Adult Mortality Estimations from Cohort and Census/Survey data: a comparison of direct and indirect methods in rural Malawi

Patrick Gerland[1], James Kaphuka[2] and George Mandere[3], Humphreys Misiri[4], Peter Fleming[5]

Extended Abstract for UAPS 5th African Population Conference (Arusha, Tanzania, December 10-14, 2007)

Summary:

In countries lacking reliable vital registration, our knowledge of adult mortality depends largely on cross-sectional data from censuses or surveys providing us information on recent deaths in the households or on specific relatives (spouse, siblings, etc.). While such information remains invaluable to assess levels and trends of adult mortality, comparison with data from small rural areas monitored through demographic surveillance systems suggests frequent under-reporting of adult deaths in censuses and surveys. Existing datasets, however, do not easily allow systematic comparison and evaluation of these differences because information is almost always collected only for one set of deaths (either spouse, parents, siblings, household members) and associated cohort data are unavailable to compare the accuracy and reliability of direct and indirect estimates from census or survey data.

This paper aims to fill this gap by analyzing a longitudinal household survey conducted in 1998-2006 in three rural areas of Malawi. Using these individual and household data, we plan first to use survival analysis to compute regional life tables against which we will evaluate more conventional adult mortality estimates based on (a) household deaths in last 12 months, (b) widowhood, (c) survival of parents, (d) survival of siblings as reported in 2006 through the household questionnaire.

Background:

Adult mortality in developing countries remains one of the greatest challenges for monitoring, analyzing and projecting the health situation of a large proportion of the world's population (Hill 1997). Because of limited resources, many developing countries, especially in sub-Saharan Africa, continue to lack vital registration systems that could reliably and continuously collect information on, inter alia, adult mortality. Much, if not most, of what we assume about adult mortality in developing countries is based on borrowed evidence from more developed regions (model life tables, for instance), expert judgment, models and indirect estimations (Hill 2003; Jamison et al. 2006; Timaeus and Jasseh 2004).

Census data on deaths that occurred in the household in last 12 months remain the most commonly available source of data to directly compute life tables, but reporting is often biased with omissions and age misreporting. It is in response to this major problem that demographers have developed over the last decades a variety of alternative indirect estimation methods aimed at measuring adult mortality from survey and census data using information on the survival of the

1. United Nations Population Division. Estimates and Projection Section. Room DC2 -1906 – 2 UN Plaza. New York, NY 10017, USA. E-mail: gerland@un.org
2. Head of Population Studies Dept. - Chancellor College, University of Malawi, P.O. Box 280. Zomba, Malawi. E-mail: jameskaphuka@yahoo.co.uk
3. Population Studies Dept. - Chancellor College, University of Malawi, P.O. Box 280. Zomba, Malawi. E-mail: jmandere@chanco.unima.mw
4. Department of Community Health, College of Medicine, University of Malawi, Blantyre, Malawi. E-mail: hemisiri@yahoo.co.uk
5. University of Pennsylvania. Population Studies Center. 239 McNeil Building. 3718 Locust Walk. Philadelphia, PA 19107. E-mail: pfleming@pop.upenn.edu

spouse (widowhood method), parents (maternal or paternal orphanhood), or siblings (brothers or sisters) - (Hill, Choi and Timaeus 2005; Hill and Trussell 1977; Preston, Heuveline and Guillot 2001).

As explained G. Feeney (United Nations 2002:1), all these estimates should coincide if data were always free from error and all assumptions on which these indirect methods are based were satisfied. Unfortunately, data problems are common and many assumptions are often violated – especially amongst population experiencing increased adult mortality due to HIV/AIDS. In addition, most comparisons can only be performed between different datasets often collected for different reference periods and based on different measurement methods. Such cross-sectional comparisons are inherently challenging and plagued with intractable difficulties since each method is based on a different sample which can carry its own biases and no "gold standard" (i.e., "true" or "unbiased" direct measure of adult mortality) can be used as reference to evaluate the quality and defects of each estimation method.

This paper focuses on three regions (North, Centre and South) in rural Malawi and examines recent levels and trends in adult mortality at the national and regional levels in rural Malawi based on the 1987 and 1998 censuses and DHS siblings data between 1992, 2000 and 2004. These general trends and differences are then examined in the light of the survival of adult cohorts monitored between 1998-2006 through the Malawi Diffusion and Ideational Change Project (MDIC) organized by the University of Pennsylvania and the University of Malawi College of Medecine. This is followed by a more in-depth analysis of more conventional adult mortality estimates based on (a) household deaths in last 12 months, (b) widowhood, (c) survival of parents, (d) survival of siblings as reported in 2006 through the MIDCP household questionnaire.

Data:

This paper draws extensively on individual and household data gathered in a four-round panel survey (1998, 2001, 2004 and 2006) conducted by the Malawi Diffusion and Ideational Change project (organized by the University of Pennsylvania and the University of Malawi College of Medecine). The survey used a 1998 random sample of about 2,000 women of reproductive age and their husbands in 125 villages divided equally among three rural districts (Balaka, Mchinji and Rumphi). This panel was expanded in 2004 to include an additional 850 adolescents. In total, due to mobility, marriage dissolution, new unions and polygamy, the MDICP sample has been monitoring about 5,700 individuals between 1998 and 2006.

In addition to these individual cohort data, the MIDCP household questionnaire provides in 2006 a rich set of information about the number and characteristics of household deaths, as well as on widowhood, parental orphanhood, and siblings survival.

Analytical strategy:

This paper uses survival analysis to compute life table probabilities from the MDICP individual survey data, and the standard set of direct and indirect adult mortality estimation methods as described in the United Nations (1983) Manual X on Indirect techniques for Demographic Estimations and the United Nations (2002) Report on Methods for Estimating Adult Mortality.

Expected results:

This systematic comparison of both direct and indirect estimates of adult mortality across three rural settings of Malawi – varying extensively in socio-cultural, ecological and economic settings – is expected to provide some useful insights not only on regional mortality levels and trends but also to improve our understanding of the strengths and limitations of more conventional mortality measures obtained from surveys and censuses through direct or indirect methods.

The unique ability to use MDICP cohort mortality data by age and sex, in particular, should allow to us to analyze further existing adult mortality differential by sex and to confirm or invalidate existing findings based on indirect methods.

References:

Hill, K. 1997. "The Measurement of Adult Mortality: an Assessment of Data Availability, Data Quality and Estimation Methods." Presented at Health and mortality : issues of global concern : proceedings of the Symposium on Health and Mortality, 1999, Brussels, 19-22 November 1997.

—. 2003. "Adult Mortality in the Developing World; What We Know and How We Know It." Presented at TRAINING WORKSHOP ON HIV/AIDS AND ADULT MORTALITY IN DEVELOPING COUNTRIES, 8-13 September 2003, New York.

Hill, K., Y. Choi, and I. Timaeus. 2005. "Unconventional approaches to mortality estimation." *Demographic Research (on-line)* 13:281-300.

Hill, K.and J. Trussell. 1977. "Further Developments in Indirect Mortality Estimation." *Population Studies* 31(2):313-334.

Jamison, D.T., R.G. Feachem, M.W. Makgoba, E.R. Bos, F.K. Baingana, K.J. Hofman, and K.O. Rogo. 2006. "Disease and mortality in Sub-Saharan Africa." Pp. xxii, 416 p., edited by World Bank. New York: World Bank.

Preston, S.H., P. Heuveline, and M. Guillot. 2001. *Demography : measuring and modeling population processes*. Malden, MA: Blackwell Publishers.

Timaeus, I.M.and M. Jasseh. 2004. "Adult mortality in sub-Saharan Africa: evidence from Demographic and Health Surveys." *Demography* 41(4):757-772.

United Nations. 1983. *Manual X, indirect techniques for demographic estimation*. New York: United Nations.

—. 2002. *Methods for estimating adult mortality.* New York: United Nations.

Adult Mortality Estimations from Cohort and Census/Survey data: a comparison of direct and indirect methods in rural Malawi

Patrick Gerland (United Nations Population Division)
Prof. James Kaphuka (Chancellor College, Univ. of Malawi)
Peter Fleming (Univ. of Pennsylvania), George Mandere and Humphreys Misiri (Univ. of Malawi)

UAPS 5th African Population Conference
Arusha, Tanzania - Dec 10-14, 2007

Outline

- Context of this research
- Research Objectives
- Data and Study design
- Estimation methods
- Results and findings

1. Context of this research

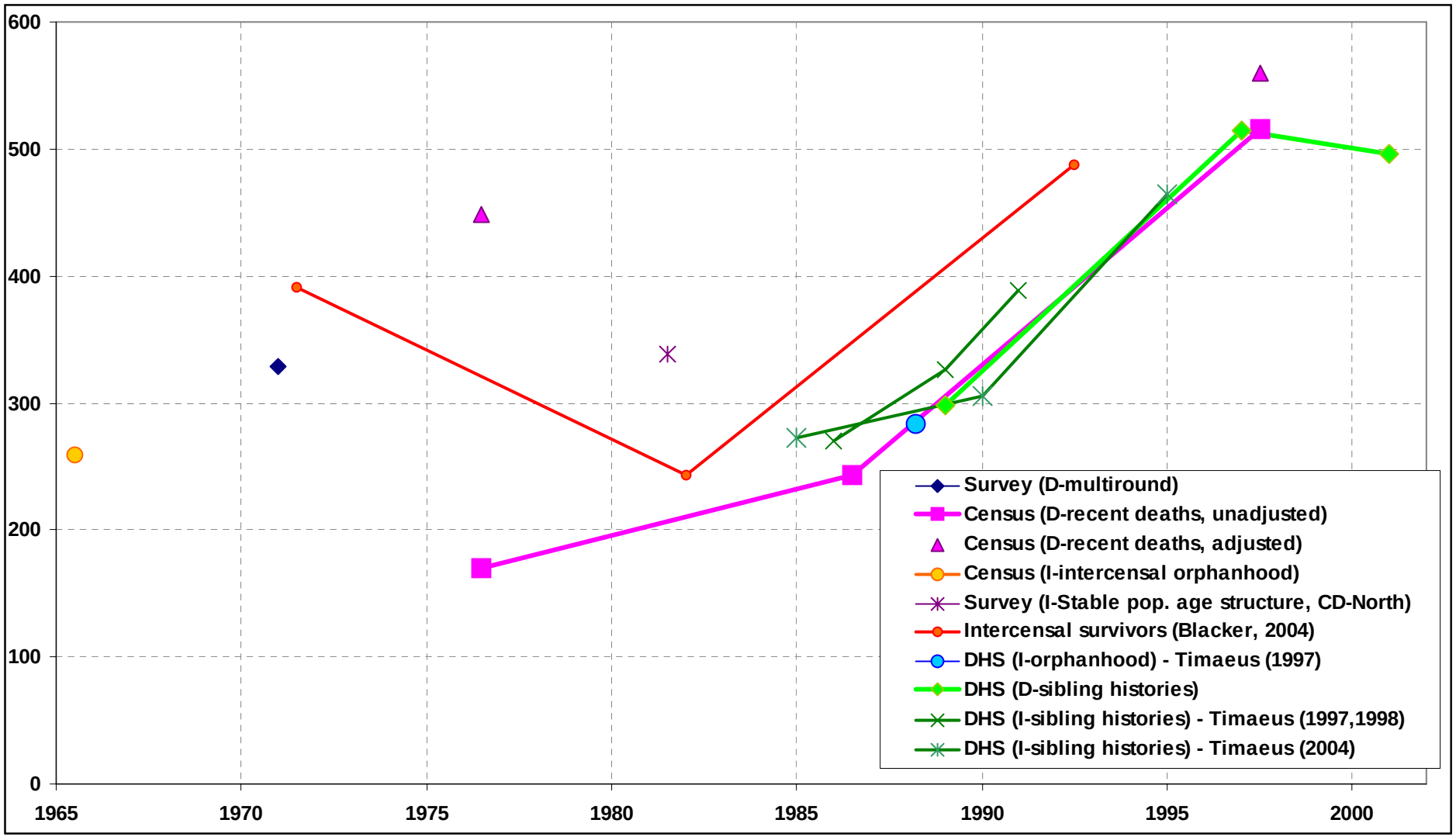
Background: adult mortality in Malawi

- Data sources: censuses and surveys
- Estimation methods: intercensal survivors, recent deaths in household, adult orphanhood, sibling histories and indirect sibling method, etc.
- Reference periods: intercensal vs. retrospective periods
- Lack of comparability: different indicators and age groups used by various authors over the years and studies: convert/extend published measures using Brass relational model to estimate 45q15

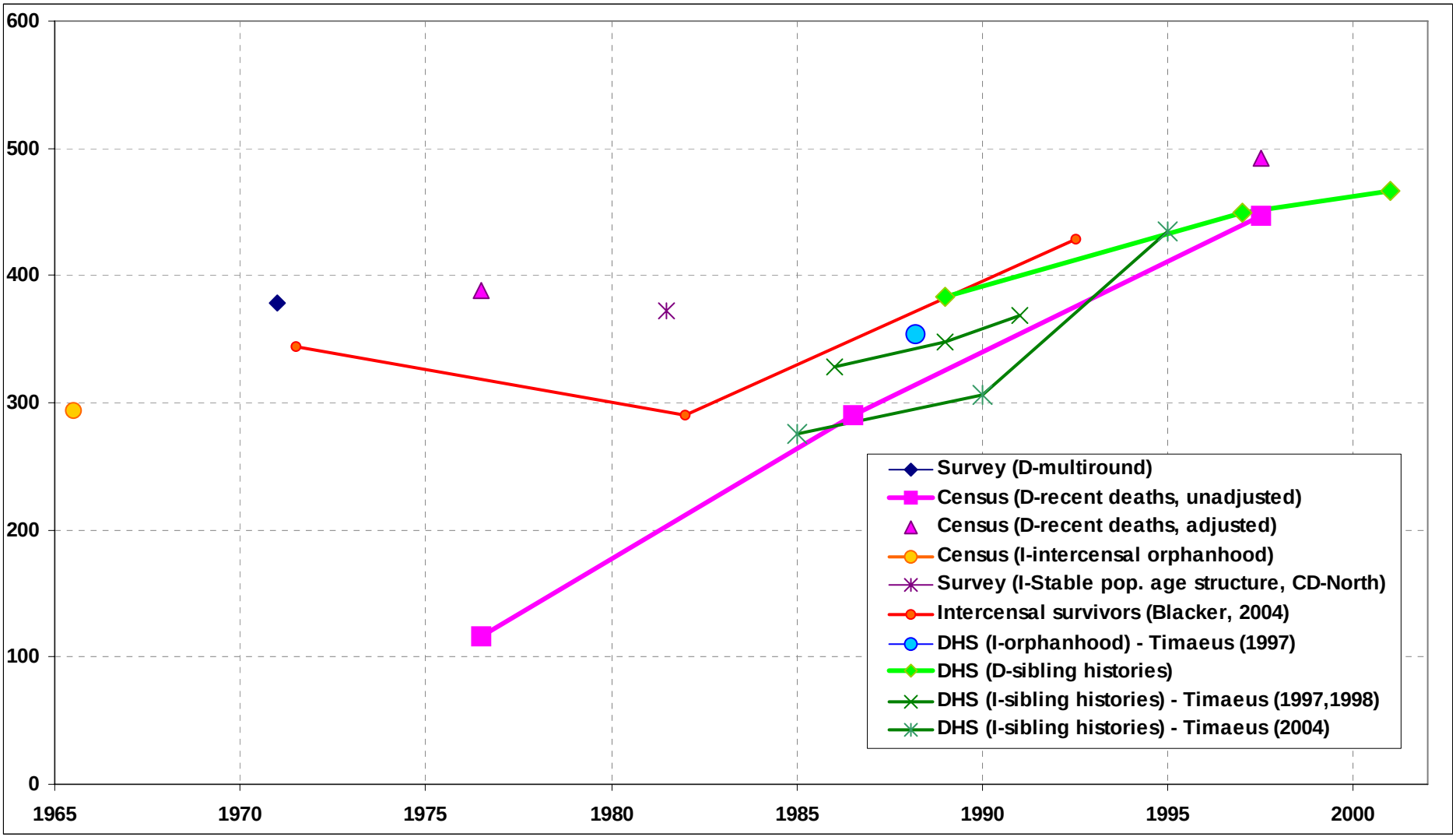
Data source	Year	Intercensal survivors	Recent HH deaths	Stable age structure	Orphanhood	Siblings (D)	Siblings (I)
Census	1966	**X**					
	1977	**X**	**X**		**X**		
	1987	**X**	**X**				
	1998	**X**	**X**				
Survey	1970-72		**X**				
	1982			**X**			
DHS	1992				**X**	**X**	**X**
	2000					**X**	**X**
	2004					**X**	**X**

Malawi: direct $_{45}q_{15}$ MALE estimates

Malawi: direct/indirect $_{45}q_{15}$ MALE estimates



Malawi: direct/indirect $_{45}q_{15}$ FEMALE estimates



Challenges in comparing ${}_{45}q_{15}$ estimates

- Frequent lack of internal consistency between estimates obtained from different sources and/or methods
- Problem with varying reference periods between estimation methods
- Omissions and misreporting of adult deaths can vary depending of the questions asked
- Difficult to resolve differences due to the lack of direct comparability between estimates

Research Objectives

- Compare to “gold standard” (i.e., from cohort study) cross-sectional direct and indirect estimates of adult mortality obtained for the SAME population and period.
- Use standard sets of questions from census/survey to collect data from panel participants on retrospective deaths from:
  - Household and family (recent deaths direct method)
  - Mother/Father (orphanhood indirect method)
  - Brothers/Sisters (siblings indirect method)

2. Data and Study Design

Data source

- **Malawi Diffusion and Ideational Change Project (MDICP)** organized by the University of Pennsylvania and the University of Malawi.

  http://www.malawi.pop.upenn.edu

- a longitudinal household survey (including a subset of semi-structured interviews), organized in 1998, 2001, 2004 and 2006, on the role of informal conversations on health and AIDS behavior in rural Malawi.
- Initial 1998 sample: 1537 ever-married women of reproductive age and their husbands (1068 men).

Study sites

HIV prevalence rates (both sexes) for MDICP sites in 2006

North (Rumphi): 6.6%

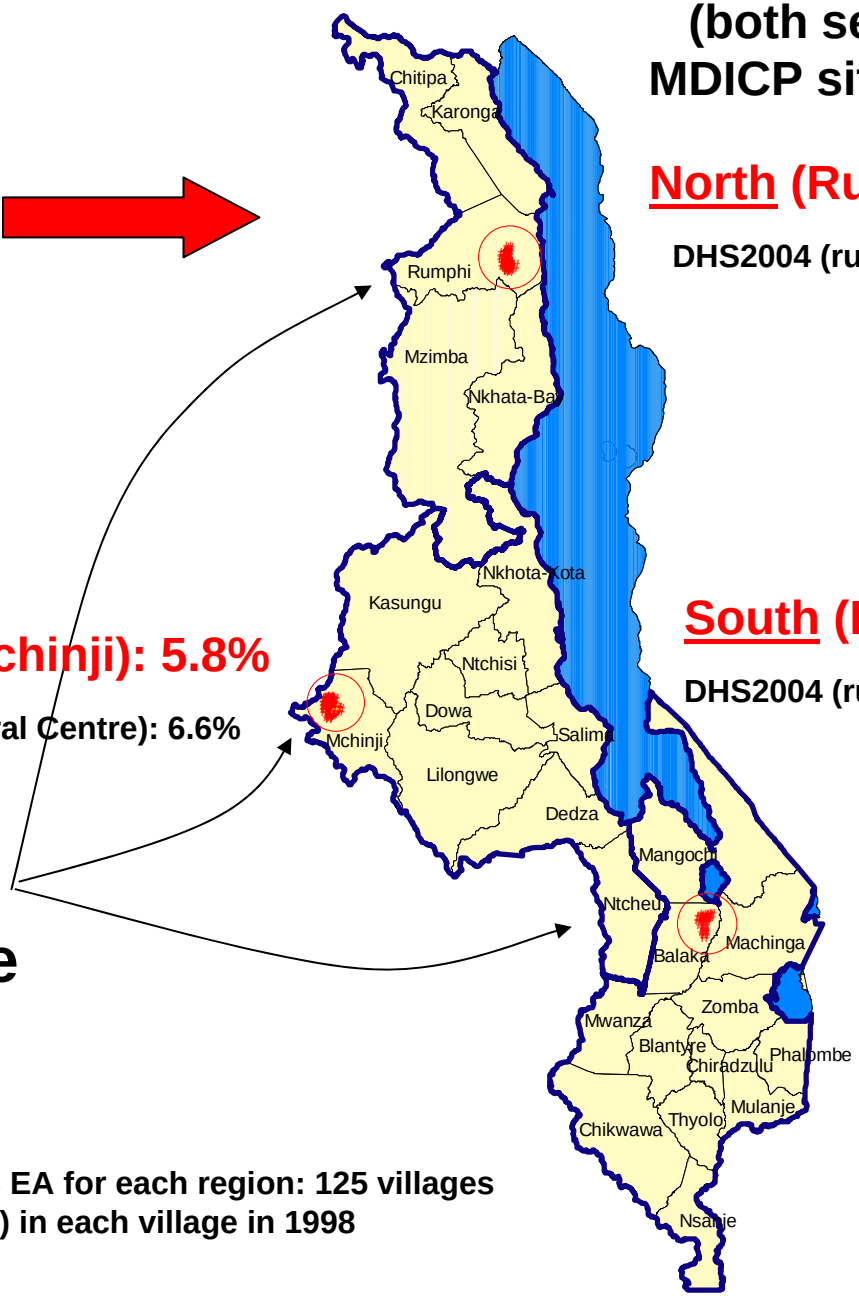
DHS2004 (rural North): 10.4%

Centre (Mchinji): 5.8%

DHS2004 (rural Centre): 6.6%

South (Balaka): 9.2%

DHS2004 (rural South): 19.8%



Malawi Diffusion and Ideational Change survey field sites

Sampling similar to DHS:

1) Random sample of villages in one census EA for each region: 125 villages

2) Random sample of married women (15-49) in each village in 1998

Malawi MDICP Panel characteristics

	MDICP 1	MDICP 2	MDICP 3	MDICP 4
	1998	2001	2004*	2006
Number of respondents	**3,310**	**3,535**	**4,922**	**5,683**
Age range of respondents	16-82	15-90	14-80	13-82
Percentage of female respondents	53%	55%	54%	54%
Number of completed interviews	**2,602**	**2,548**	**3,298**	**3,950**
Response rate to survey	79%	72%	67%	70%
Number of linked couples	2,053	2,036	2,404	3,148
Couple interview rate	79%	80%	73%	80%
Acceptance rate for HIV test	---	---	91%	91%
HIV prevalence	**---**	**---**	**6.4%**	**7.2%**
Attrition rate since previous round	---	15%	22%	20%
Attrition due to				
-- migration (temporary or permanent)	---	76%	58%	63%
-- mortality	**---**	**13%**	**10%**	**6%**
-- other factors	---	11%	31%	31%
Median time between rounds (years)		3.0	2.9	2.0

(*) Added new spouses in 2001-2006 rounds and about 1500 adolescents (age 15-25) in 2004

Estimation Methods

Adult mortality estimation

Cohort-based analysis:

- **Individual level survival analysis** (Kaplan-Meyer estimator): 1998-2006
  - control for date of entry in panel, age, sex and region
  - non-parametric method (no assumption on hazard function)
  - address censoring/truncation of cases only observed in some survey rounds (i.e., temporarily away or permanently moved)
  - 5,258 subjects under observation (27,071 persons-years of exposure)
  - 292 adult deaths recorded over 5.1 years of observation (median time)

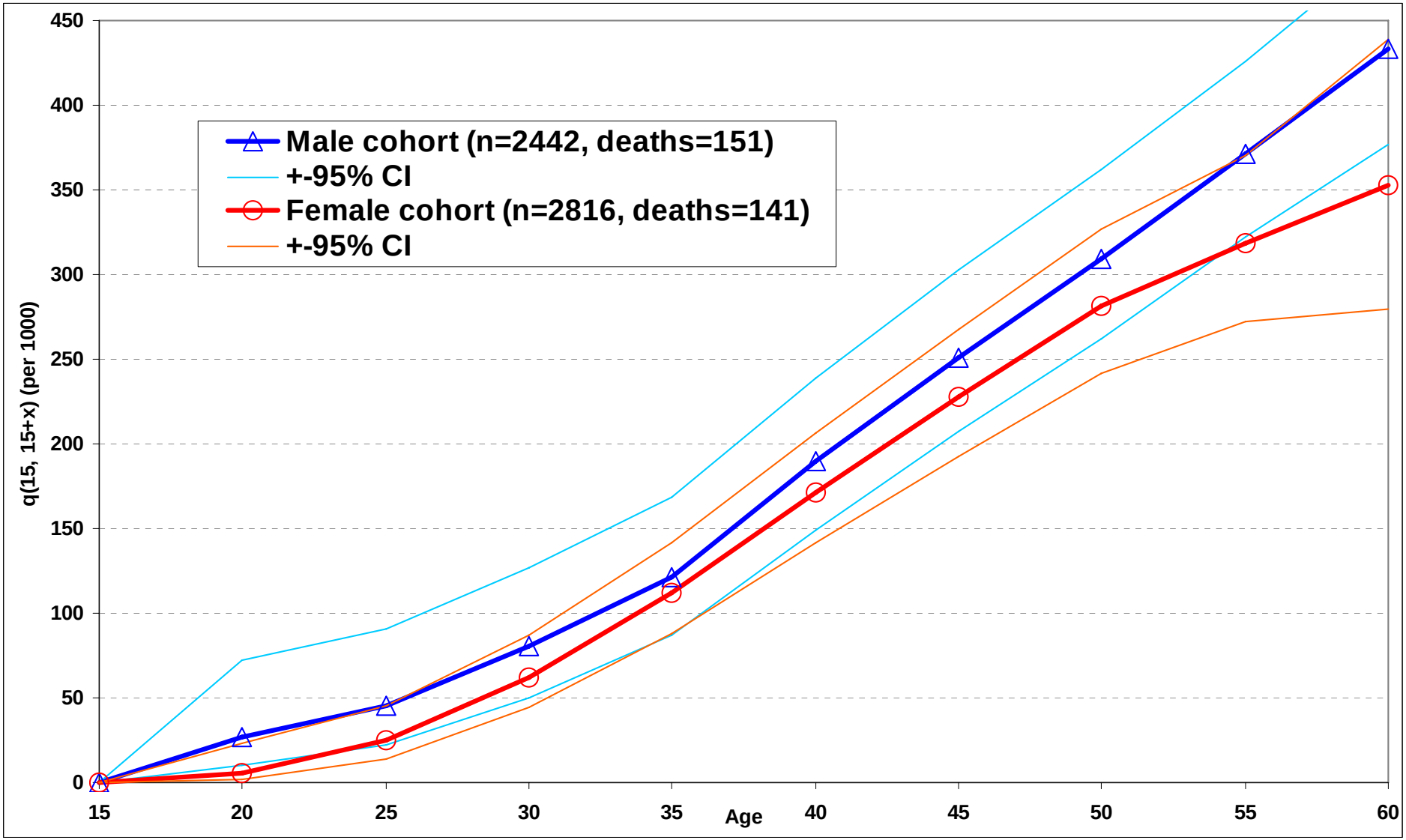
Adult mortality estimation

Cross-sectional analysis: 2006 - Aggregate level analysis (by age, sex and region) through household/family roster and retrospective mortality questions (UN, 1983 and 2002)

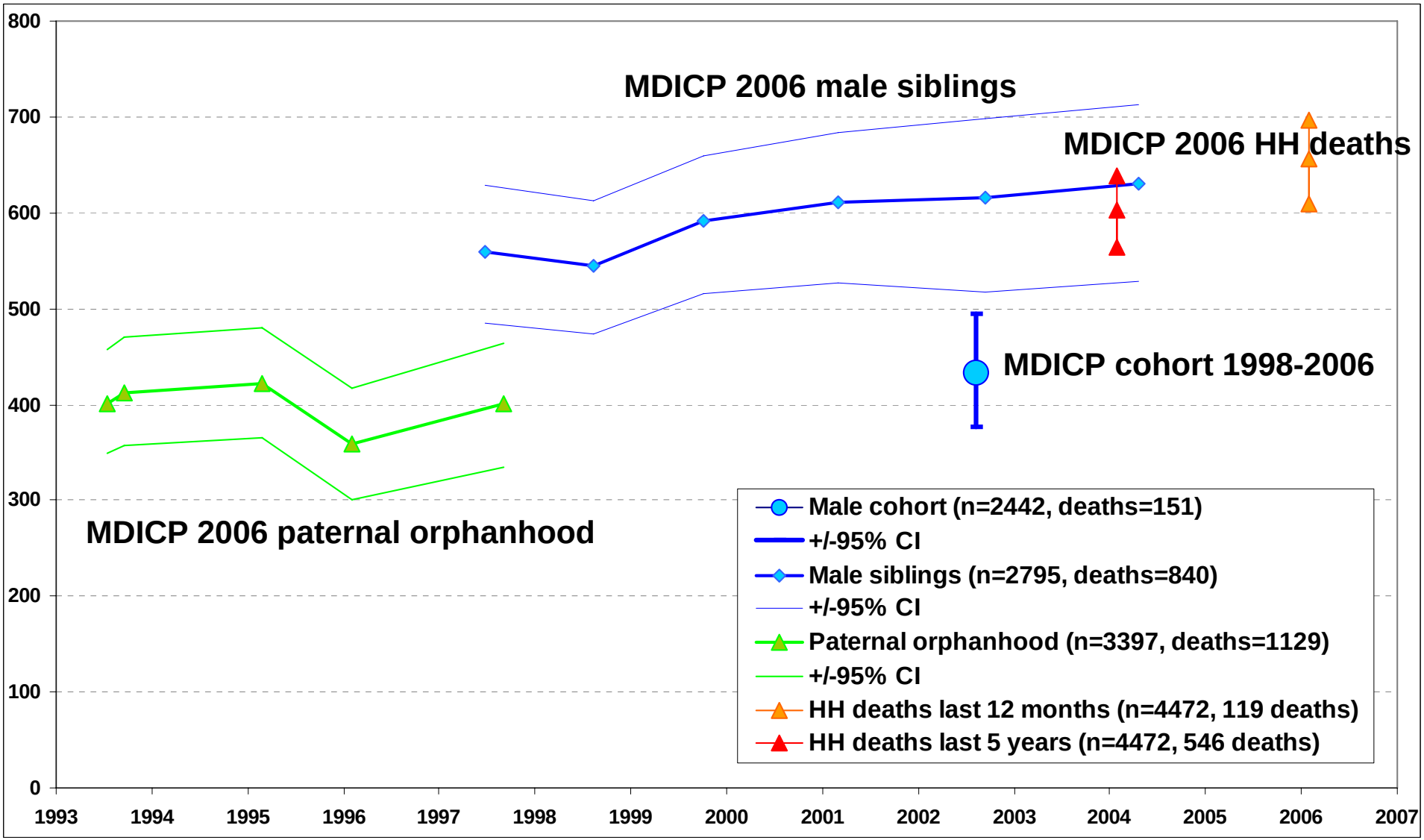
- **Households deaths** in last 12 months, and in last 5 years
- **Survival of parents**: is your mother still alive?, is your father still alive? – Timaeus (1991, 1992)
- **Survival of siblings**: how many brothers/sisters alive at age 15+? and still alive today? – Graham et al. (1989), Timaeus et al. (2000, 2001)

Results

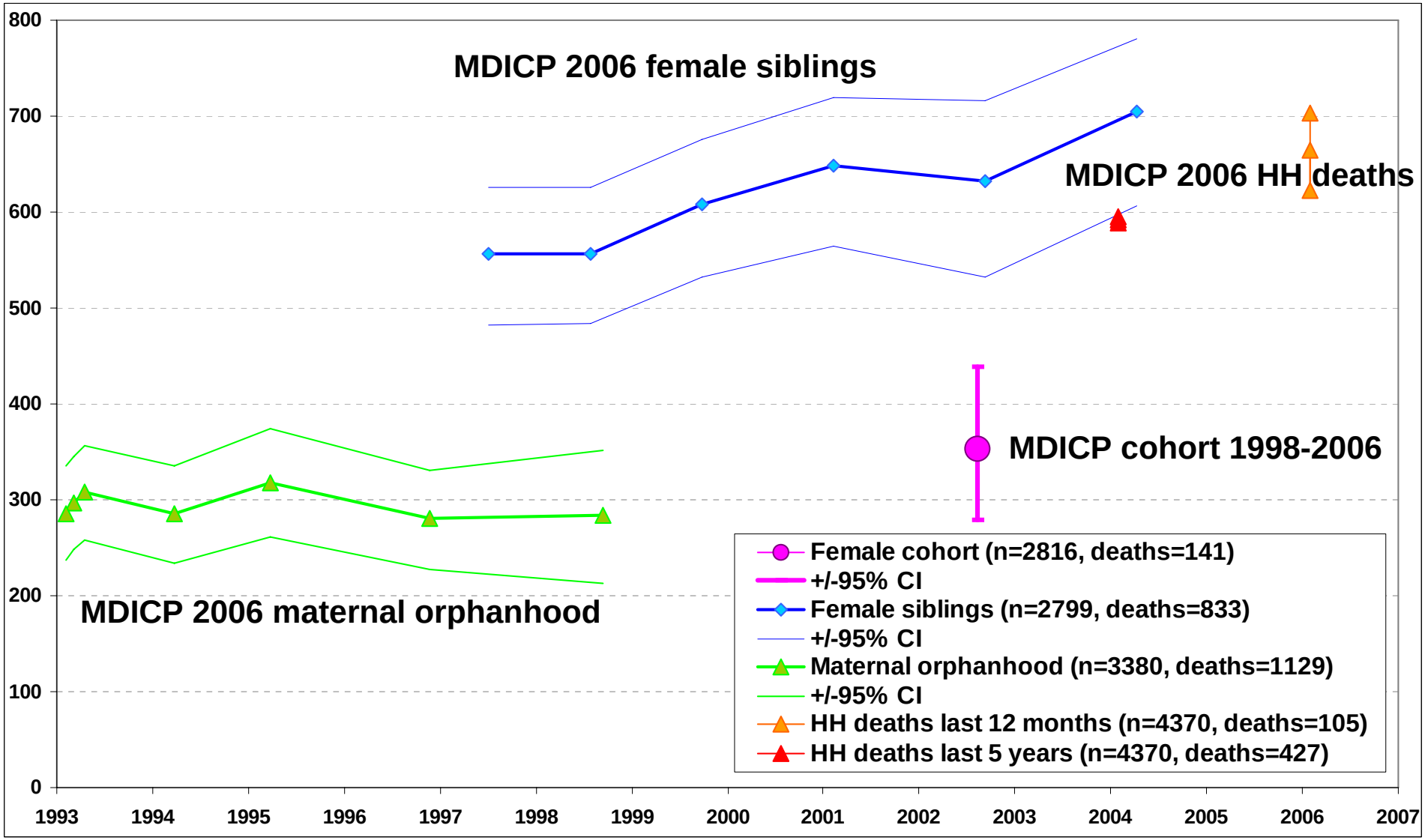
Malawi MDICP 1998-2006 cohort: conditional probability of dying between age 15 and age x



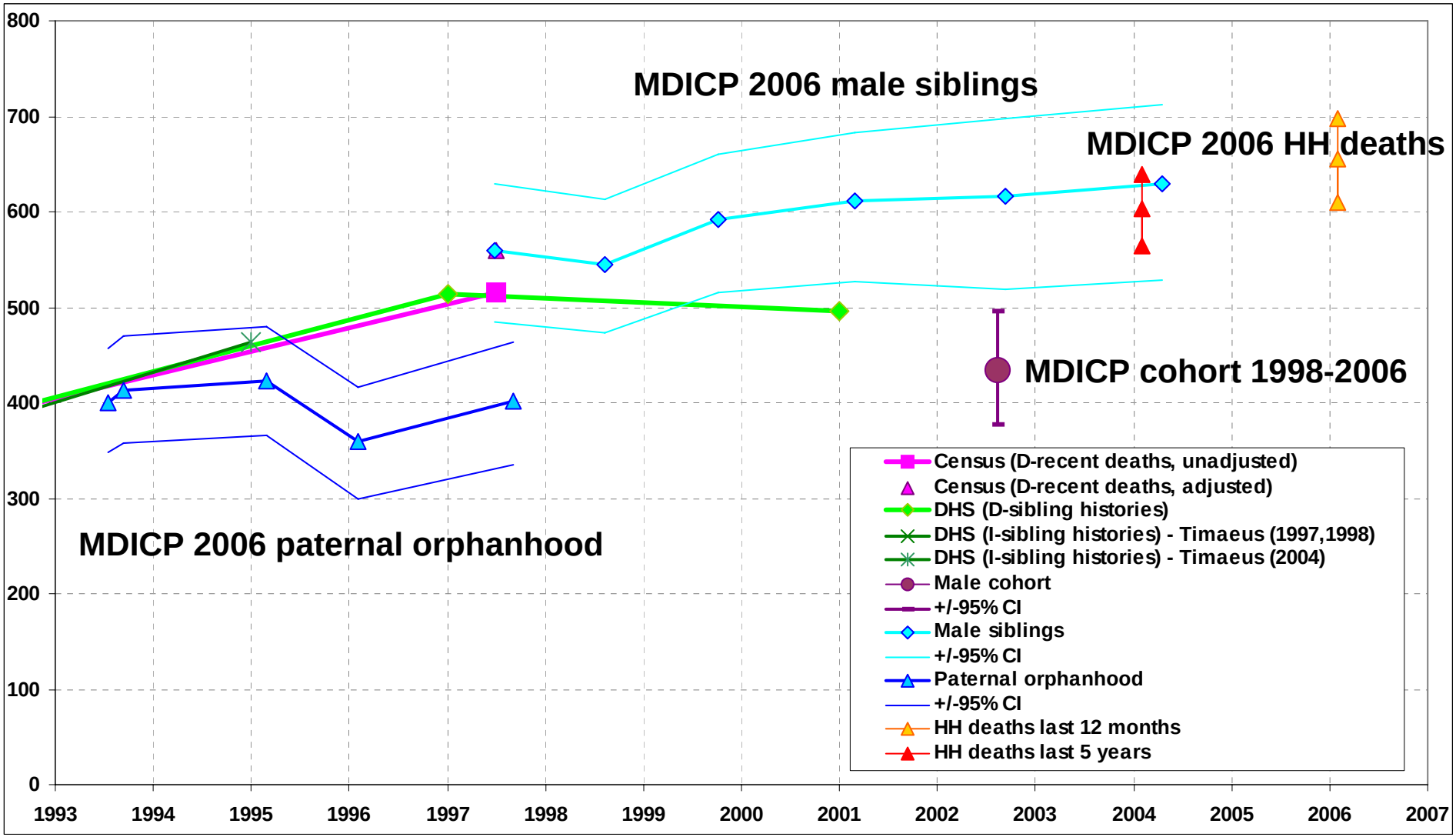
Malawi MDICP - 45q15 Male mortality: 1998-2006 cohort vs. 2006 direct/indirect estimates



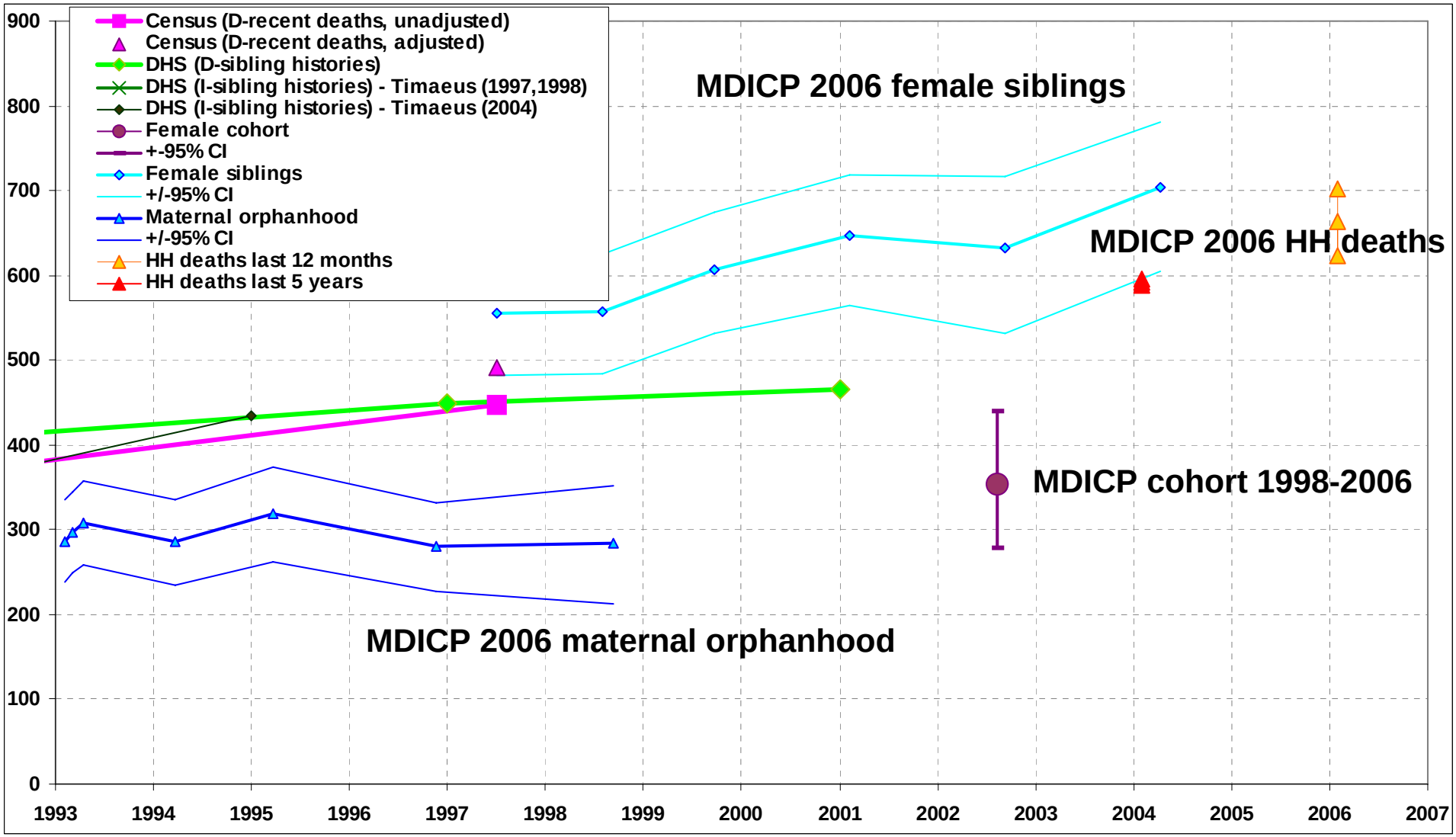
Malawi MDICP - 45q15 Female mortality: 1998-2006 cohort vs. 2006 direct/indirect estimates



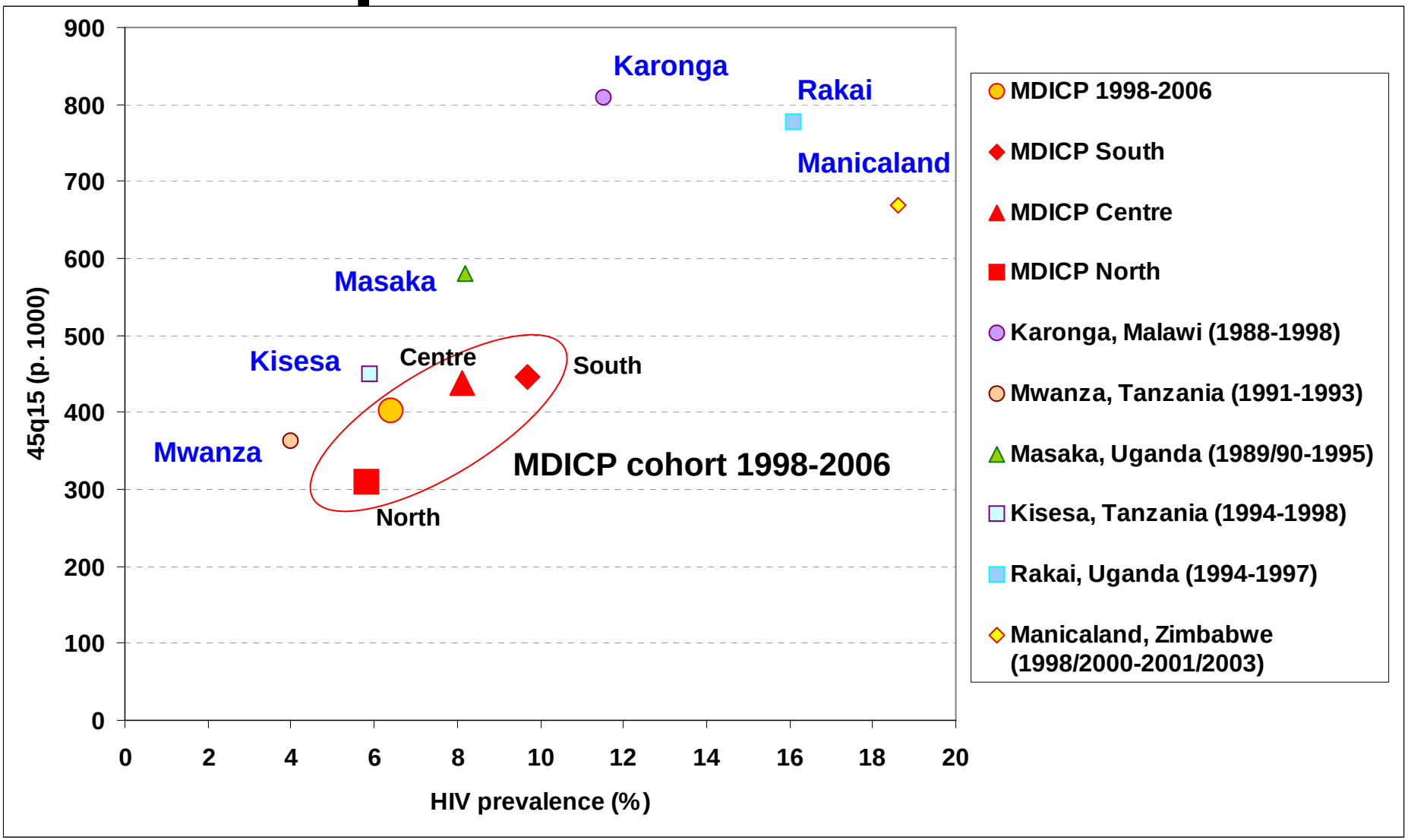
Male adult mortality comparison: 45q15 MDICP local estimates vs. Malawi national estimates



Female adult mortality comparison: 45q15 MDICP local estimates vs. Malawi national estimates



Cohort studies: $_{45}q_{15}$ both sexes vs. HIV prevalence



Main findings

1. MDICP 45q15 cohort estimates lower but within the same order of magnitude as national estimates (< 500 p. 1000) and other cohort studies with similar HIV prevalence.
2. Cohort estimates slightly higher but comparable to indirect estimates from parental survival.
3. But indirect estimates from siblings survival and direct estimates from recent household deaths much higher.
4. Overall lower female adult mortality not statistically significantly different than for male (too few deaths in cohort).

Are these differences in ${}_{45}q_{15}$ estimates real?

- **Option #1**: cohort deaths underreported.

1. From the national trend in adult mortality in last 20 years, and the large number of adult deaths and funerals experienced by everyone in these communities, would expect a continuing rise in adult mortality as suggested by siblings survival and recent household deaths data.
2. This would imply that reporting of cohort deaths is severely deficient and/or too many panel members lost at follow-up (due to migrations or other causes) died and have not been recorded accordingly.

Are these differences in ${}_{45}q_{15}$ estimates real?

- **Option #2**: but if recording of cohort deaths is accurate, then indirect siblings estimates and direct reporting of recent deaths are overestimated by about 30%.
- Cross-national comparisons of indirect adult mortality estimates obtained from orphanhood and sibling histories suggest that estimates are overall consistent with another, but can as often exceed one another (e.g., Feeney, 2001; Timaeus and Jasseh 2004, etc.).

Are these differences in ${}_{45}q_{15}$ estimates real?

1. **Option #3**: flaws in 2006 survey instrument and/or interviewer/supervisor instructions collecting household data and siblings data.
2. Potential siblings reporting errors: Used only direct questions on siblings ever born, alive at age 15 and still alive today rather than DHS siblings history (to save time) which has lead to various inconsistencies and potential reporting errors (e.g., differential under/over-reporting of overall number of siblings ever-born, of those alive at age 15 and still alive now). Potential reporting of non-biological siblings.

3. Potential problems in household/family roster:

- Risks of double-count and over-reporting relatives and extended family members as part of the household:
  - Used a multipage roster with very specific interview instructions to systematically collect data for:
    (1) respondent, (2) spouse(s) including former if widowed, (3) parents, (4) parents in-law, (5) children, (6) everyone else who slept in this HH last night, (7) everyone else who usually sleep in this HH, but not last night.
  - Only asked usual place of residence to filter regular member of household.
  - Collected household/family data independently from each adult panel participant in the household.

Work in progress

- Additional estimation methods to be investigated:
  - 2004-2006 survival of parents
  - 2004-2006 deaths distribution from intersurvey household composition
  - 1998-2006 widowhood using marital history (but problem with substantial marital dissolution)

Work in progress

- Sensitivity analysis on mortality estimates:
  - How much household composition matters (i.e., regular members vs. family members, omission patterns)?
  - How much age/date reporting problems matters (for respondent and for deaths)?
  - How much ignoring or censoring temporary migrants matters?
  - How much inconsistencies in reporting siblings matters?

Conclusion

- Longitudinal surveys and demographic surveillance sites (DSS) provide potentially unique opportunities to evaluate existing retrospective and indirect methods to measure adult mortality.
- Further research and more systematic comparisons / evaluations of standard survey questions on survival of parents and of relatives (siblings, widowhood, etc.) and reporting biases should be conducted with other cohort studies / DSS data.