

Evaluating the Completeness of Death Registration for Developing Countries at Old Ages

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(I) Analytical Evaluations

Using population numbers to estimate deaths; then using the estimated deaths to evaluate the registered deaths.

For stable populations (Brass, 1975)

$$D(x+) = p(x) - r \cdot P(x+)$$

For non-stable populations (Hill, 1987)

$$D(x+) = p(x) - r(x+) \cdot P(x+)$$

These models have three elements: Death, Entry population (or birth for $x=0$) and Growth.

In methodology, these methods are sound:

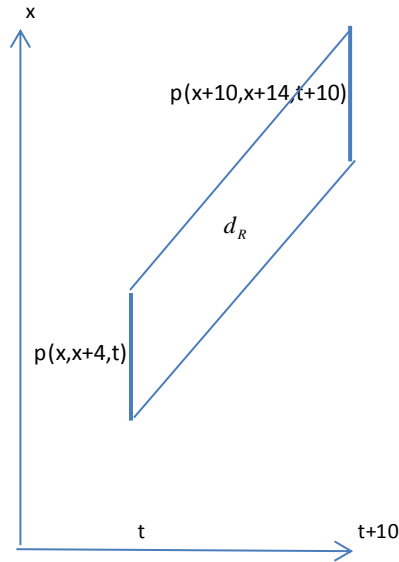
the effects of migration and errors in Growth and entry population can be included
and therefore the errors in $D(x+)$ can be eliminated.

But the errors in $D(x+)$ cannot be eliminated in practice,
because migration and errors in Growth and Entry population are often unknown.

When we cannot eliminate the errors, what can we do?

We can analyze the errors, and then choose to have the smaller ones.

(II) Intercensal Cohort Survival Evaluation (ICSE)



ICSE estimates the deaths occurred in the process of cohort survival:

$$\hat{d} = p(x, x+4, t) - p(x+10, x+14, t+10),$$

the age groups can be open as $x+$,
and the assumption of zero migration will be removed in a minute.

On the other hand, the registered deaths in the diamond shape,
can be counted or estimated using even distributions.

Subsequently, the completeness of DR is evaluated as

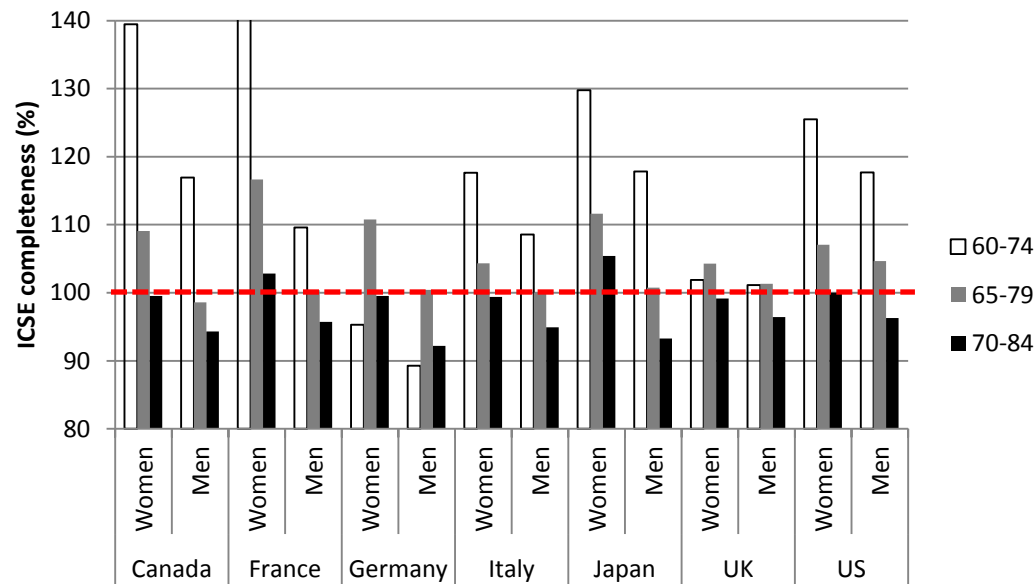
$$\hat{c} = d_R / \hat{d},$$

ICSE is proposed for old ages such as 60+.

The assumption of zero migration is replaced by the knowledge that:
At old ages migration is negligible comparing to deaths.

ICSE is based on survival, and does not have 'Entry population' and 'Growth'.
This simplification allows to analyze the errors of evaluation.

(III) Applying ICSE to the G7 countries in 2000-2010



We checked the data of Japan: Migration is negligible and census errors are less than 2% at old ages. We believe this is common for the other G7 countries.

Then, why are the errors of evaluation so large?

(IV) The errors of ICSE

$$\begin{aligned}
 E_c(s, u_1, u_2) &= \frac{\hat{c} - c}{c} = \frac{d_R / \hat{d} - d_R / d}{d_R / d} = \frac{d - \hat{d}}{\hat{d}} \\
 &= \frac{p_1 - p_2 - [\hat{p}_1 - \hat{p}_2]}{[\hat{p}_1 - \hat{p}_2]} = \frac{p_1 - p_2 - [p_1(1 - u_1) - p_2(1 - u_2)]}{[p_1(1 - u_1) - p_2(1 - u_2)]} \\
 &= \frac{p_1 - s \cdot p_1 - [p_1(1 - u_1) - s \cdot p_1(1 - u_2)]}{[p_1(1 - u_1) - s \cdot p_1(1 - u_2)]} = \frac{1 - s - [(1 - u_1) - s(1 - u_2)]}{[(1 - u_1) - s(1 - u_2)]} \\
 &= \frac{u_1 - s \cdot u_2}{1 - s - (u_1 - s \cdot u_2)} = \frac{u}{1 - s - u}
 \end{aligned}$$

This formula indicates two features about the errors of evaluation.

Feature 1: Evaluation error is bigger when mortality level is lower, and vice versa.
Mortality level affects evaluation was unknown before.

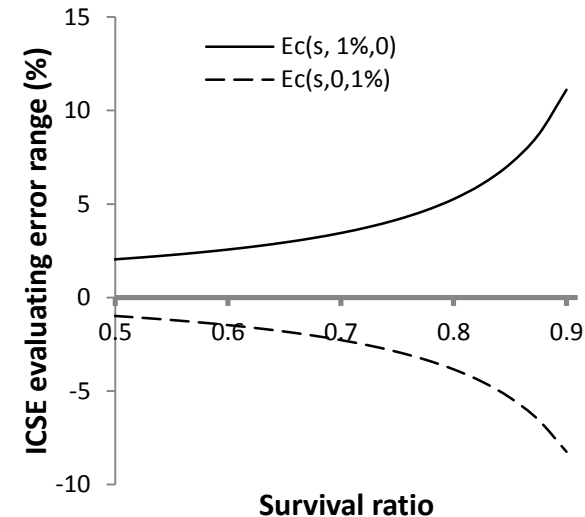
*The evaluation error rises with u by a slope bigger than $1/(1-s)$.
 When the s is about 0.95 (some G7 females aged 60),
 the evaluation error could be larger than 40% if u is about 2%.*

Feature 2: Over evaluation would occur more often than under evaluation.
This was also unknown before.

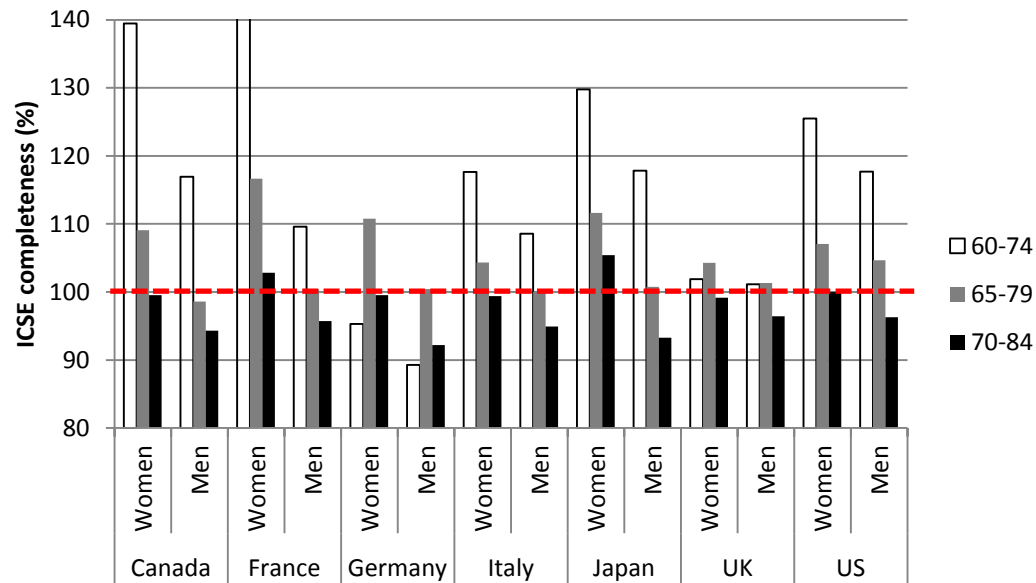
The effects of the errors of the first and second census are different:

$$\frac{-s \cdot u_2}{1 - s + s \cdot u_2} = E_c(s, 0, u_2) < E_c(s, u_1, u_2) < E_c(s, u_1, 0) = \frac{u_1}{1 - s - u_1}$$

Conclusion: ICSE tends to work when mortality is high and completeness is low,
which is typically the situation of developing countries at old ages.



The two features can explain the details of the G7 applications.



Feature 1:

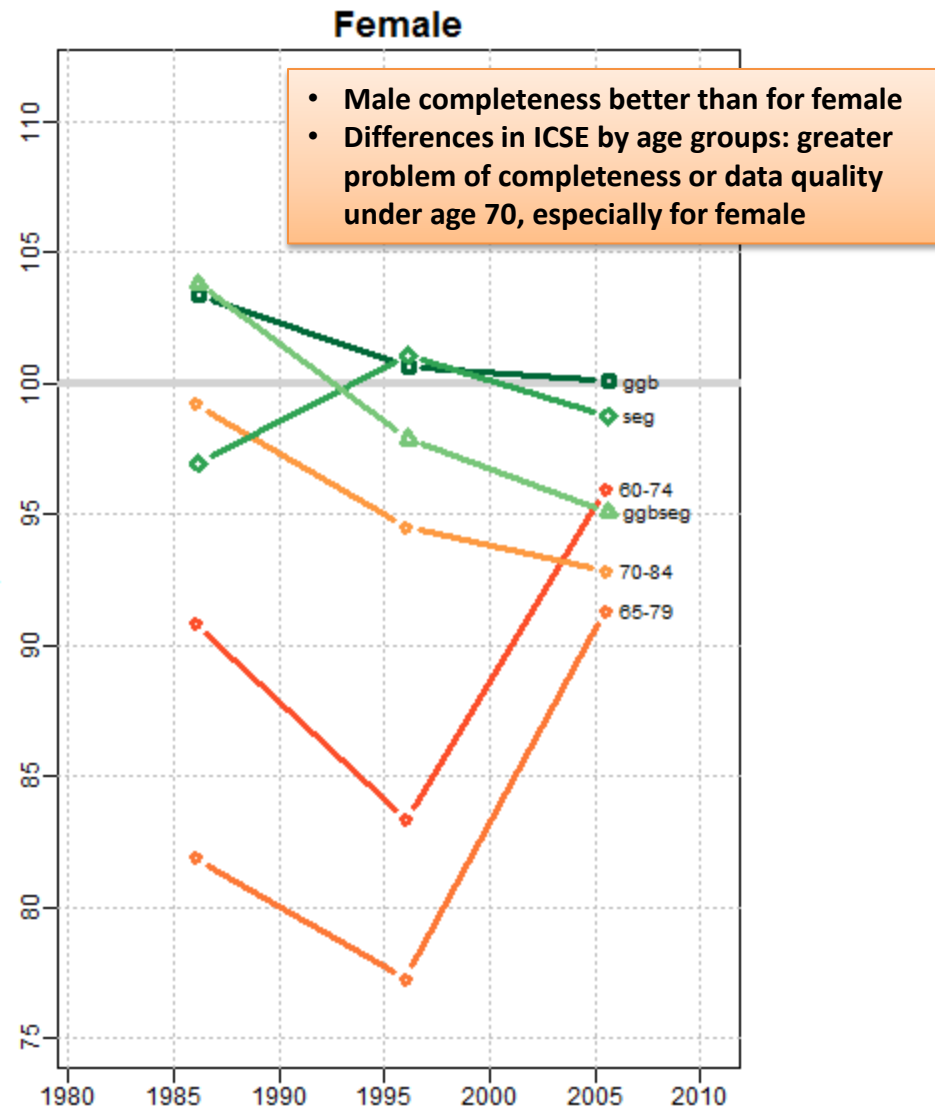
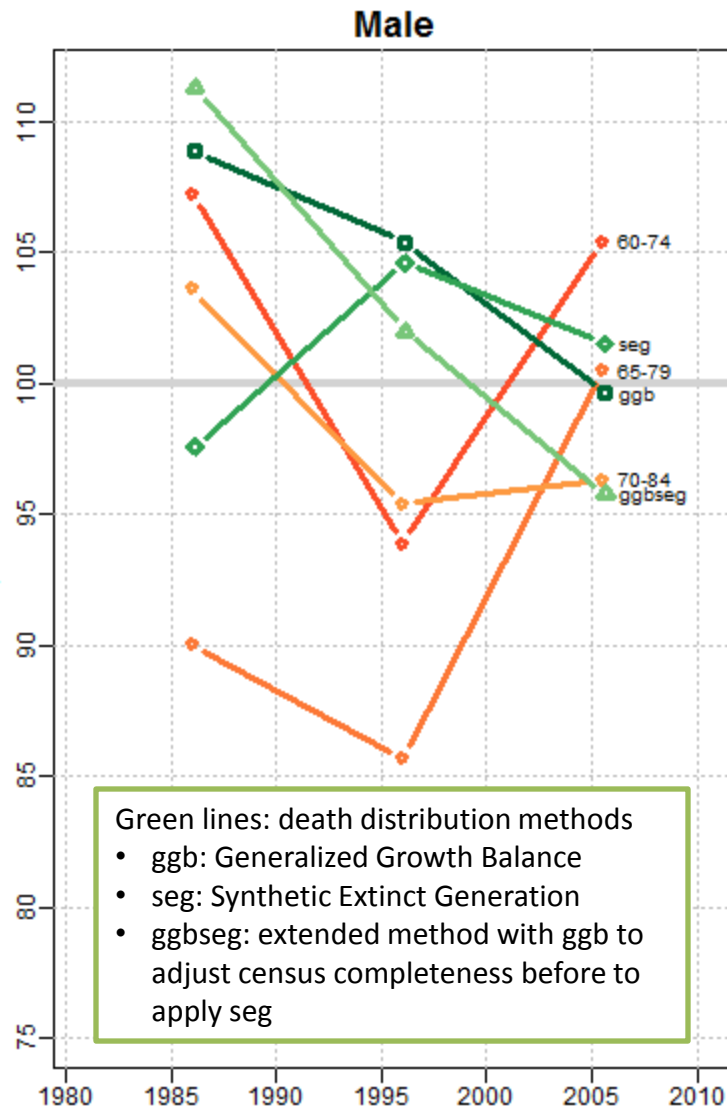
Female mortality are lower than that of male,
the evaluation errors of female (4.8%) are larger than that of male (2.3%).

Mortality levels at younger ages are lower than that at older ages,
the evaluation errors at younger ages are larger than that at older ages (8.5%, 2.6%, 1.1%).

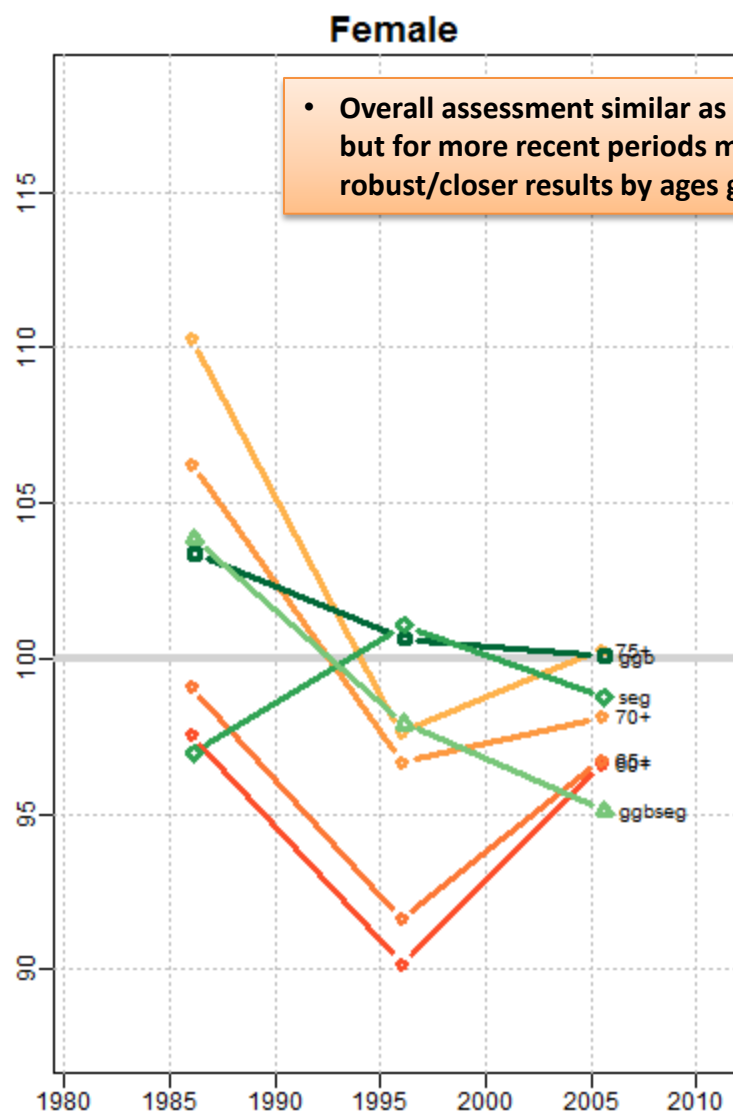
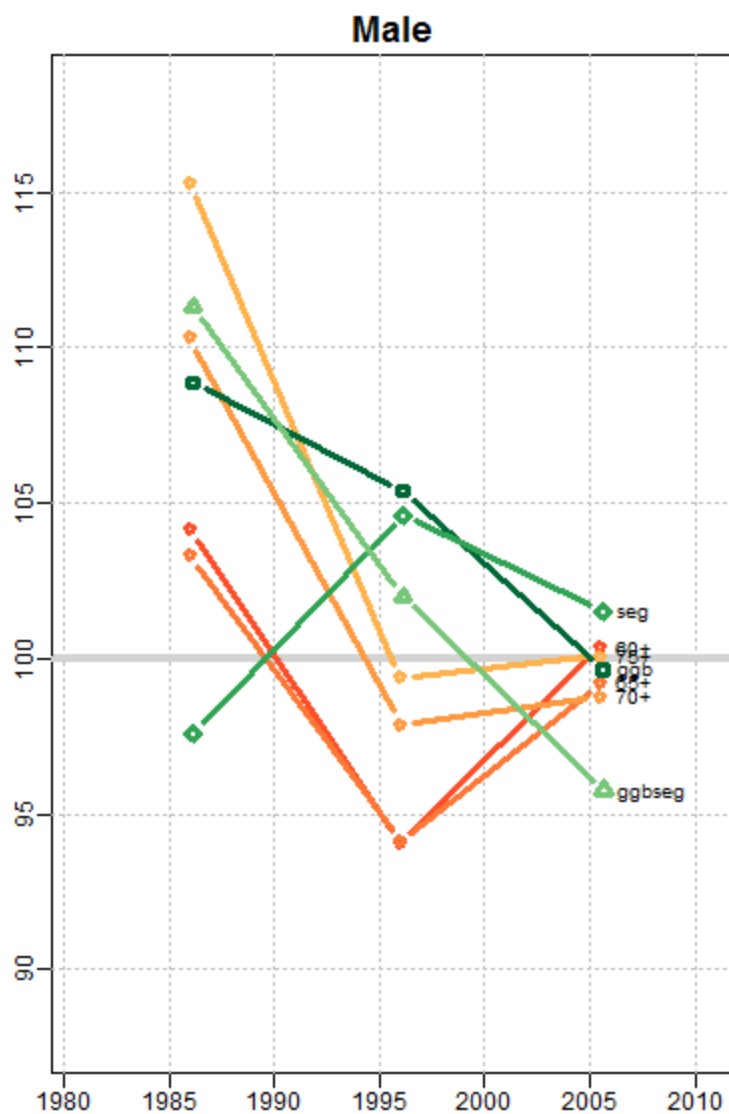
Feature 2:

more over evaluations (>100, 28 out of 42) than under-evaluations (<98, 9 out of 42).

Brazil: 1980-2010 – ICSE by age group

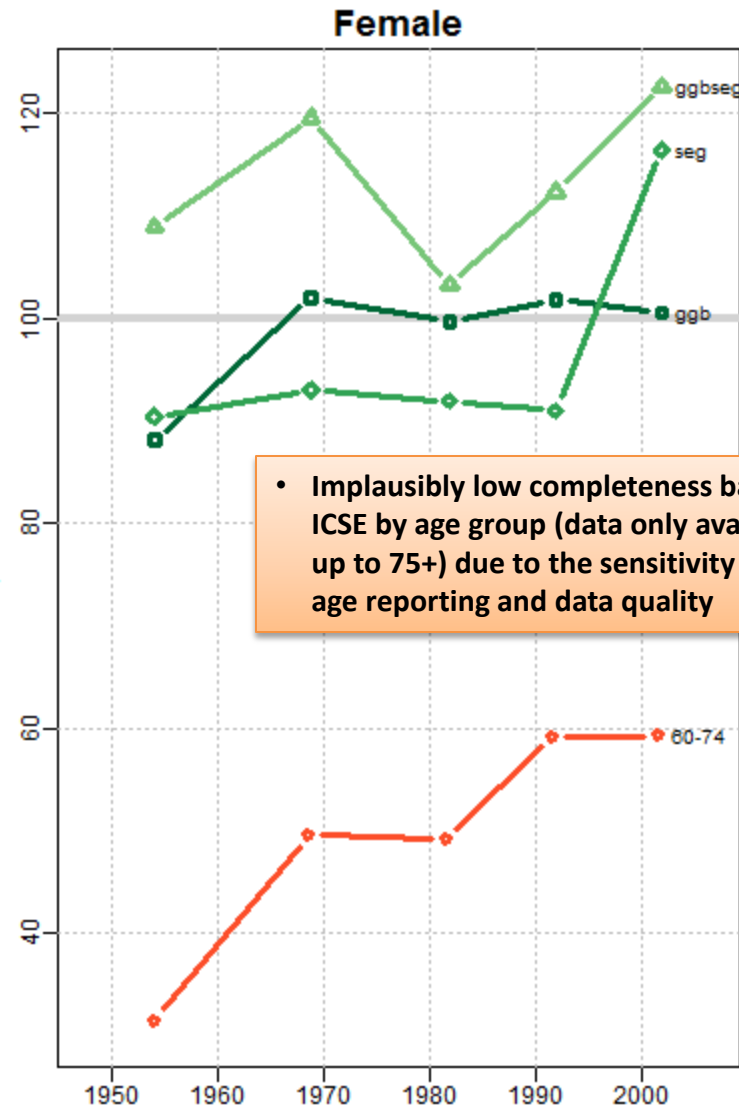
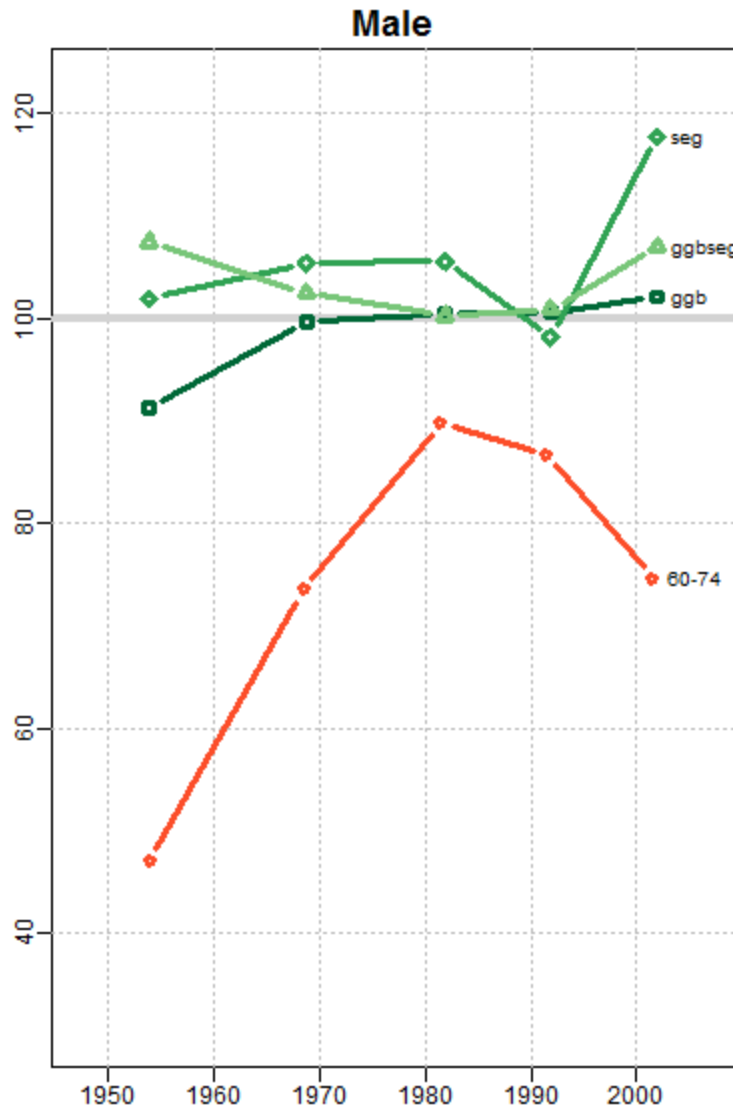


Brazil: 1980-2010 – ICSE by open age group



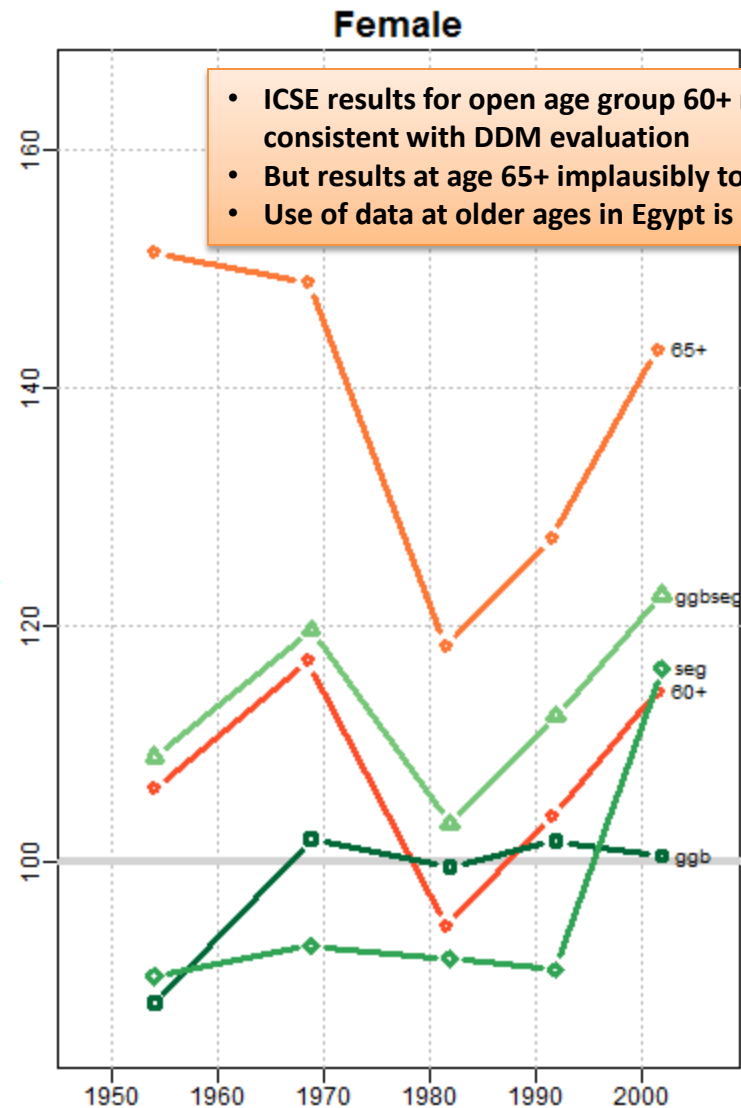
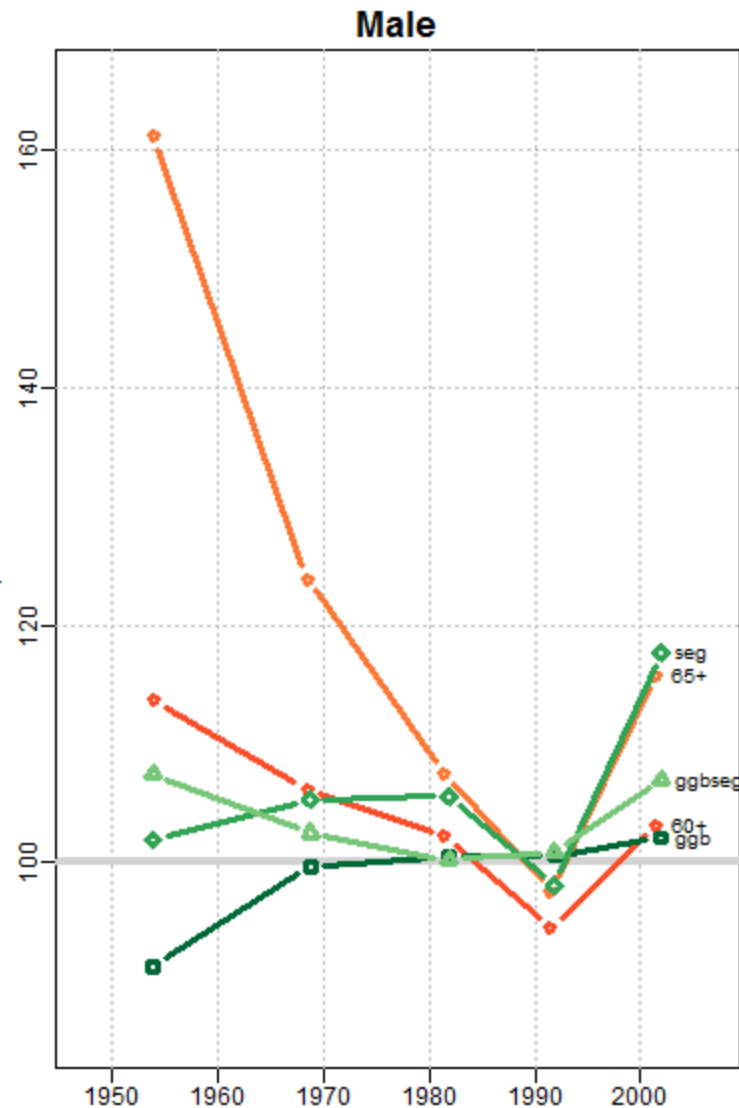
- Overall assessment similar as by age group, but for more recent periods more robust/closer results by ages groups

Egypt: 1947-2006 – ICSE by age group



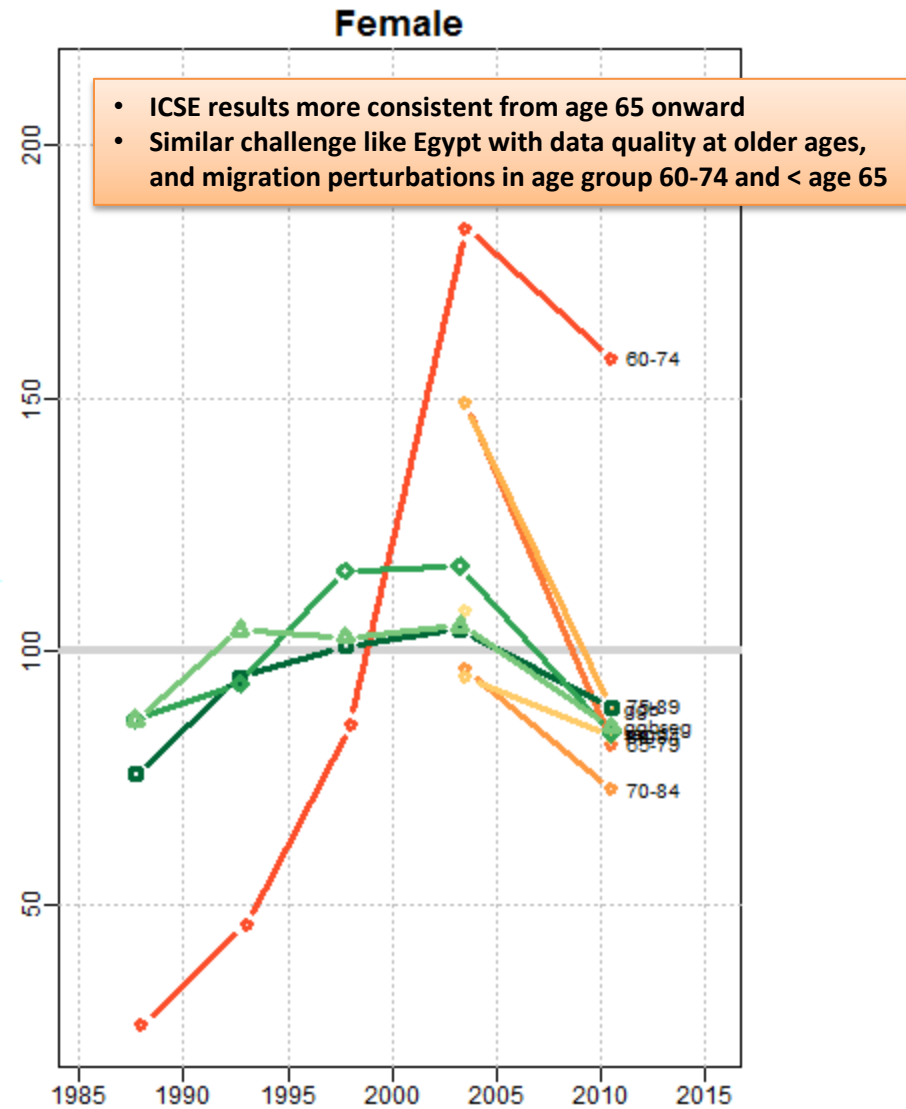
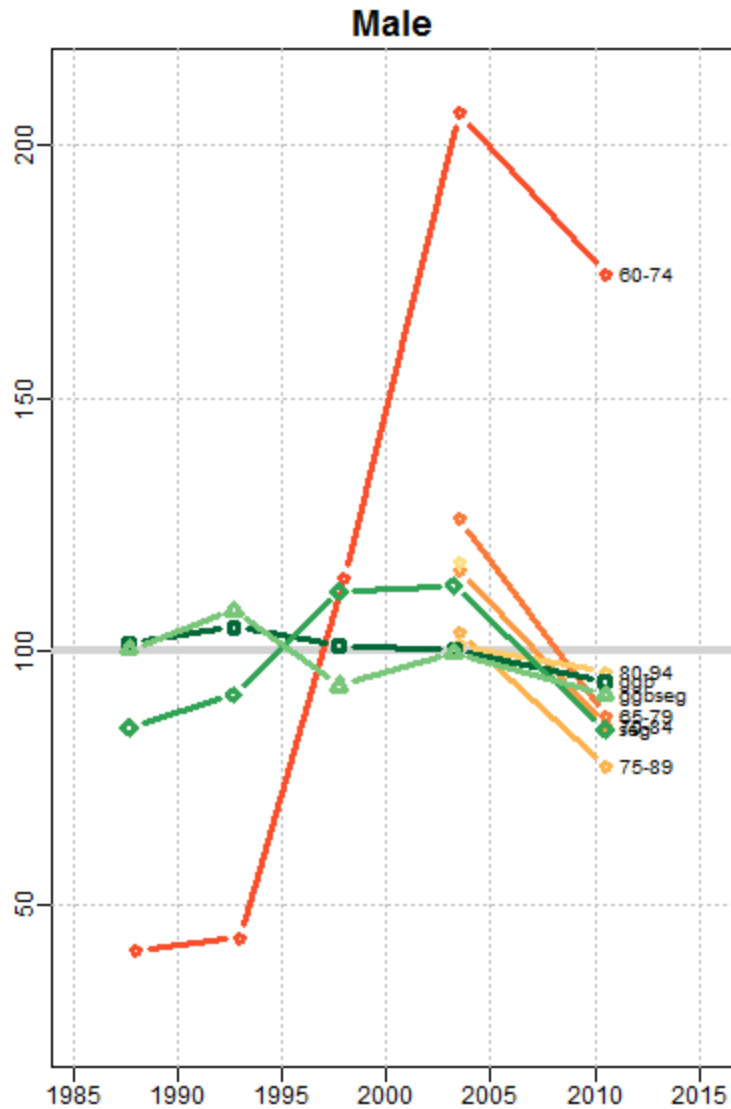
- Implausibly low completeness based on ICSE by age group (data only available up to 75+) due to the sensitivity of the age reporting and data quality

Egypt: 1947-2006 – ICSE by open age group

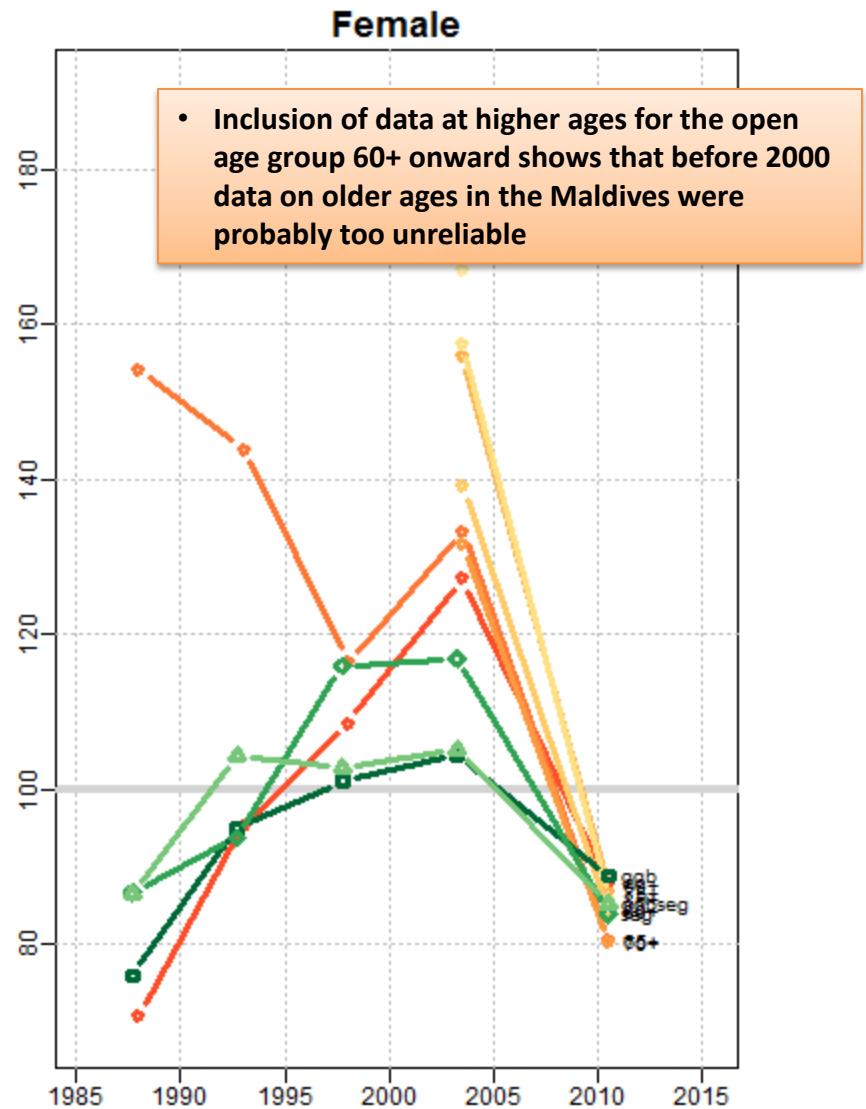
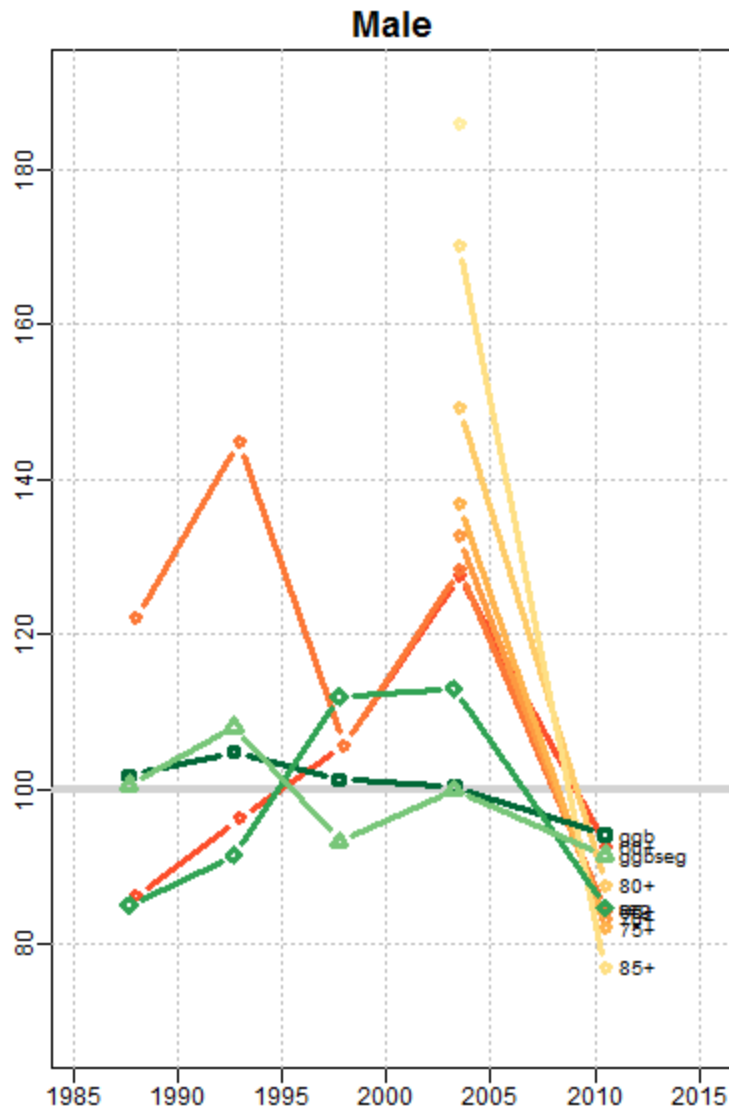


- ICSE results for open age group 60+ more consistent with DDM evaluation
- But results at age 65+ implausibly too high
- Use of data at older ages in Egypt is problematic

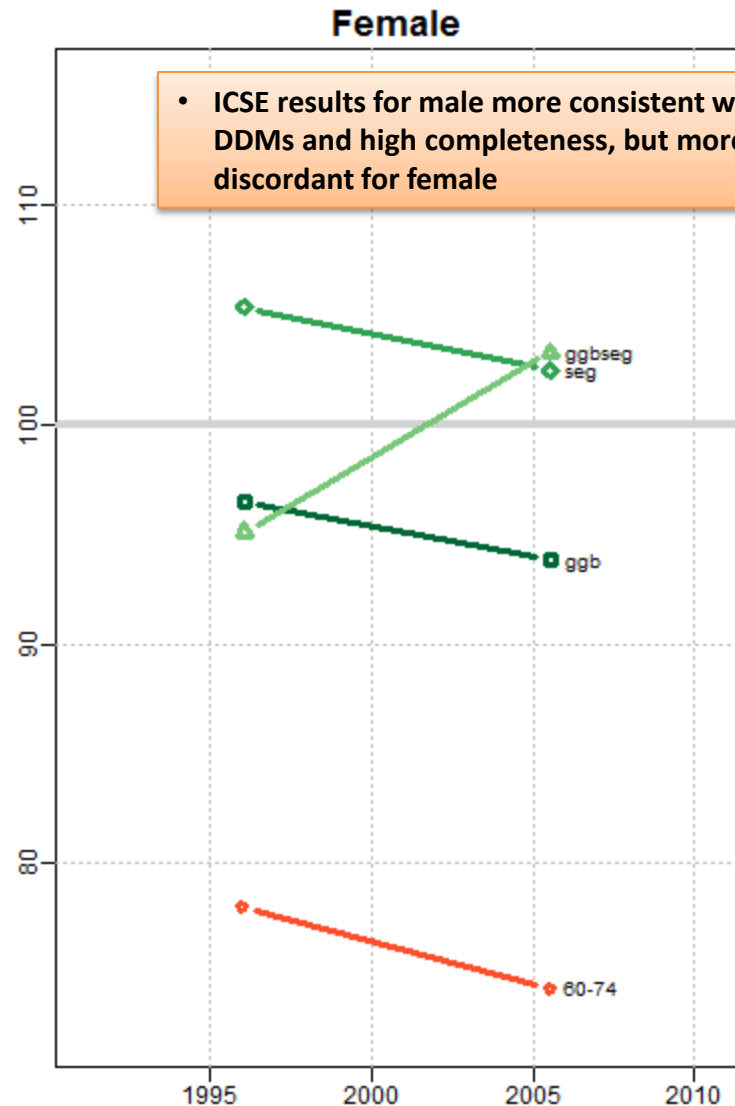
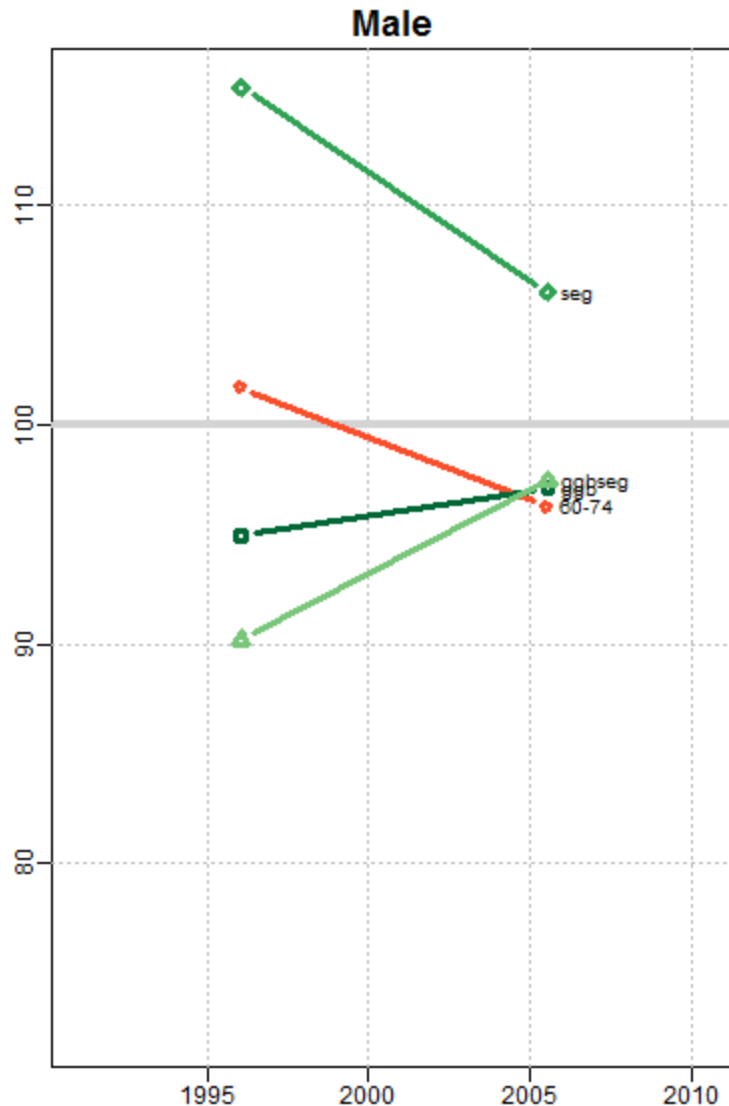
Maldives: 1985-2014 – ICSE by age group



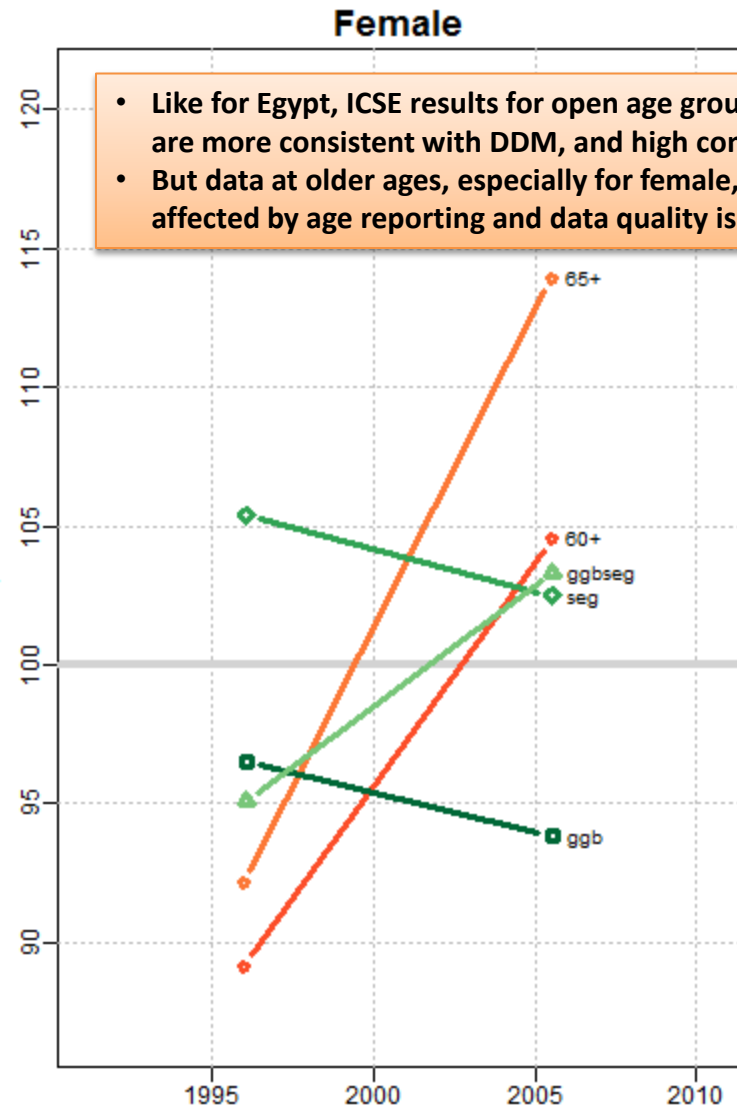
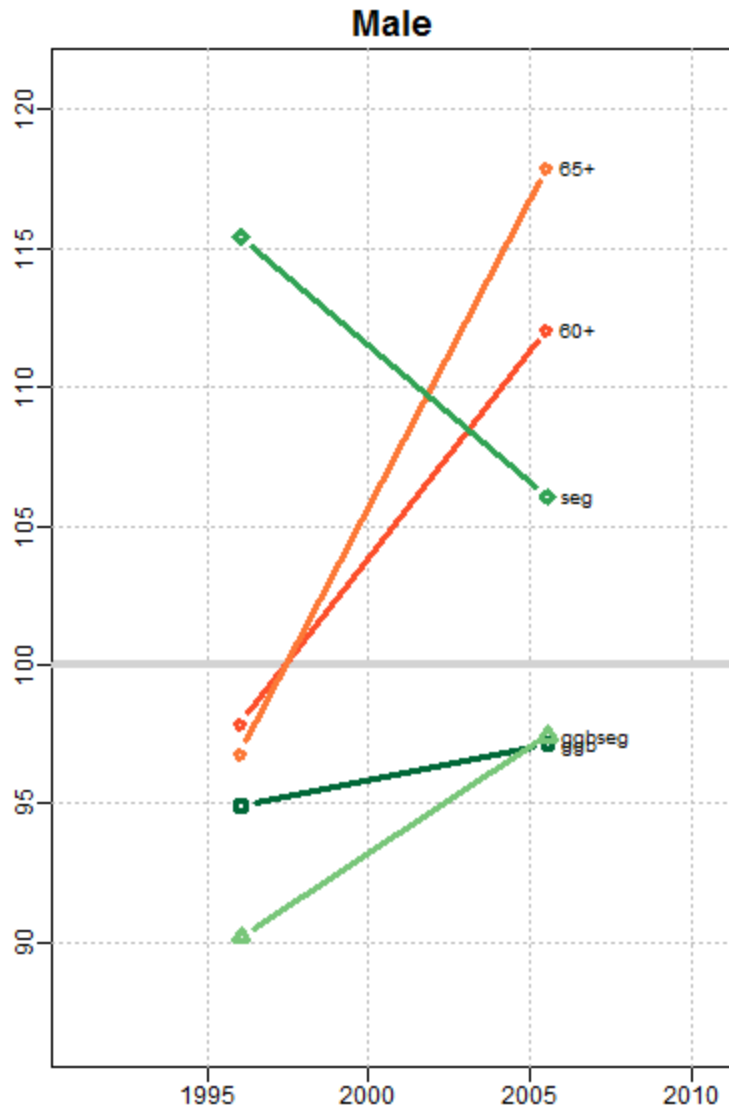
Maldives: 1985-2014 – ICSE by open age group



Malaysia: 1991-2010 – ICSE by age group

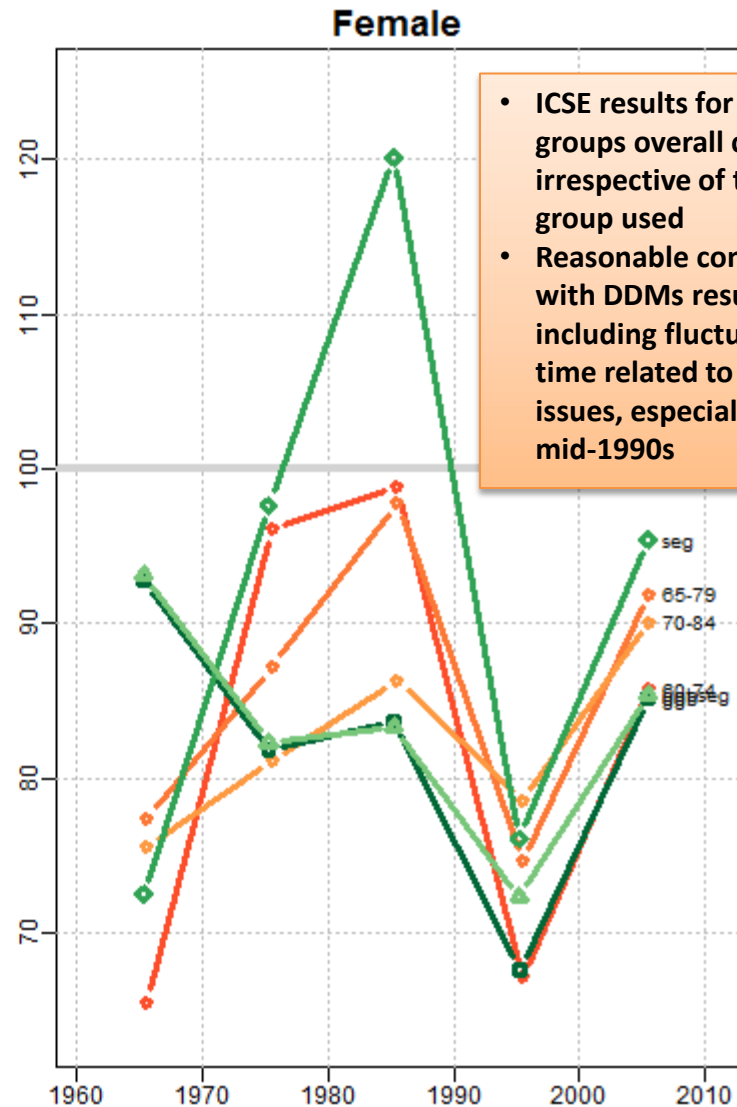
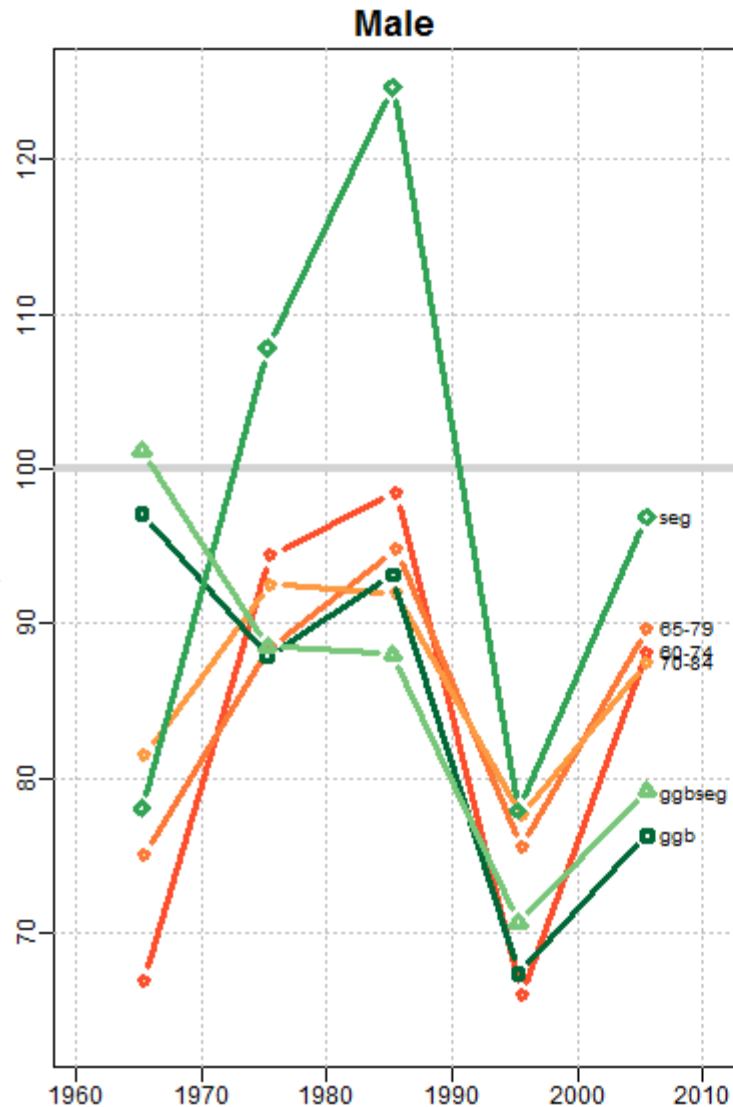


Malaysia: 1991-2010 – ICSE by open age group



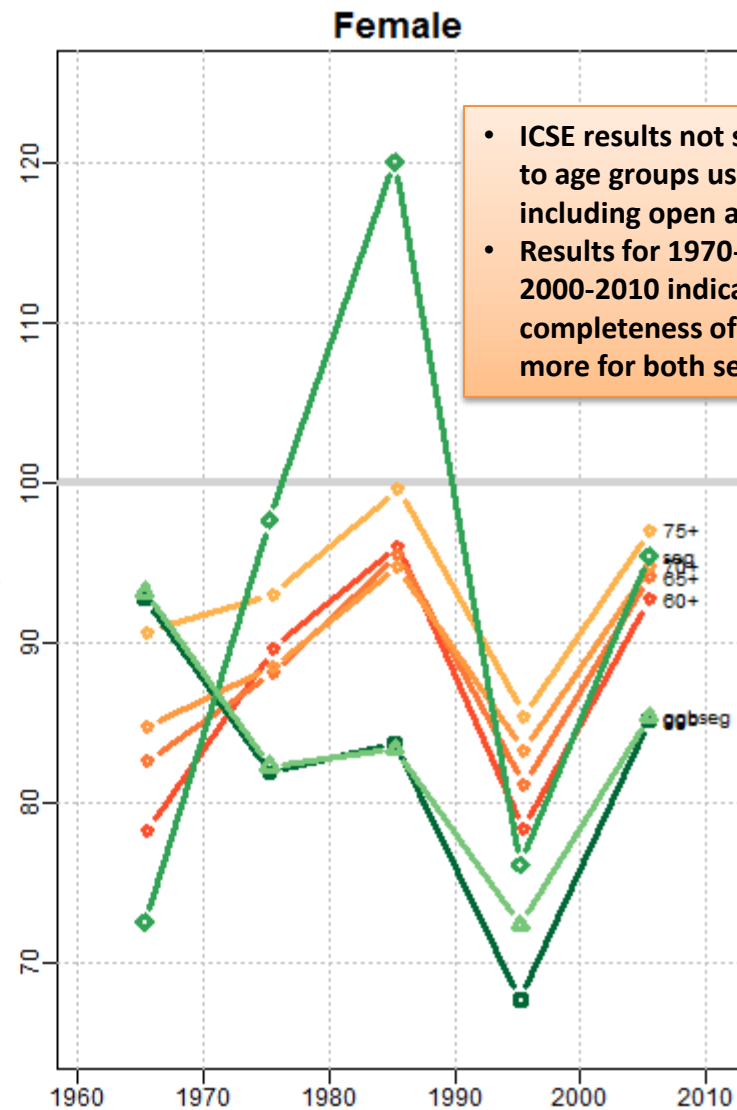
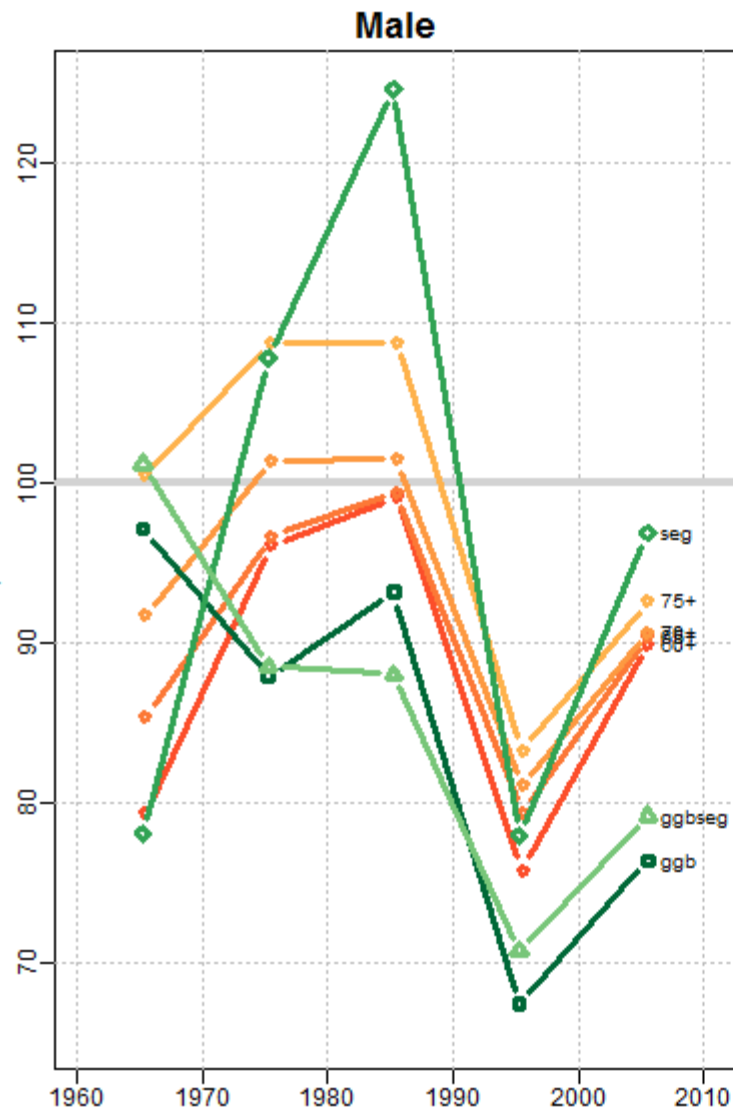
- Like for Egypt, ICSE results for open age group results are more consistent with DDM, and high completeness
- But data at older ages, especially for female, are more affected by age reporting and data quality issues

Thailand: 1960-2010 – ICSE by age group



- ICSE results for specific age groups overall consistent irrespective of the age group used
- Reasonable consistency with DDMs results, including fluctuations over time related to migration issues, especially in the mid-1990s

Thailand: 1960-2010 – ICSE by open age group



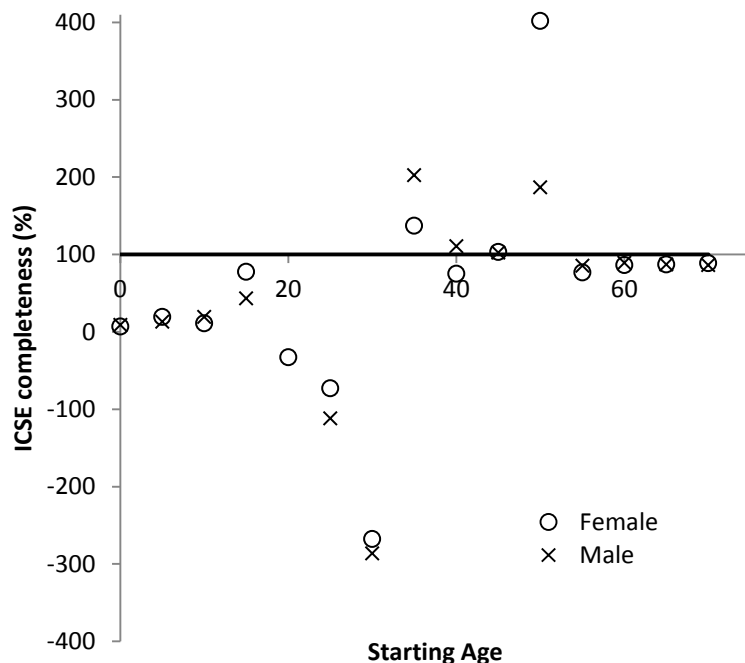
- ICSE results not sensitive to age groups used, including open age group
- Results for 1970-1990 and 2000-2010 indicate a high completeness of 90% or more for both sexes

Conclusion

Paper focused on conditions under which census populations can be used to evaluate the completeness of DR:

- focus on old ages where migration is negligible comparing to deaths
 - given the levels of census error, the lower the mortality level, the larger the evaluation error
1. ICSE cannot provide reasonable results for situations where mortality is low and completeness is high
 2. ICSE can provide reasonable results for situations where mortality is not low and completeness is not high – but ICSE depends on the reliability of the census data
 3. Evaluation using different age groups, including data for open age group, provides further insights on the sensitivity and robustness of these results, and potential issues with the reliability of data at older ages in some countries or periods

ICSE results for 2000-2010 in Thailand



ICSE cannot provide reasonable results to young ages, at which the level of mortality is the low, and the number of migrants can matter more than deaths

ICSE is unable to work for ages younger than 55 years, because of migration and low mortality.

Can we make an over-age average that may look better?

This is similar to using a gun to shoot a target:

missed the target too high about half of the time and too low another half, and announce that the shooting was OK on average.

A potential solution for younger ages could be the Records Linkage Methods (RLM).

ICSE works for 60+ for Thailand.

But ICSE may still fail if the censuses failed to keep their errors moderate.

ICSE results for Thailand female 2000-2010

