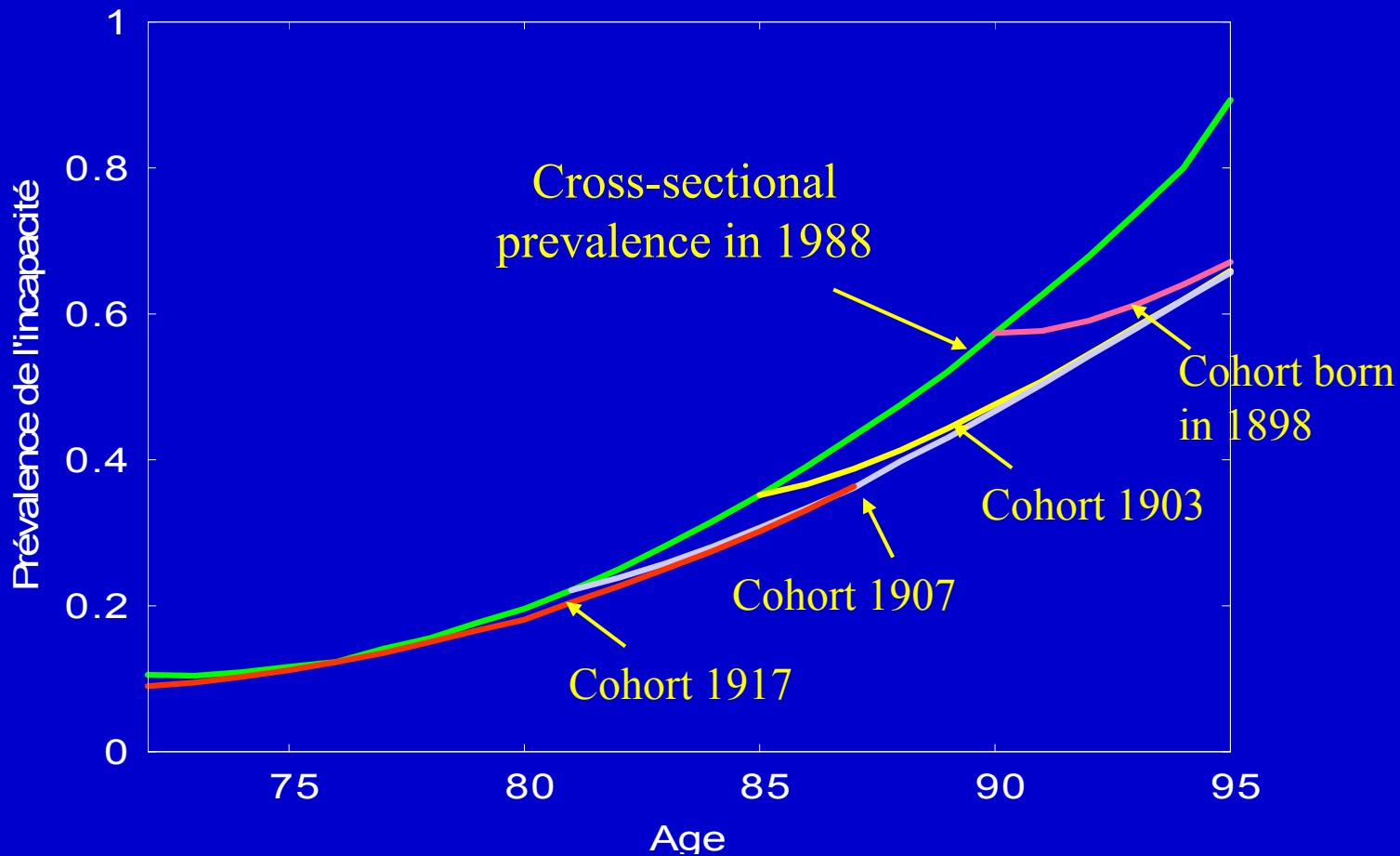
And of cohort born in 1903



And of cohort born in 1907



And of cohort born in 1917



Cross-sectional prevalence and period prevalence: implication on Life Expectancy

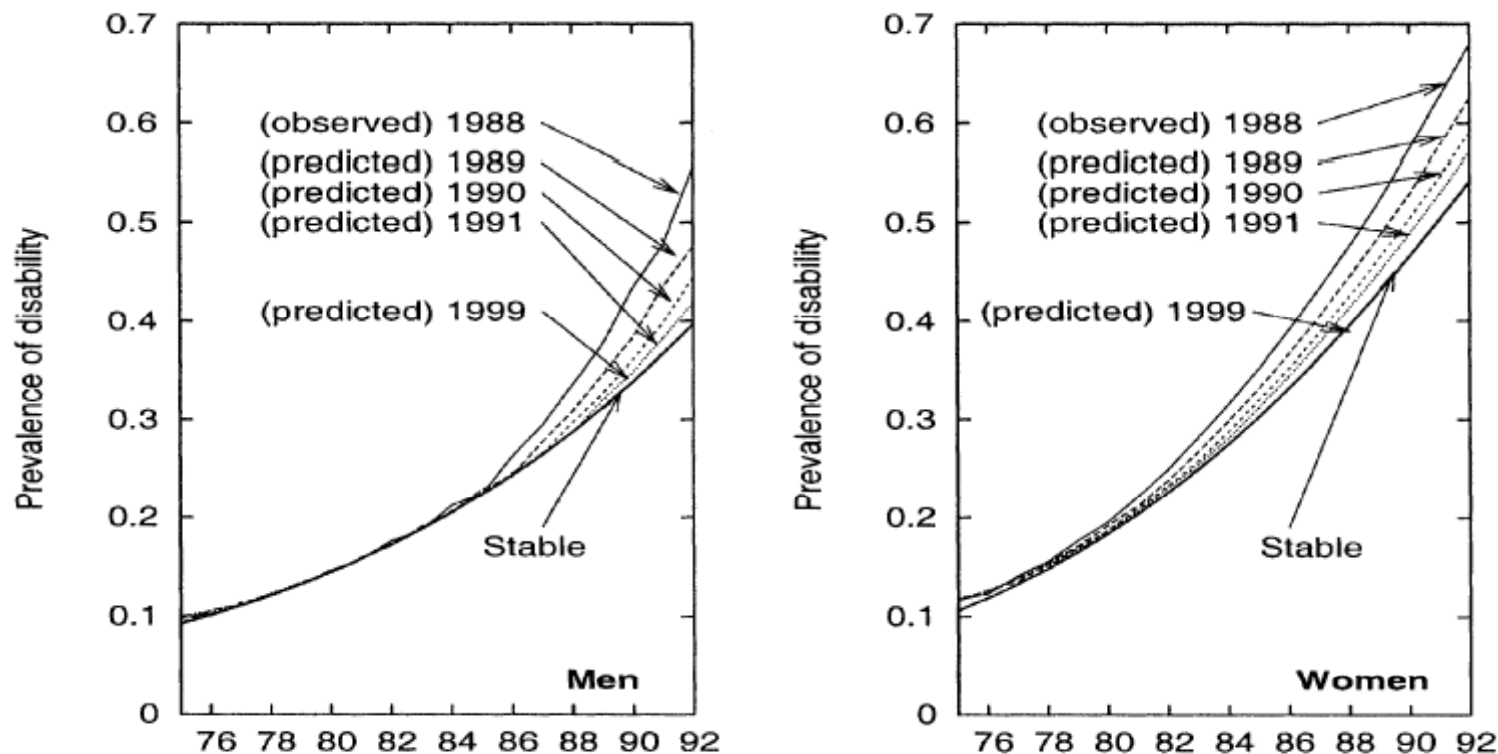
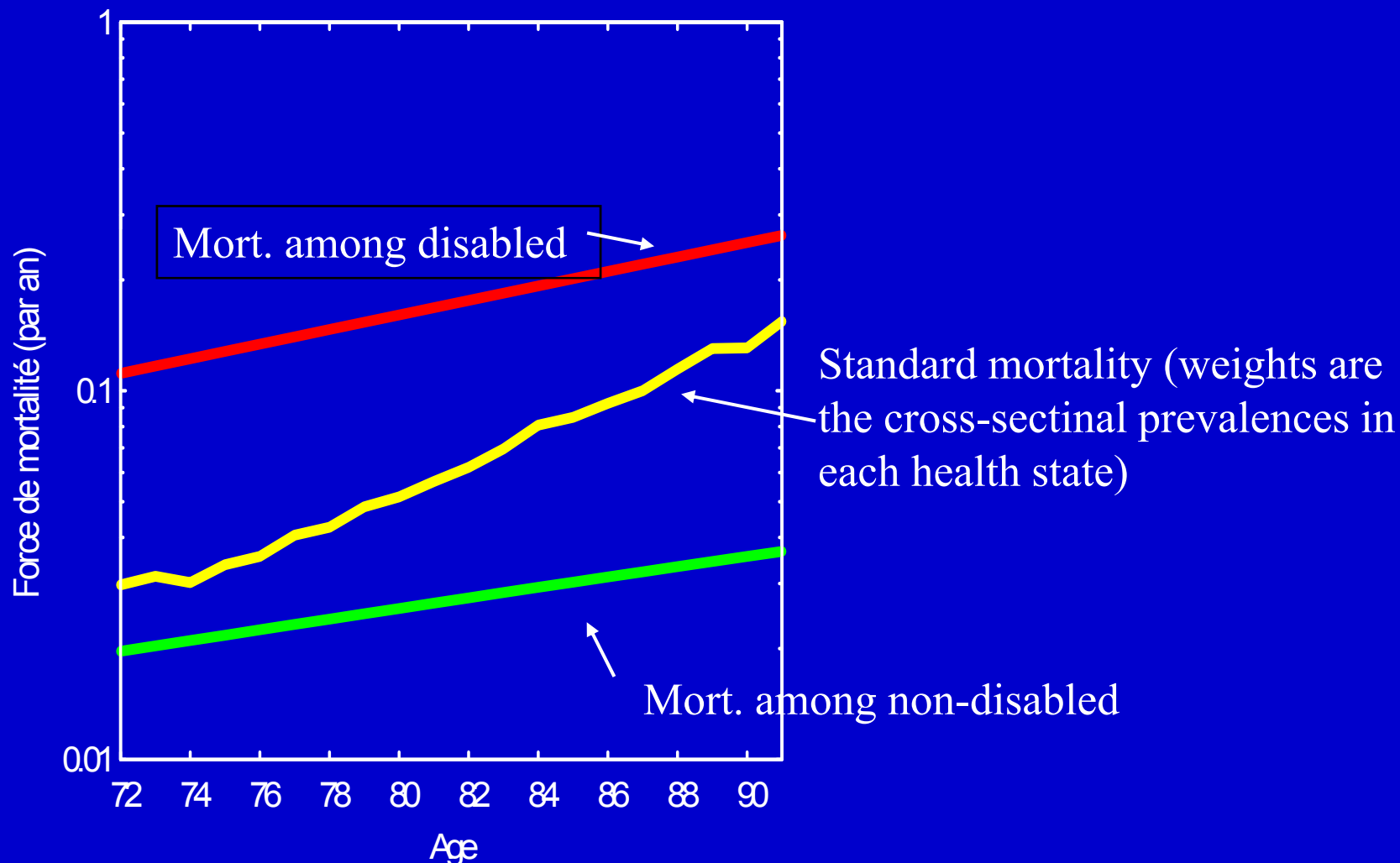


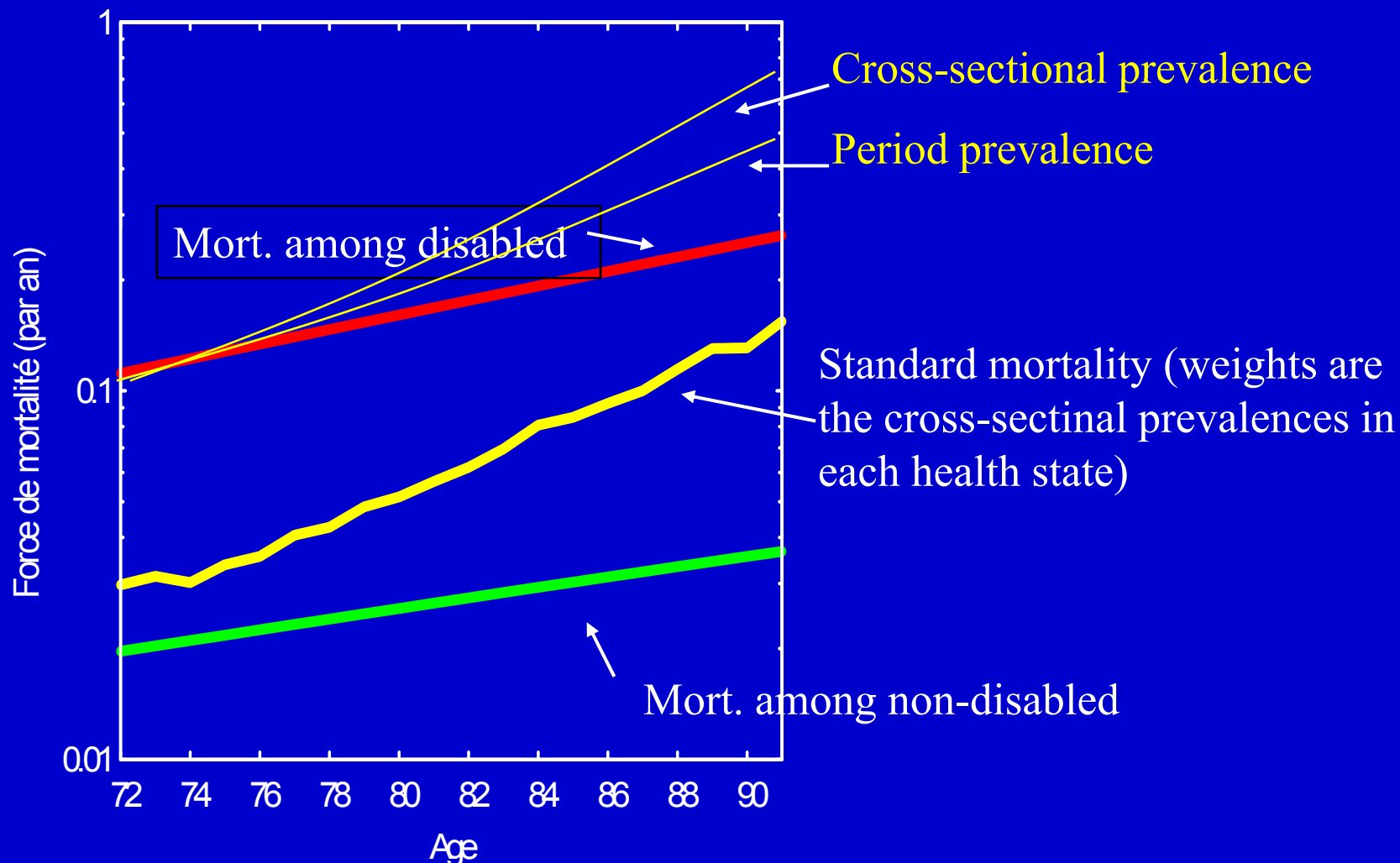
FIGURE 14. Projection of the age-specific prevalence of disability in the USA from the observed (and adjusted for institutions) prevalence in 1988 up to the stable prevalence, by sex.

Standard life expectancy : mortality is weighted by *cross-sectional* prevalences



Source: LSOA 1986-90 calculated with IMACh version 0.96d. Women.

Standard life expectancy : mortality is weighted by *cross-sectional* prevalences



Source: LSOA 1986-90 calculated with IMACh version 0.96d. Women.

- Current Life Expectancy is underestimated because it is based on cross-sectional prevalence of disability
- A more realistic Life Expectancy is computed from Period prevalence of disability.

Cross-sectional life table

- Life table=period survival function
- Survivors from cohorts born around 1924 are reaching age 80 today (2004). This cross-sectional prevalence of survivors (proportion of survivors from birth to age 80) is very low compared to proportion derived from period prevalence, i.e from the simulation using current age-specific mortality rates. Why? Because of 80 years of improvements against mortality.

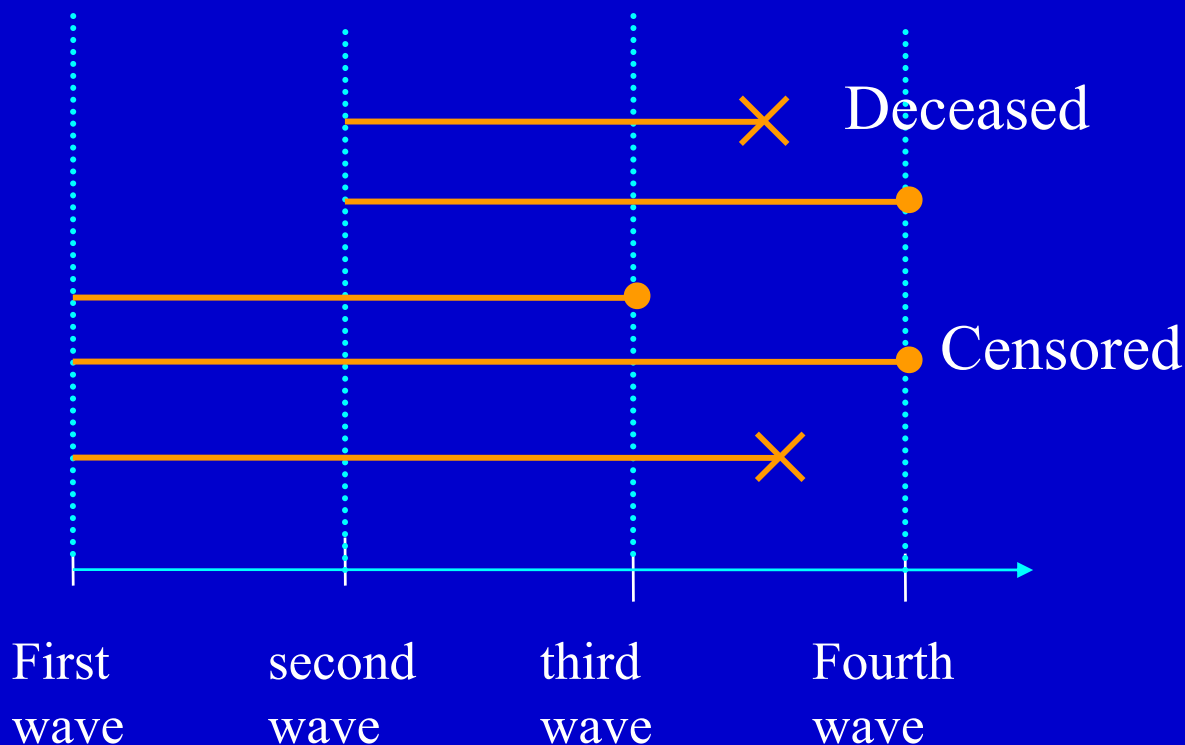
Using IMaCh for simple mortality analysis

- Estimating mortality from cross-longitudinal surveys is neither easy nor accurate with classical demographical tools.
- Even if dates of death are checked with data from vital statistics and are of good quality the samples are often too small to be divided into subgroups.
- Also it is mandatory to estimate the mortality of subgroups or even of the whole sample if it suspected of biases in comparison with national mortality estimates.

Background

- IMaCh 0.96d was able to estimate global mortality (and Life Expectancy) as a weighted mean of state specific mortality.
- Objective of the study : estimating mortality directly i.e. without specifying any health status from cross-longitudinal surveys

Survival time = exact duration between the first interview and the death if the person died before the last interview or the exact duration between the first and the last interview if the person is still alive.



Modeling approach

- Age-specific force of mortality is modeled as a Gompertz function $\mu(x) = a \exp(bx)$ where a and b are the parameters and x is age

- Contribution to the likelihood of the deceased:

$$\mu(x^d) \exp\left(-\int_x^{x^d} \mu(u) du\right)$$

- Contribution to the likelihood of the censored:

$$\exp\left(-\int_x^{x^c} \mu(u) du\right)$$

Modeling approach

- The likelihood is the product of all the individual contributions

$$L = \prod_{i=1}^n \left[\mu(x^d) \exp\left(-\int_x^{x^d} \mu(u) du\right) \right]^{(1-\delta_i)} \left[\exp\left(-\int_x^{x^c} \mu(u) du\right) \right]^{(\delta_i)}$$

- Maximum likelihood estimation

Solving $\frac{\partial \text{Log}L}{\partial a} = 0$ and $\frac{\partial \text{Log}L}{\partial b} = 0$

to find a and b .

- Option of the IMaCh programme version 0.70

How to run this programme

- Input data : same as for the IMaCh programme i.e. date of birth, date of death, date of interview. Just put **MLE=-3**
- Output : estimated parameter with the confidence interval & graph of the force of mortality

Application on two data sets

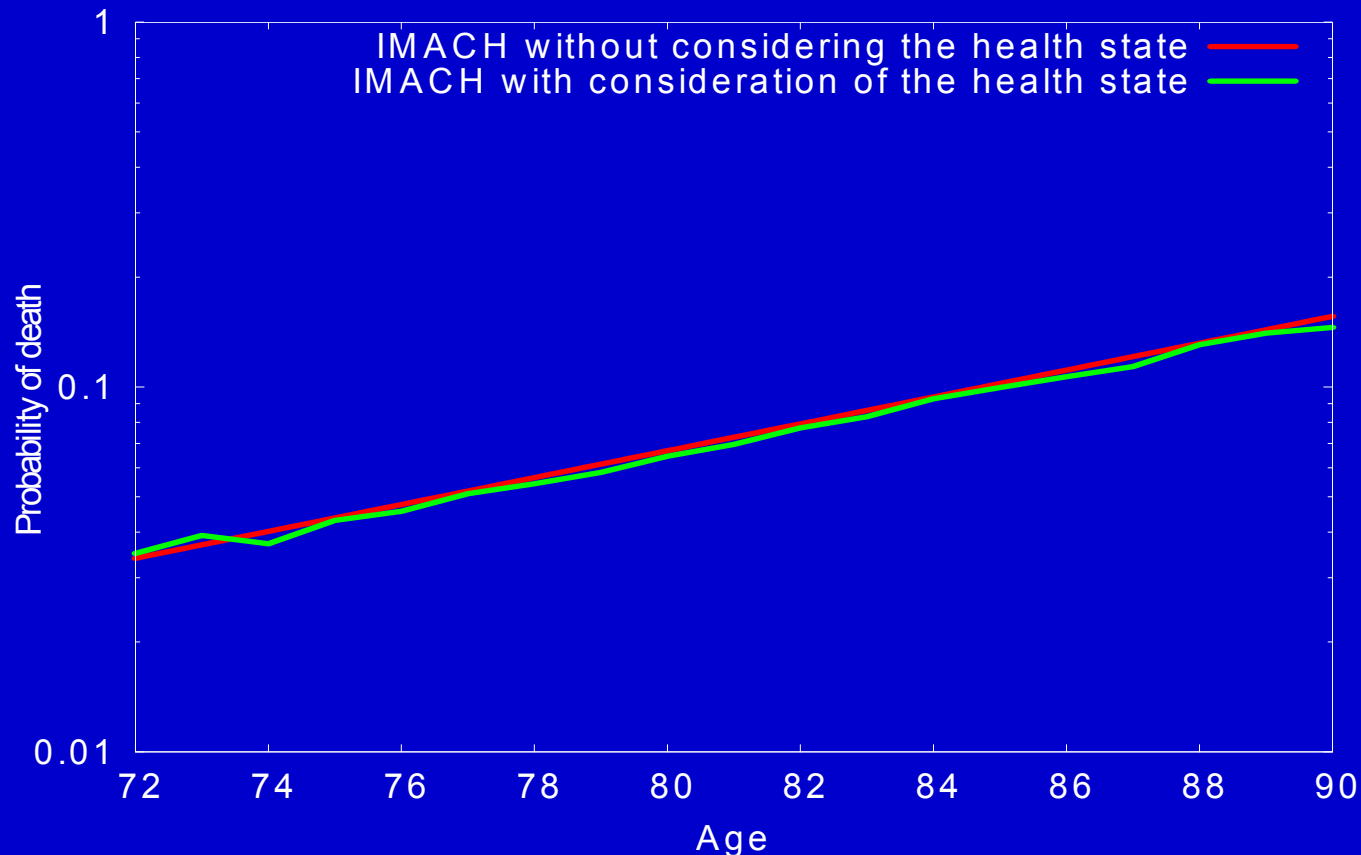
- The American LSOA survey : 4 waves 1984, 1986, 1988 and 1990.

Only the non-institutionalized persons at the baseline.

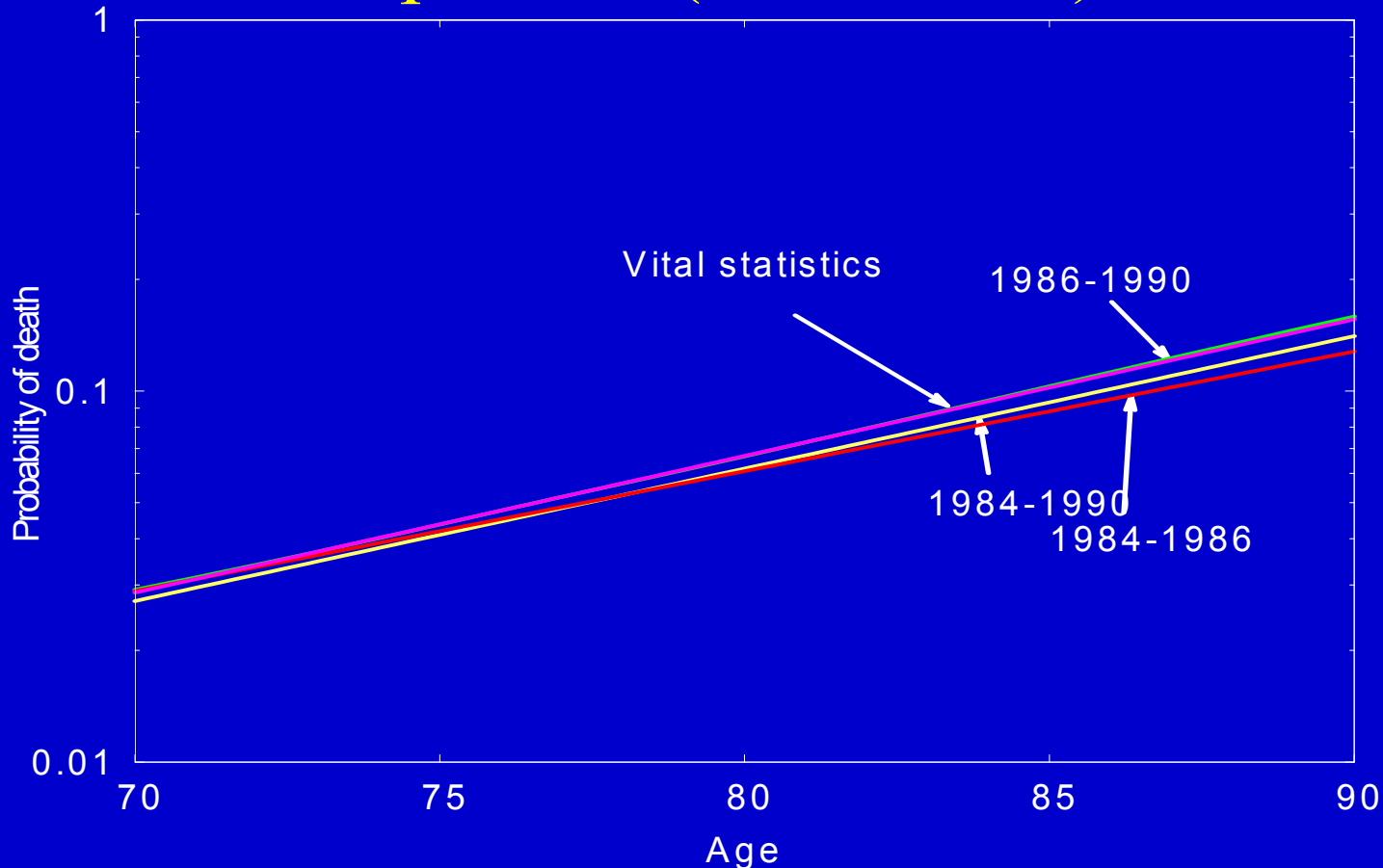
- The French HID survey : 2 populations, 2 waves 1998-2000 among institutionalized people and 1999-2001 among ordinary households.

Lack of follow-up between institution and household

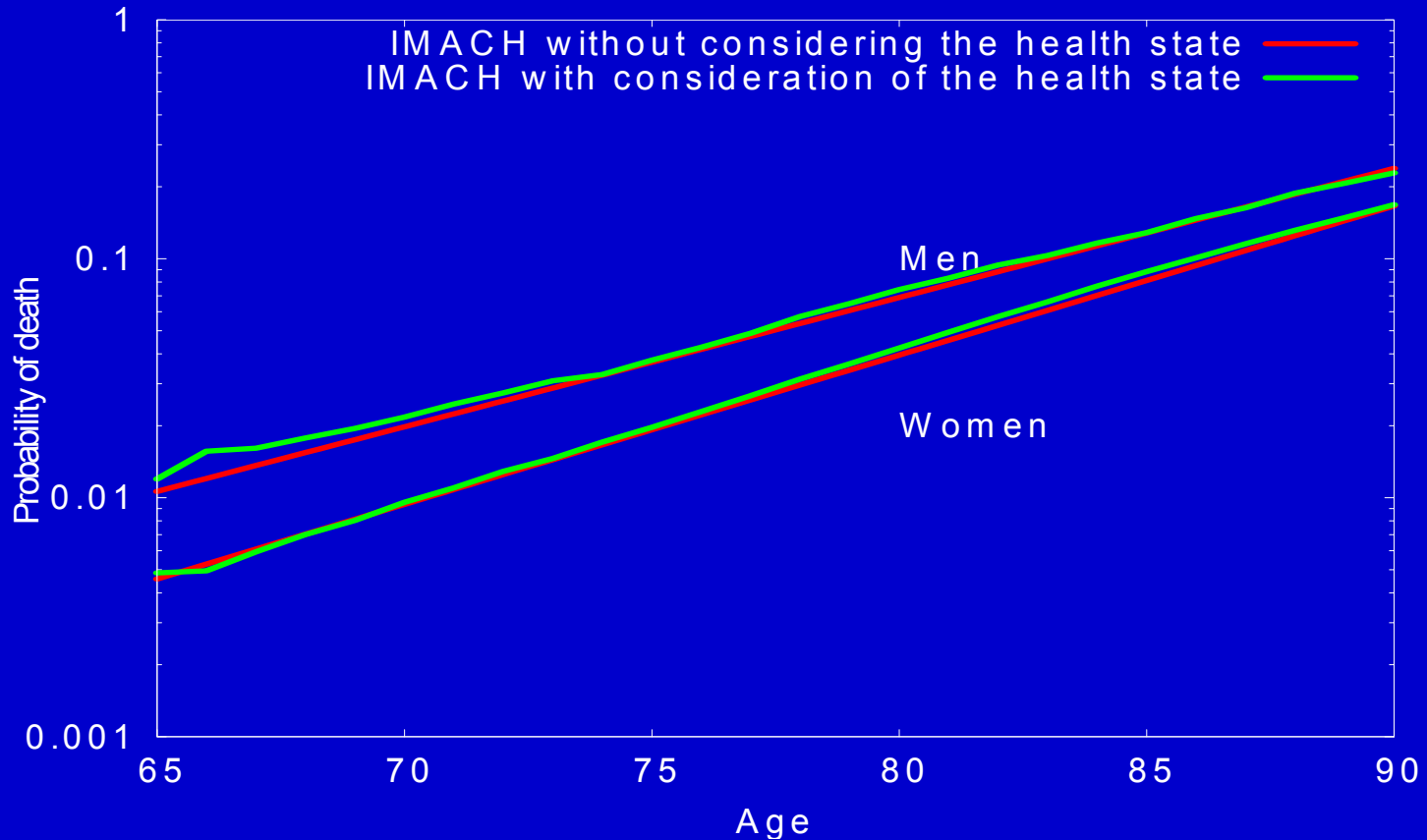
Global force of mortality calculated with and without consideration of the health state LSOA 1984-90.



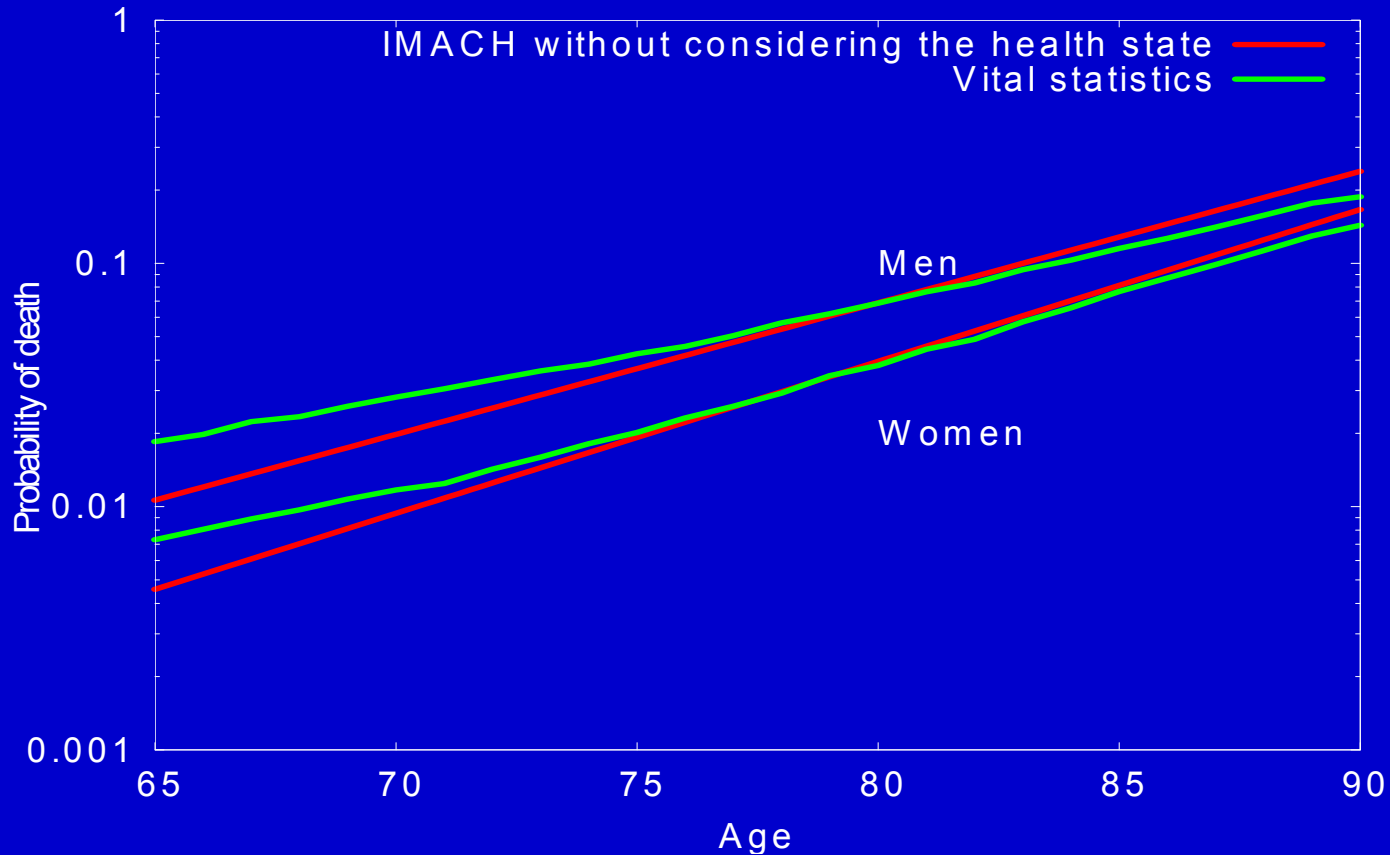
Evidence of an underestimation of mortality due to the lack of non-institutionalized persons (LSOA data)



Global force of mortality calculated with and without consideration of the health state (HID survey).



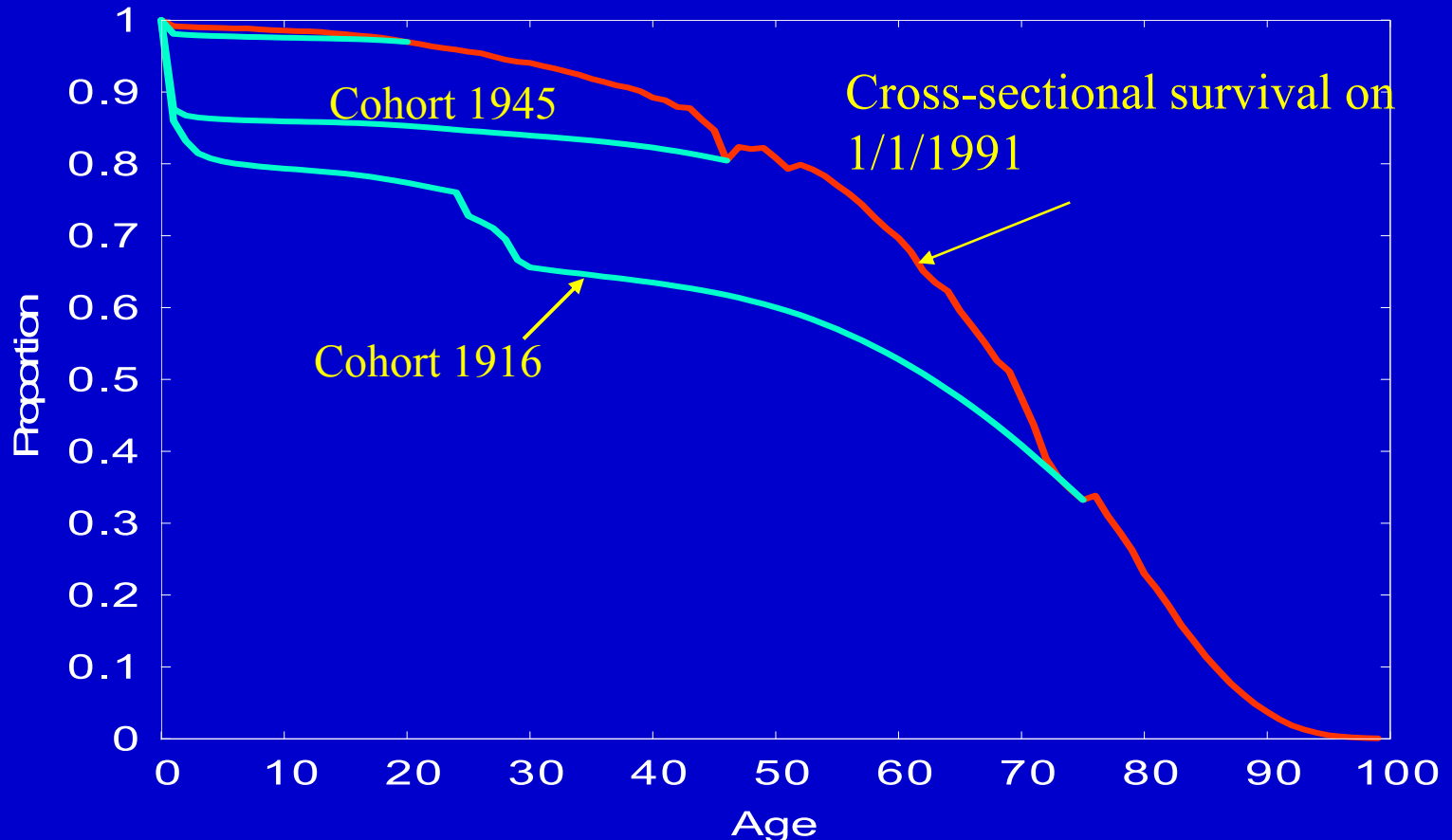
Evidence of an underestimation of mortality at youngest ages (HID survey)



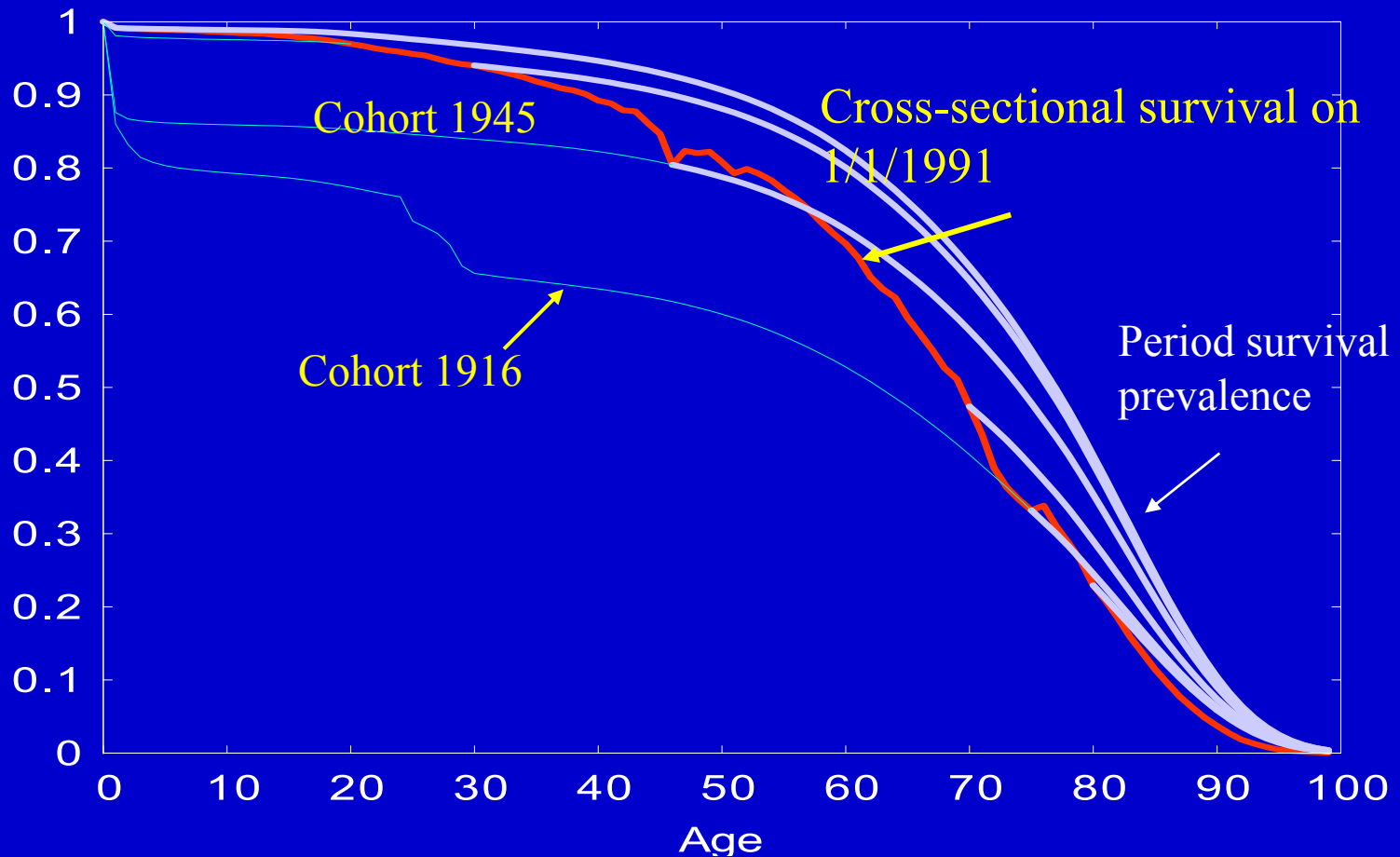
Conclusion

- Interest of period prevalence of disability in comparison to cross-sectional prevalence.
- Improvement in the IMaCh program by calculating mortality from the deaths recorded between the waves of a cross-longitudinal survey.

Proportion of survivors among cohorts and cross-sectional prevalence of survivors

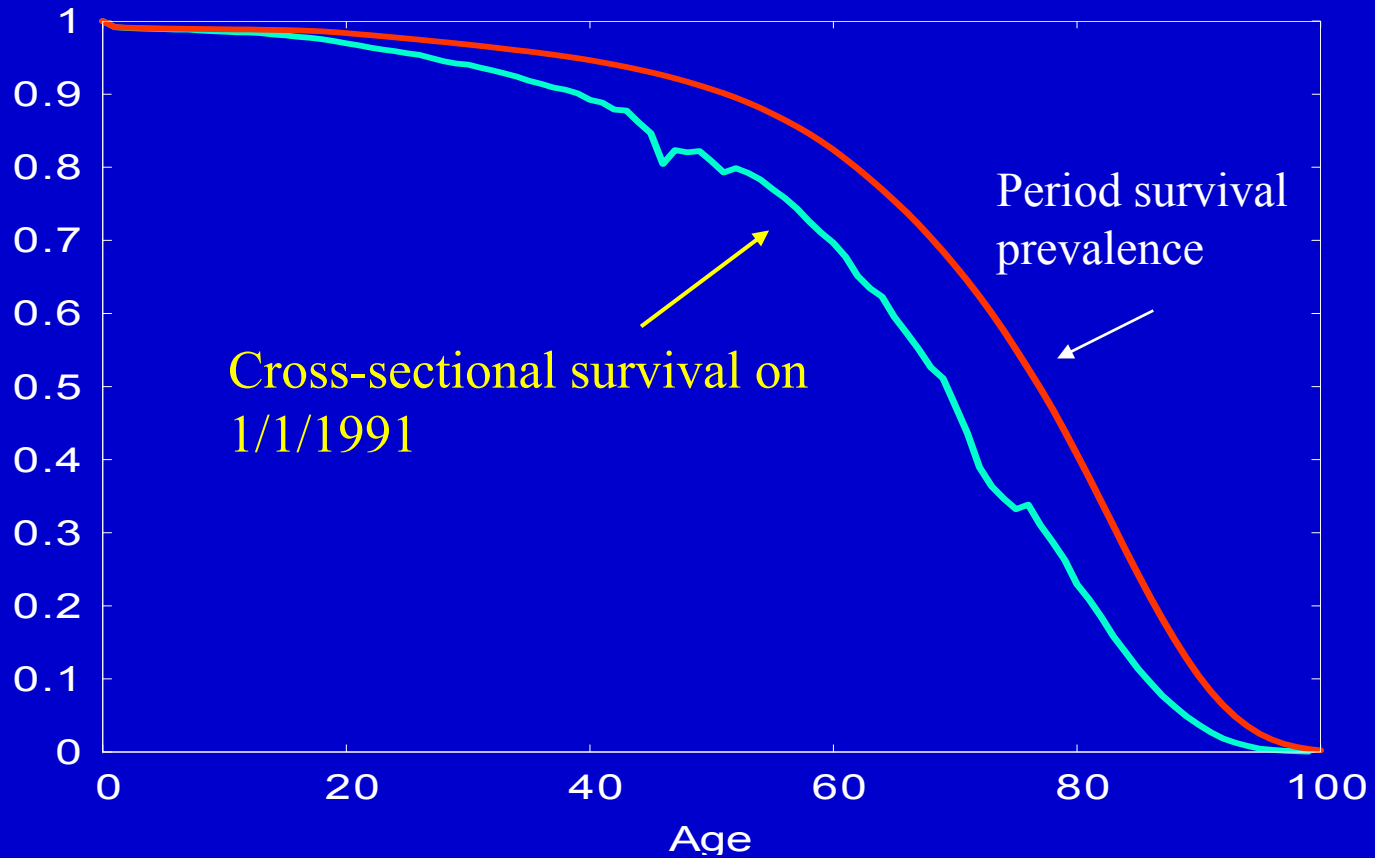


Projection of survivors for some cohorts under the hypothesis of steady mortality rates beyond 1991



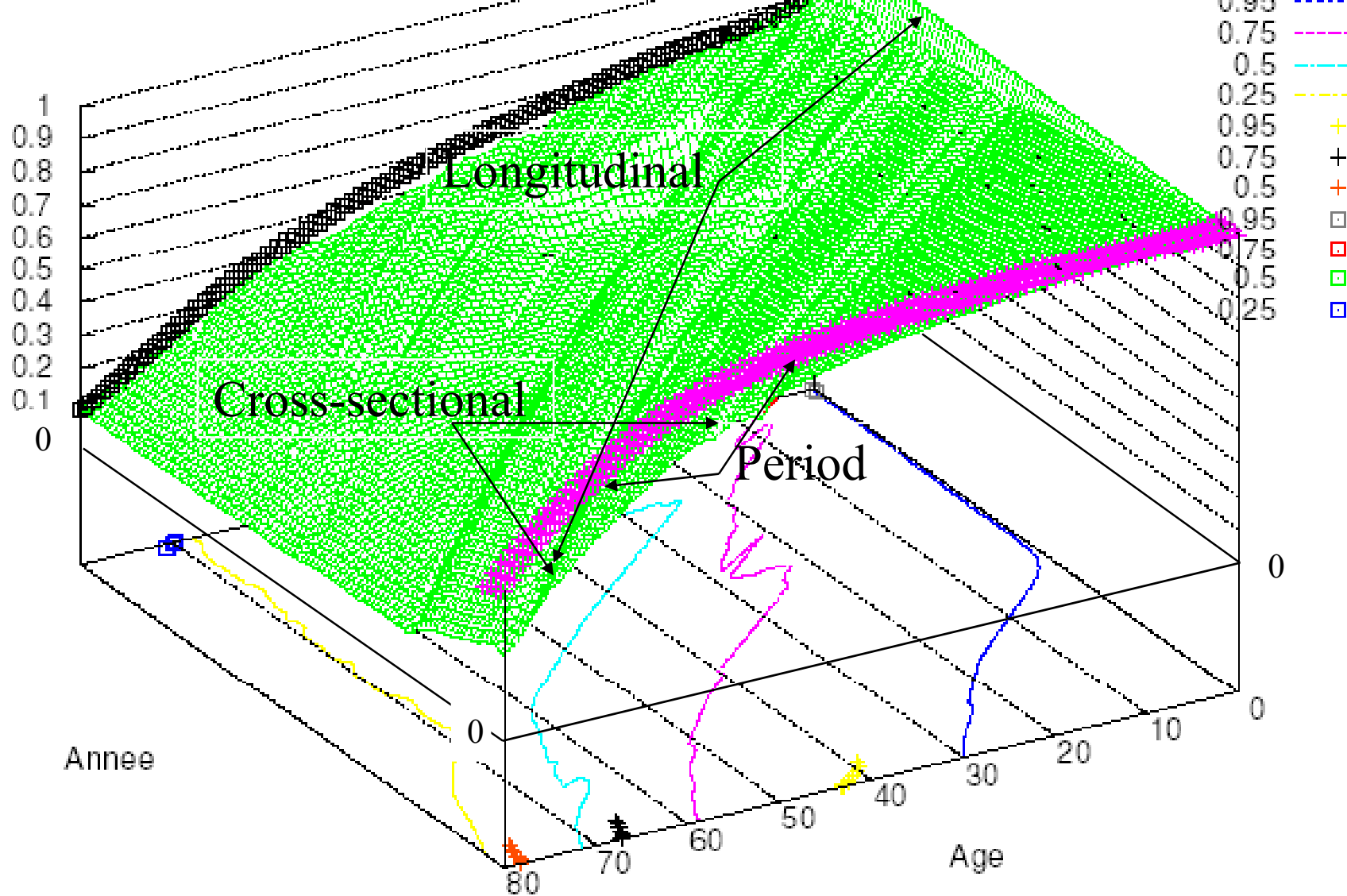
Cross-sectional survival prevalence on 1/1/1991 and period survival prevalence based on mortality from 1/1/1991 to 12/31/1991

Proportion

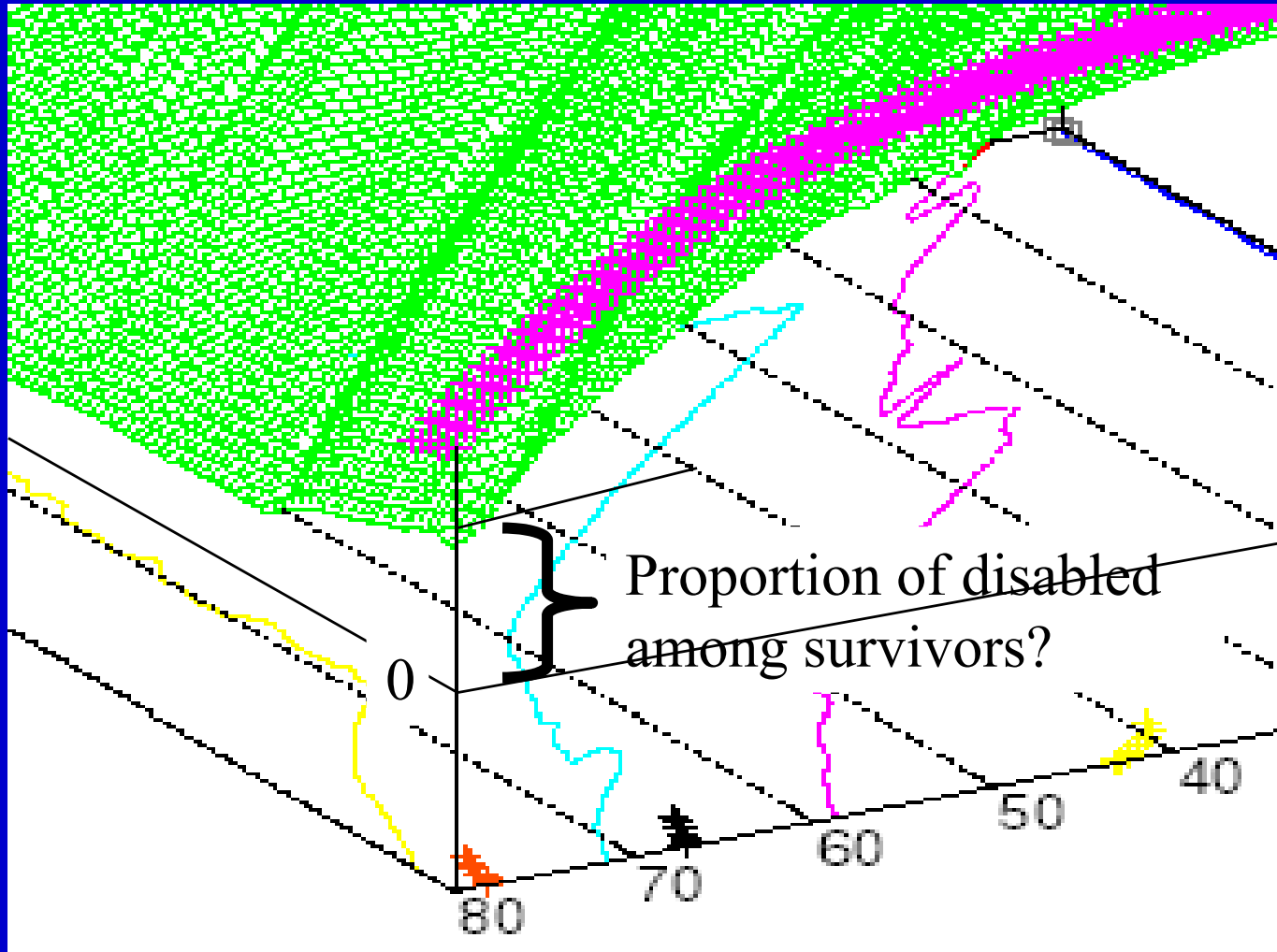


Proportion de survivants de sexe masculin en France par age et annee de naissance. 1900-1997

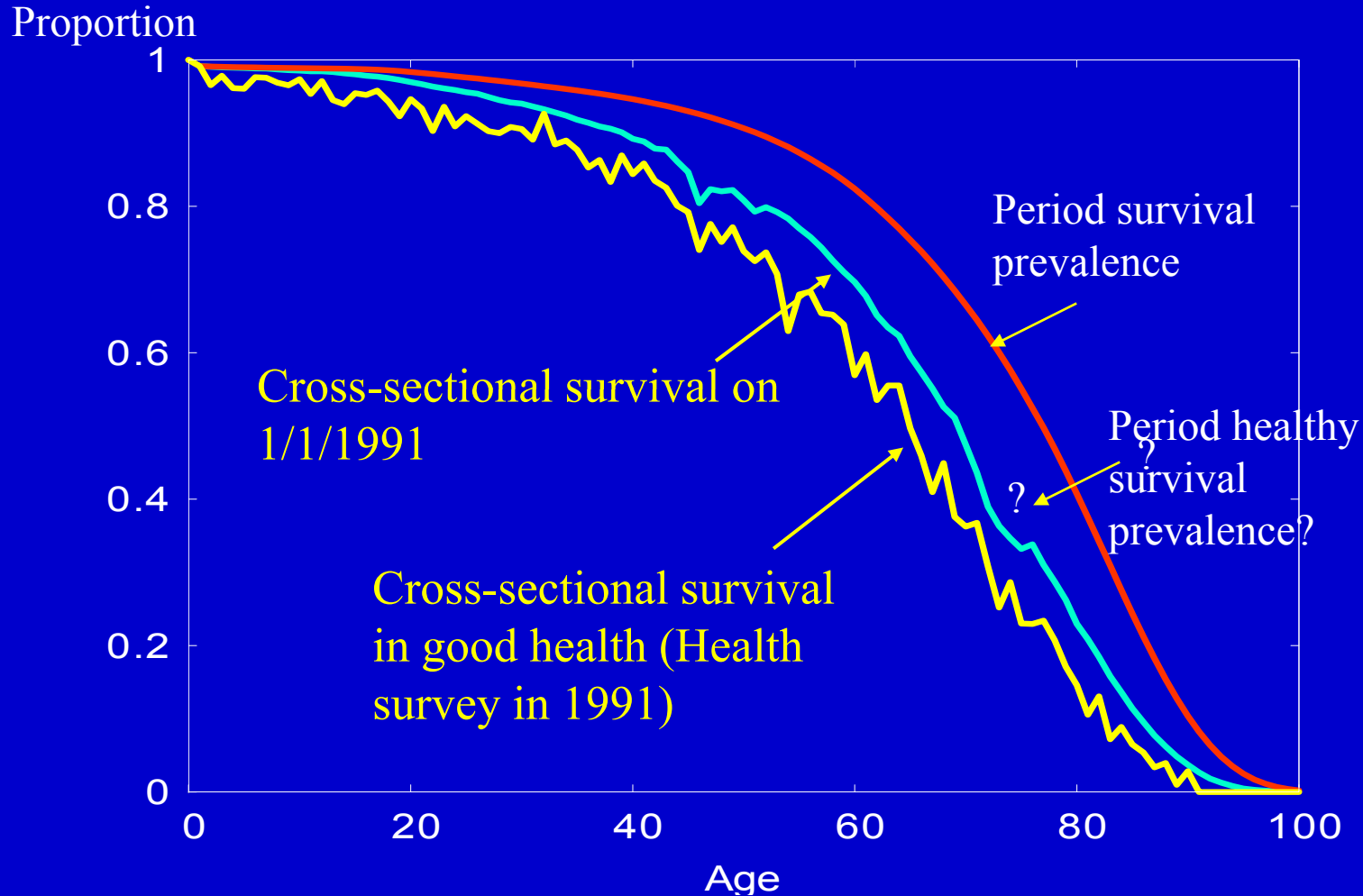
Survivants



Proportion of disabled among survivors? Again: cross-section or period?



Mean healthy life versus healthy life expectancy



Interpolated Markov Chain (IMaCh)

- A. Lièvre, N. Brouard, Ch. Heathcote.
(2003) -- Computing Health Expectancies
from Cross-longitudinal Surveys, *Math.
Pop. Stud.*, 10 (1), 1-52.
- Simplest model of a Life Table with
heterogeneity: i.e 2 Health statuses =>
differential mortality, incidence of
disability, incidence of recovery.