

Death Registration and Mortality Estimation: Completeness, Data Quality Assessment, & Data Usage

Romesh Silva, PhD
Statistics Division, ESCWA
United Nations

PRVS Version 3 Workshop for Arab States
GCC-Stat, Muscat, Sultanate of Oman
November 15, 2016



UNITED NATIONS

الاستسوا
ESCWA

DR Completeness & Quality Assessment is dependent on complementary sources

- Household Surveys
 - International Survey Programs (DHS, MICS, LSMS, PAPFAM)
 - National Survey Programs
- Population Census

- HDSS Sites and Subnational Cohort Studies
 - None in the Arab region
- SAVVY & SRS
 - None in the Arab region

Palestine: Non-CRVS Mortality Data Availability and Accessibility

N.B. (-) indicates lack of information

Country	Year	Data Source	Data Type	Child Deaths			Adult Deaths					Household Deaths	Household spouse's parents' death	Spouse death	Data publicly available	
				Infant Only	Full Birth History	Summary Birth History	Maternal	Sibling Survival		Orphanhood			In last 12 months			
								Direct Method	Indirect Method	Direct Method	Indirect Method ages 0-17	Indirect Method all ages				
Palestine																
	2000	Palestine Health Survey (MICS)	Survey	Yes			No	No	No	No	No	Yes	No	No	No	Yes
	2004	DHS	Survey	Yes			No	No	No	No	No	Yes	No	No	No	Yes
	2006	Palestinian Family Health Survey	Survey	Yes			No	No	No	No	No	Yes	No	No	No	Yes
	2007	Population census	Census	No	Yes		No	No	No	No	No	No	Yes*	No	No	Yes
	2010	Palestinian Family Health Survey (MICS)	Survey	Yes			No	No	No	No	No	Yes	No	No	No	Yes
	2014	Palestinian Family Health Survey (MICS)	Survey	No	Yes		No	No	No	No	No	No	No	No	No	No

Palestine: Non-CRVS Mortality Data Availability and Accessibility

N.B. (-) indicates lack of information

Country	Year	Data Source	Data Type	Child Deaths			Adult Deaths					Household Deaths	Household spouse's parents' death	Spouse death	Data publicly available	
				Infant Only	Full Birth History	Summary Birth History	Maternal	Sibling Survival		Orphanhood			In last 12 months			
								Direct Method	Indirect Method	Direct Method	Indirect Method ages 0-17	Indirect Method all ages				
Palestine																
	2000	Palestine Health Survey (MICS)	Survey		Yes		No	No	No	No	No	Yes	No	No	No	Yes
	2004	DHS	Survey		Yes		No	No	No	No	No	Yes	No	No	No	Yes
	2006	Palestinian Family Health Survey	Survey		Yes		No	No	No	No	No	Yes	No	No	No	Yes
	2007	Population census	Census		No	Yes	No	No	No	No	No	No	Yes*	No	No	Yes
	2010	Palestinian Family Health Survey (MICS)	Survey		Yes		No	No	No	No	No	Yes	No	No	No	Yes
	2014	Palestinian Family Health Survey (MICS)	Survey		No	Yes	No	No	No	No	No	No	No	No	No	No

Palestine: Non-CRVS Mortality Data Availability and Accessibility

N.B. (-) indicates lack of information

Country	Year	Data Source	Data Type	Child Deaths			Adult Deaths					Household Deaths	Household spouse's parents' death	Spouse death	Data publicly available	
				Infant Only	Full Birth History	Summary Birth History	Maternal	Sibling Survival		Orphanhood			In last 12 months			
								Direct Method	Indirect Method	Direct Method	Indirect Method ages 0-17	Indirect Method all ages				
Palestine																
	2000	Palestine Health Survey (MICS)	Survey	Yes			No	No	No	No	No	Yes	No	No	No	Yes
	2004	DHS	Survey	Yes			No	No	No	No	No	Yes	No	No	No	Yes
	2006	Palestinian Family Health Survey	Survey	Yes			No	No	No	No	No	Yes	No	No	No	Yes
	2007	Population census	Census	No	Yes		No	No	No	No	No	No	Yes*	No	No	Yes
	2010	Palestinian Family Health Survey (MICS)	Survey	Yes			No	No	No	No	No	Yes	No	No	No	Yes
	2014	Palestinian Family Health Survey (MICS)	Survey	No	Yes		No	No	No	No	No	No	No	No	No	No

DR Completeness & Quality Assessment is dependent on complementary sources

- Household Surveys
 - International Survey Programs (DHS, MICS, LSMS, PAPFAM)
 - National Survey Programs
 - Implications for emerging survey programs (WHO-HEIS, ESCWA-PAMPS, etc.)
- Population Census
 - Implications for upcoming 2020 round
- HDSS Sites and Subnational Cohort Studies
 - None in the Arab region
- SAVVY & SRS
 - None in the Arab region

Current Approaches to CRVS Completeness (& Quality) Assessment

1. Self-reporting in HH surveys

- Reporting bias due to terminological differences
- Reporting bias due to social desirability

2. Comparison of registered deaths to E(deaths)

- Misalignment between reference populations
- Large sampling errors

3. Indirect demographic estimation: Death Distribution Methods

- **Strong assumptions:** [1] closed population, [2] completeness of recording of deaths is constant by age, [3] the completeness of recording of population is constant by age, & [4] error-free age reporting
- Non-negligible uncertainty intervals (Murray et al., PLoSMed-2013)

4. Record-Linkage

- Labor intensive & Technically challenging

Data & Methods

- Apply different variants of death distribution methods (DDMs) to data on national populations:
 - **Generalized Growth Balance (GGB)** method uses the observed population growth rates, the observed birth rate and the observed death rate to estimate the relative coverage of the population censuses along with the relative coverage of the death registration process.
 - **Synthetic Extinct Generations (SEG)** method compares the estimated future cohort deaths to the current cohort's population size as a means to assessing the completeness of the death registration process during the intercensal time period.
 - **Adjusted-SEG** application of the GGB method to adjust the raw data followed by application of the SEG method to the GGB-adjusted data.

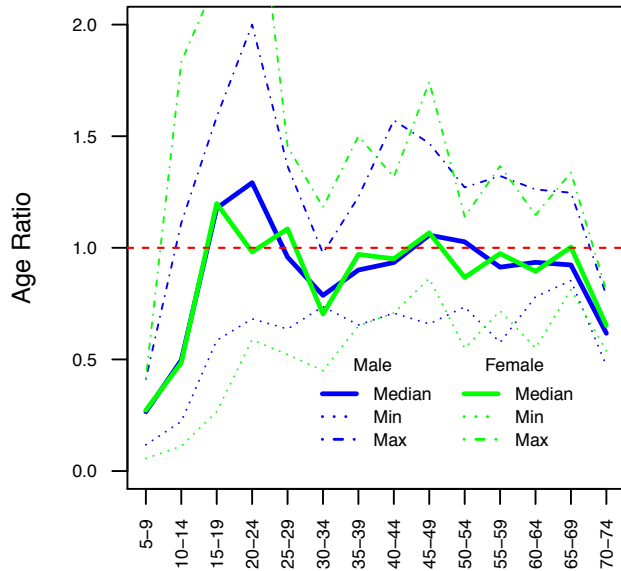
Country	Census 1	Census 2	Intercensal Deaths	Notes
Bahrain	7 April, 2001	27 April, 2010	2001 - 2010	Assessment for Nationals only.
Egypt	19 Nov, 1996	21 Nov-11 Dec, 2006	1996-2006	
Kuwait	20-21 April, 2005	21 April-20 May, 2011	2005-2011	Assessment for Nationals only.
Morocco	2 September, 1994	1-20 Sep, 2004	1994-2004	

Methodological Assumptions

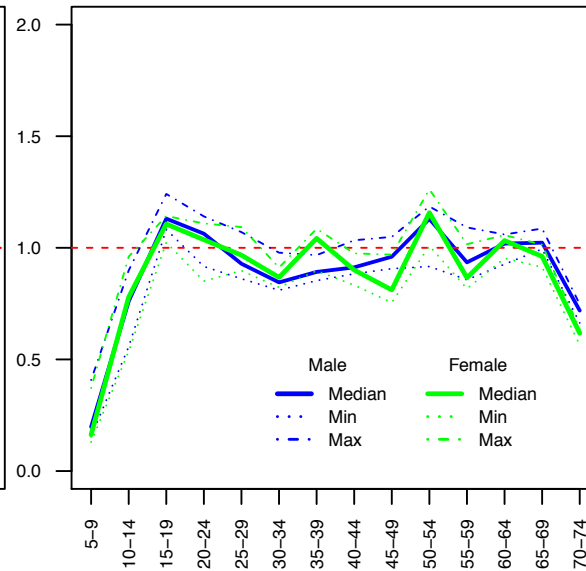
- Coverage of each individual census is the same for all ages
- Completeness of reporting of deaths is the same for all ages from a minimum age (usually age 15)
- Population is closed to migration (or information on migration is available)
- No assumption of population stability (unlike earlier one-census methods)

Age Ratios at Death by Sex of Registered Deaths

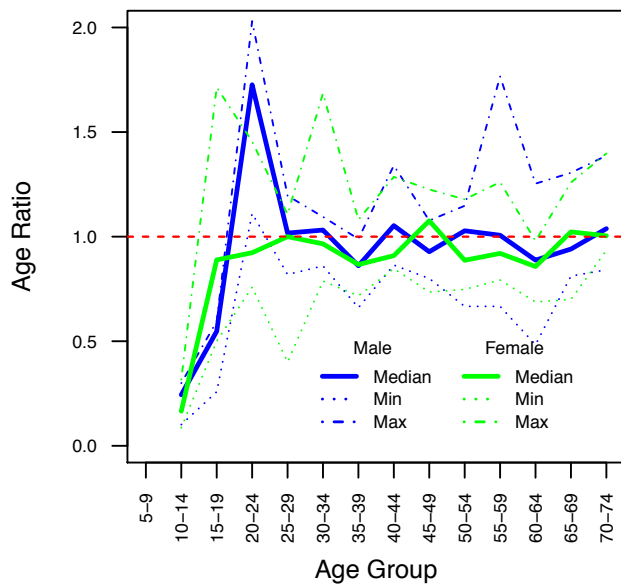
Bahrain



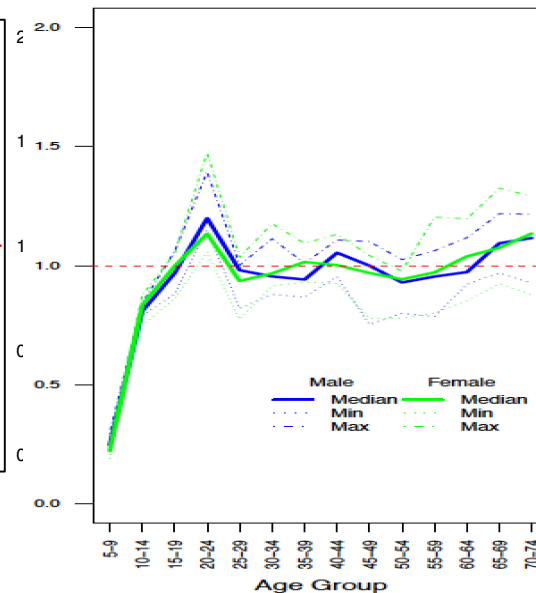
Egypt



Kuwait

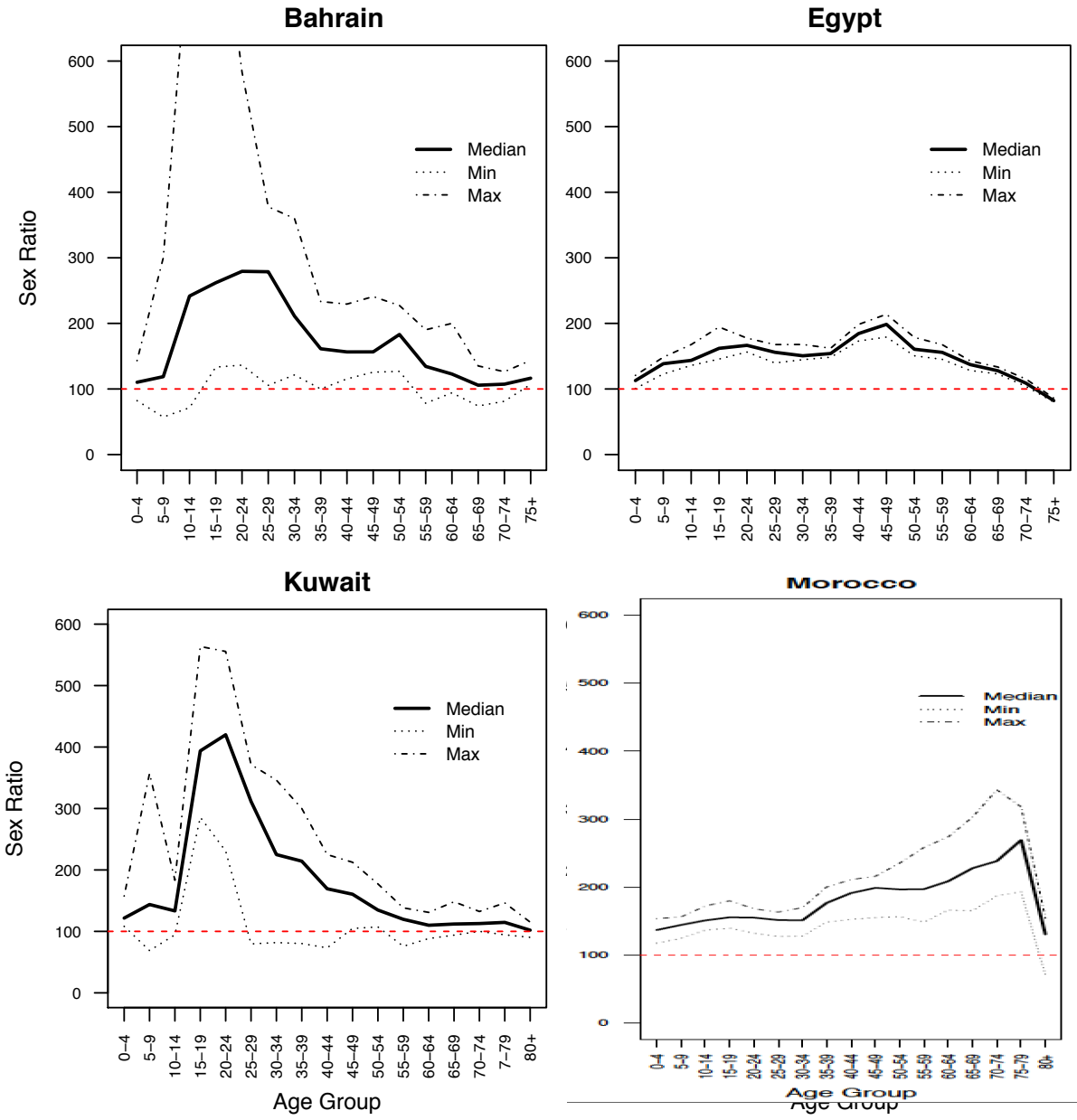


Morocco



$${}_5AR.D_x = \frac{2 \times {}_5D_x}{{}_5D_{x-n} + {}_5D_{x+n}}$$

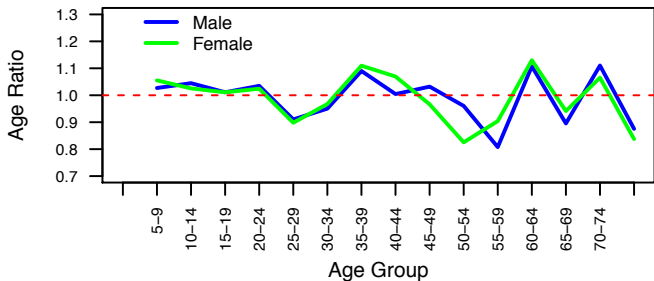
Sex Ratio at Death by Age Group of Registered Deaths



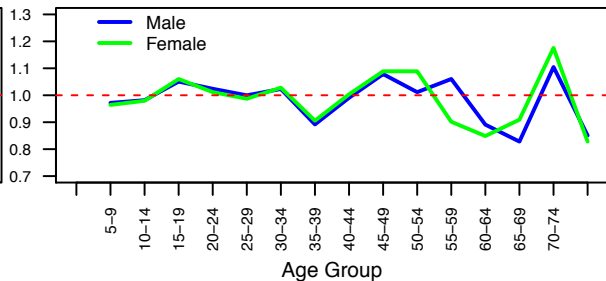
$$Sex.Ratio = \frac{{}_5M_x}{{}_5F_x}$$

Age Ratios by Sex & Population Census Enumeration

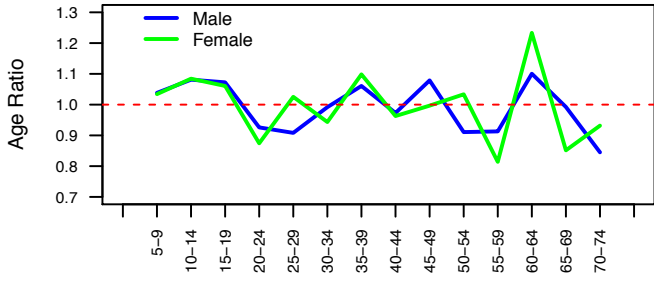
Bahrain – Census 2001



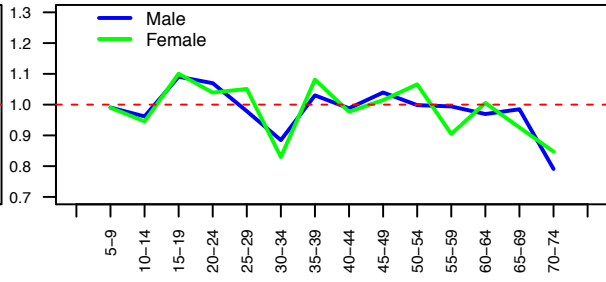
Bahrain – Census 2010



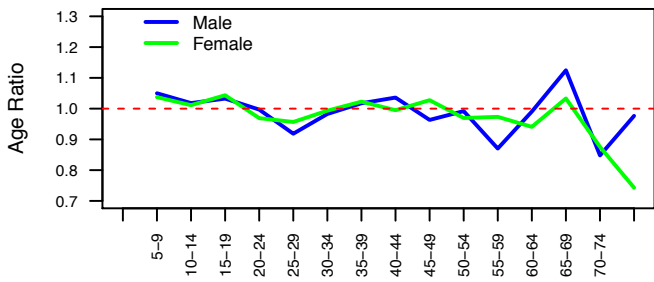
Egypt – Census 1996



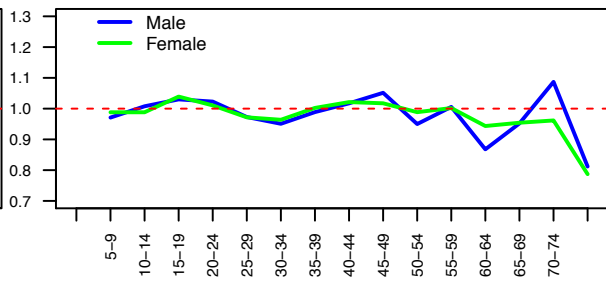
Egypt – Census 2006



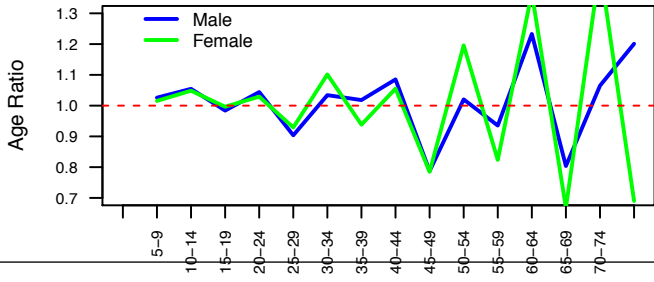
Kuwait – Census 2005



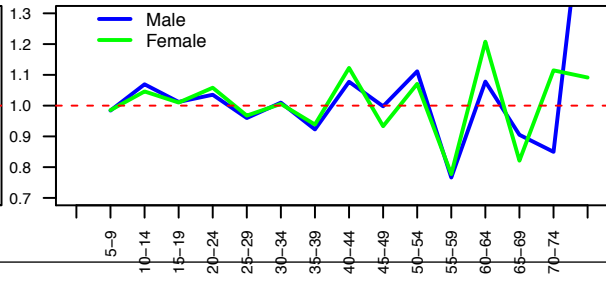
Kuwait – Census 2011



Morocco – Census 1994



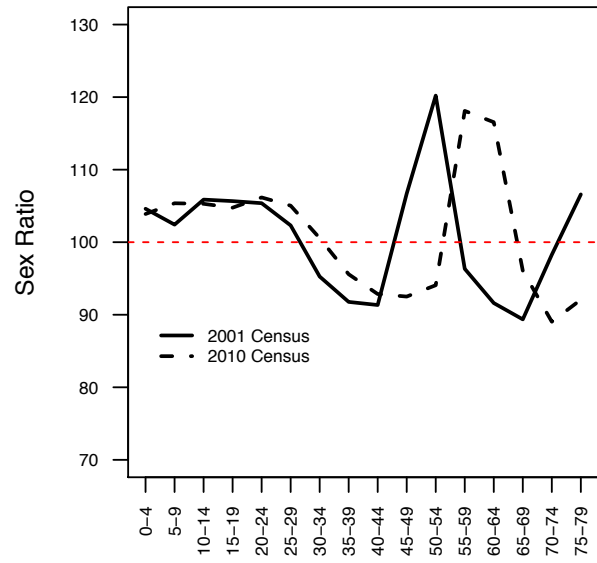
Morocco – Census 2004



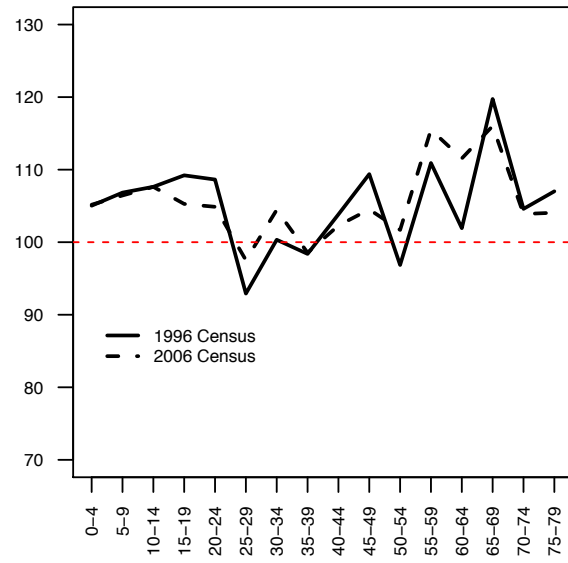
$${}_5AR.P_x = \frac{2 \times {}_5P_x}{{}_5P_{x-n} + {}_5P_{x+n}}$$

Sex Ratios by Age & Population Census Enumeration

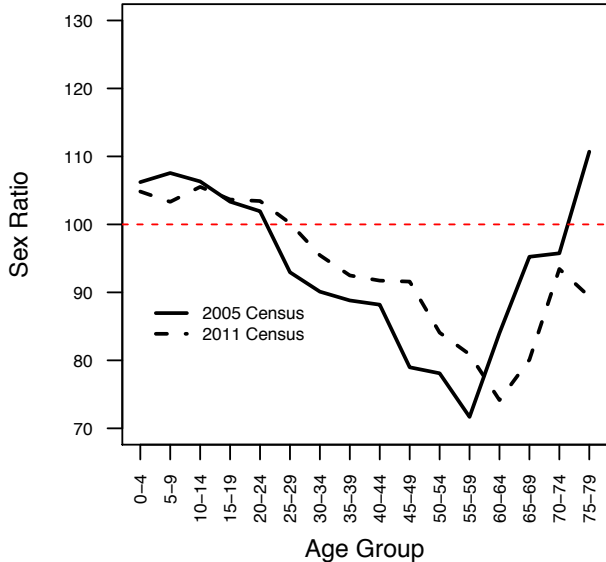
Bahrain



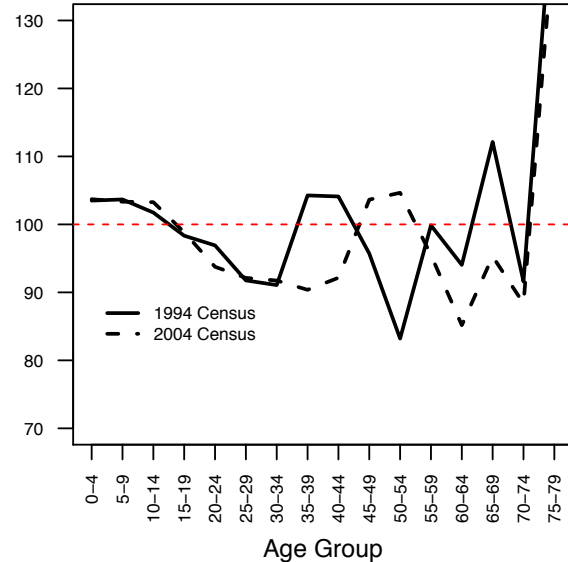
Egypt



Kuwait



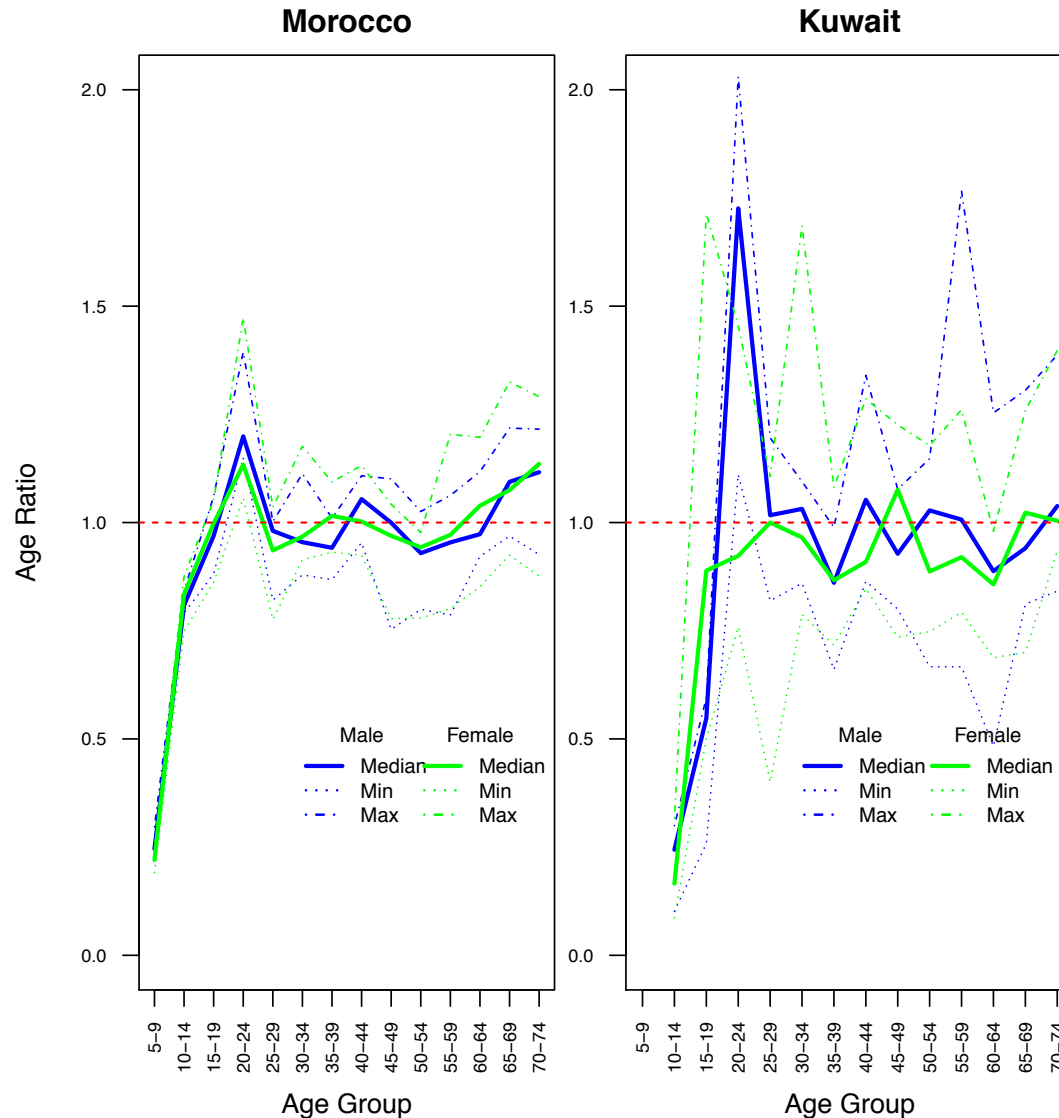
Morocco



$$Sex.Ratio = \frac{{}_5M_x}{{}_5F_x}$$

Death Register: Age Ratio

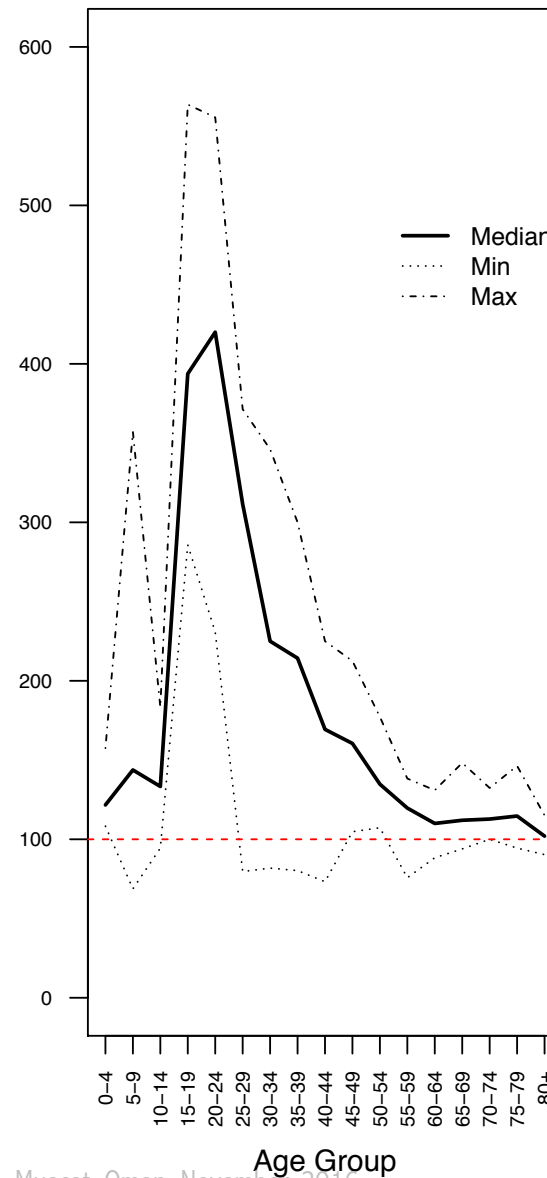
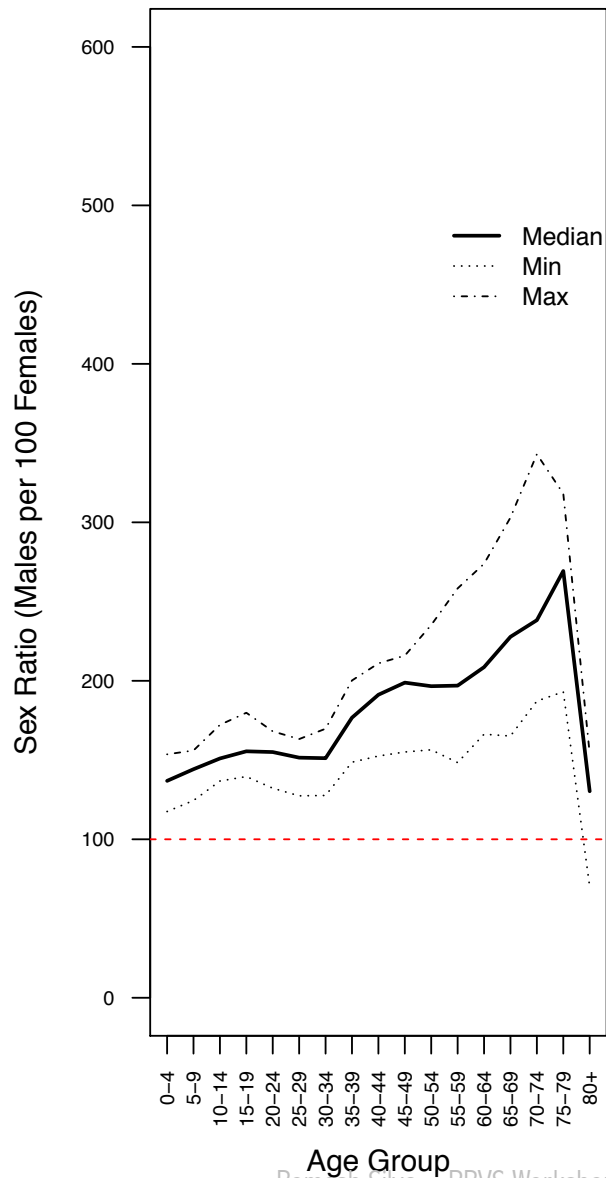
$${}_5AR.D_x = \frac{2 \times {}_5D_x}{{}_5D_{x-n} + {}_5D_{x+n}}$$



Death Register: Sex Ratio

Morocco

Kuwait



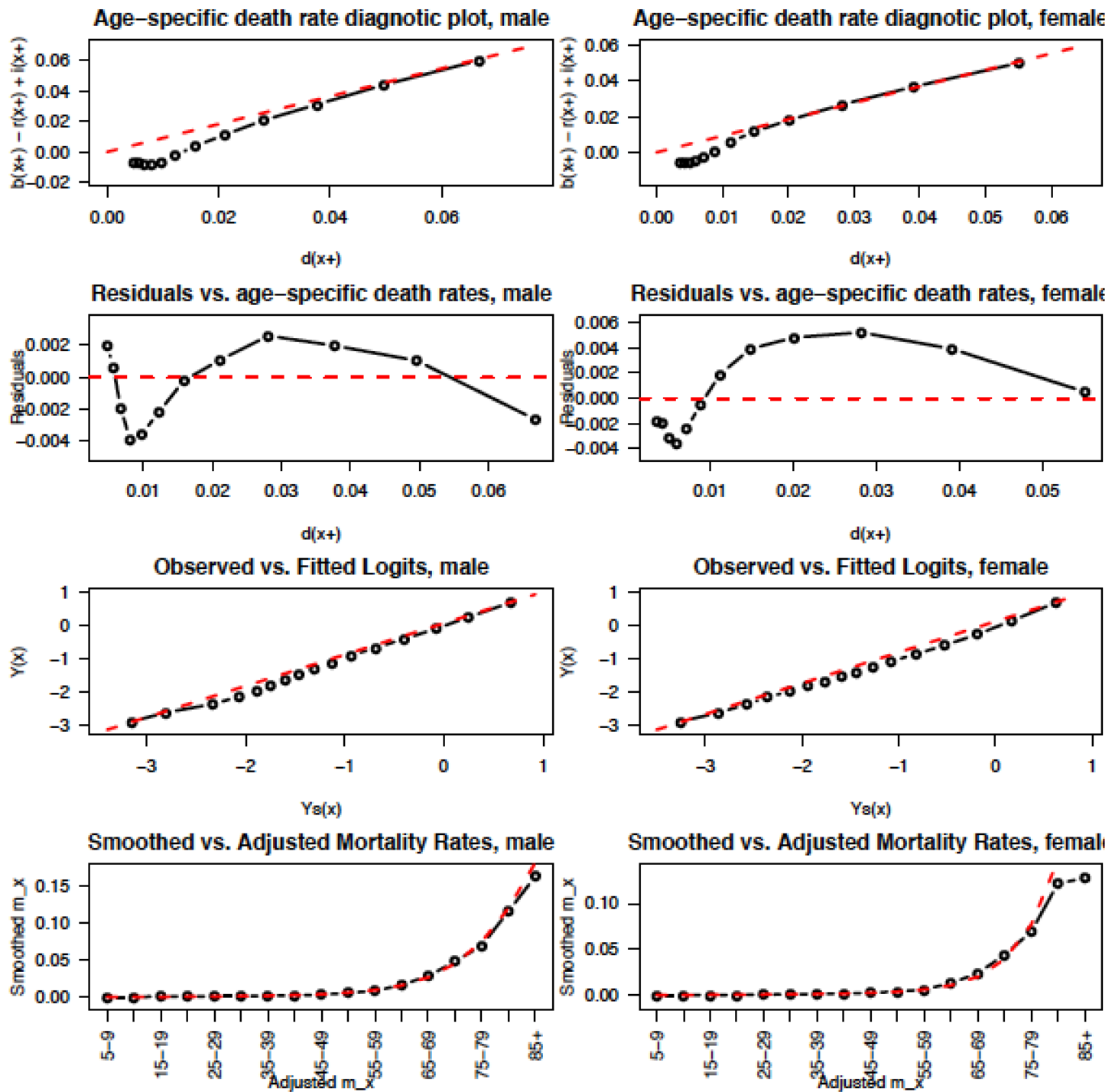
Death Registration Completeness Estimates

Member State	Male				Female			
	k1/k2	GGB	SEG	Adj. SEG	k1/k2	GGB	SEG	Adj. SEG
Bahrain	0.825	92	93	98	0.775	151	85	72
Egypt	0.986	95	93	80	1.01	88	92	95
Kuwait	0.914	86	110	73	0.946	86	113	83
Morocco	0.842	50	68	62	0.925	28	33	38

Note: GGB, SEG, and Adj. SEG completeness estimates that are b/w 90-110% are denoted in **bold**, all other completeness estimates are denoted in red.

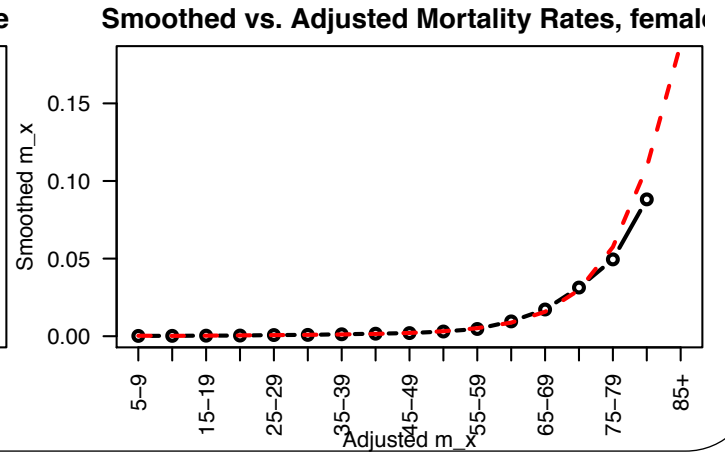
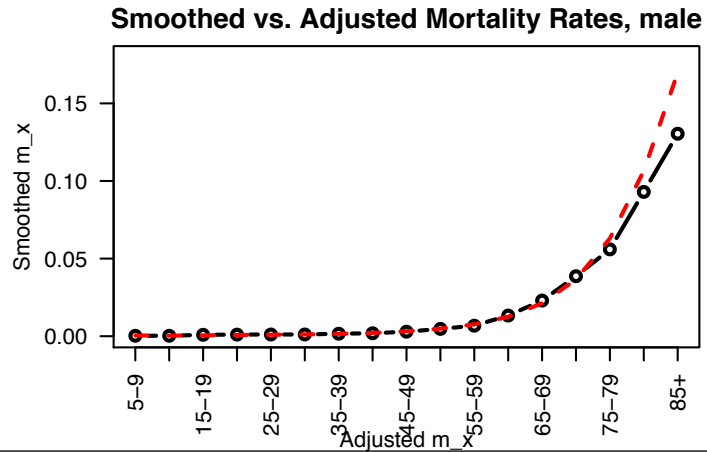
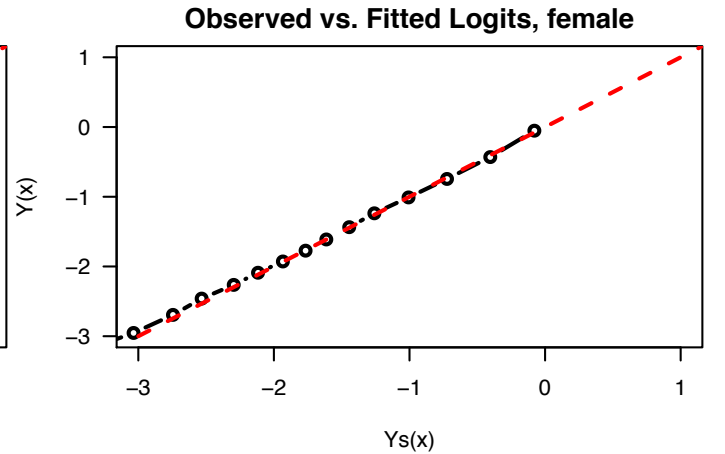
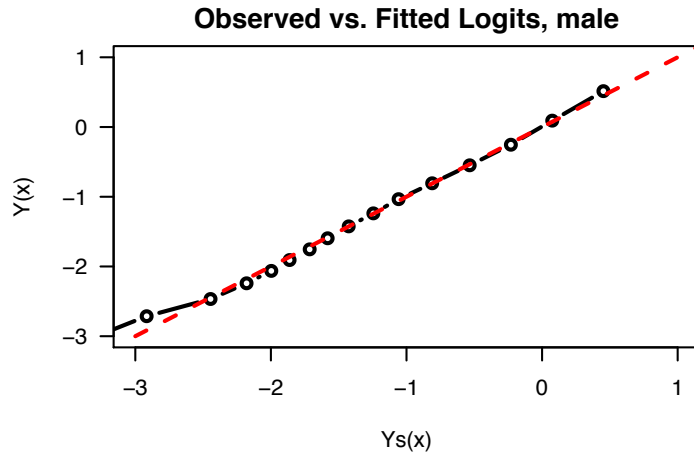
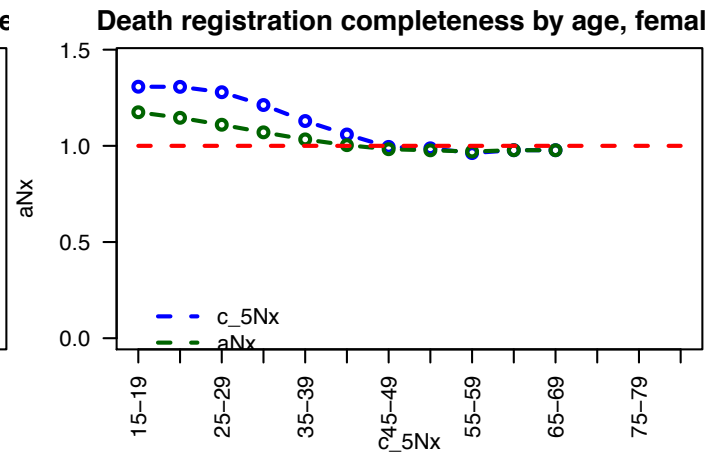
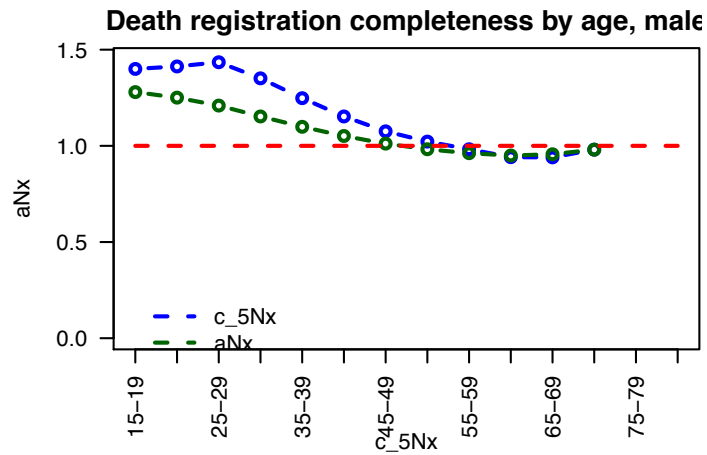
Kuwait, 2005-2011

GGB Diagnostic Plots



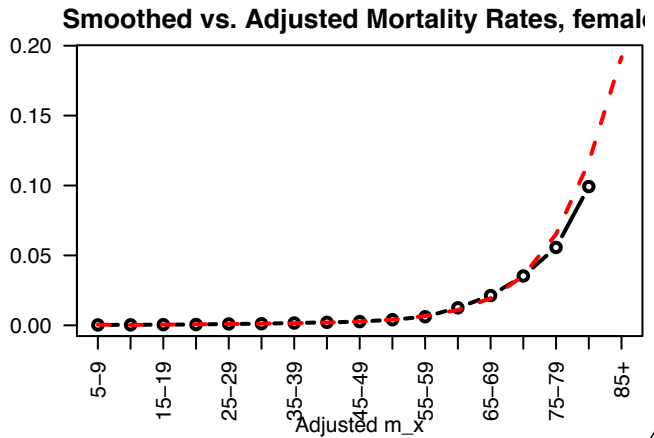
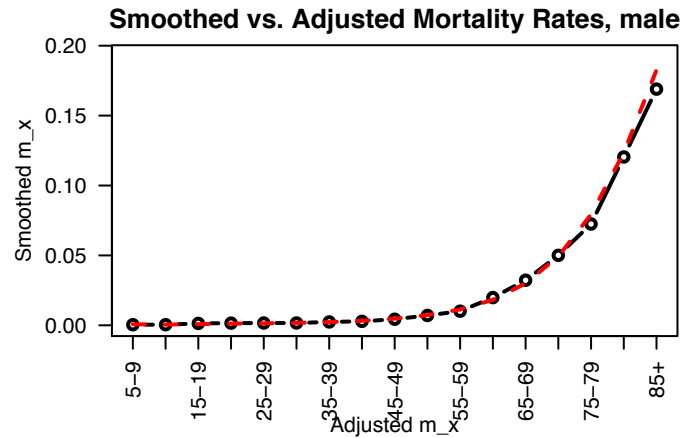
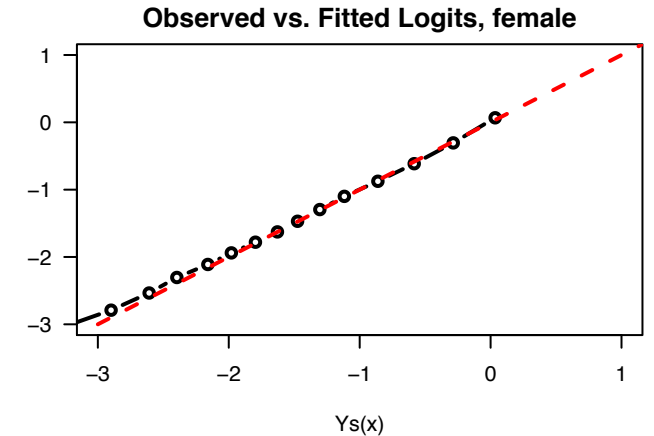
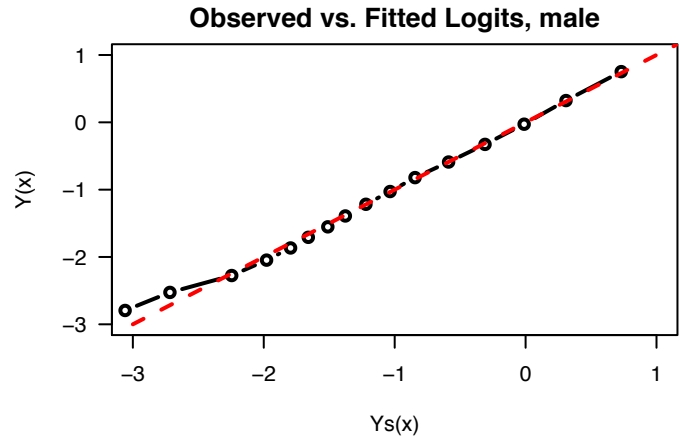
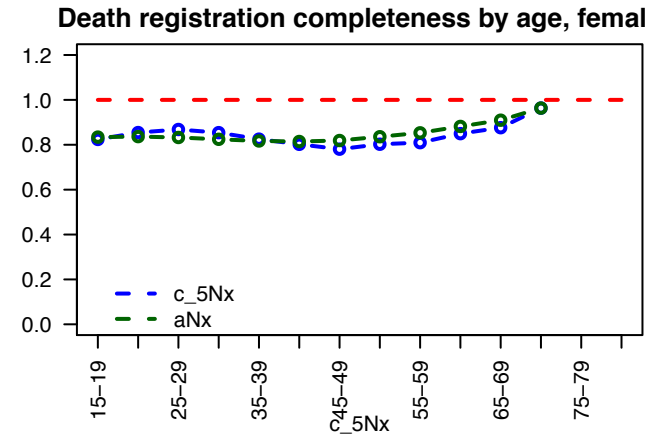
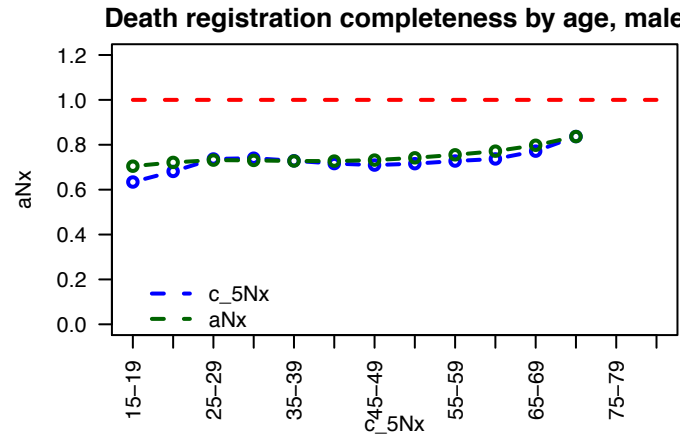
Kuwait, 2005-2011

SEG Diagnostic Plots



Kuwait, 2005-2011

Adjusted-SEG Diagnostic Plots



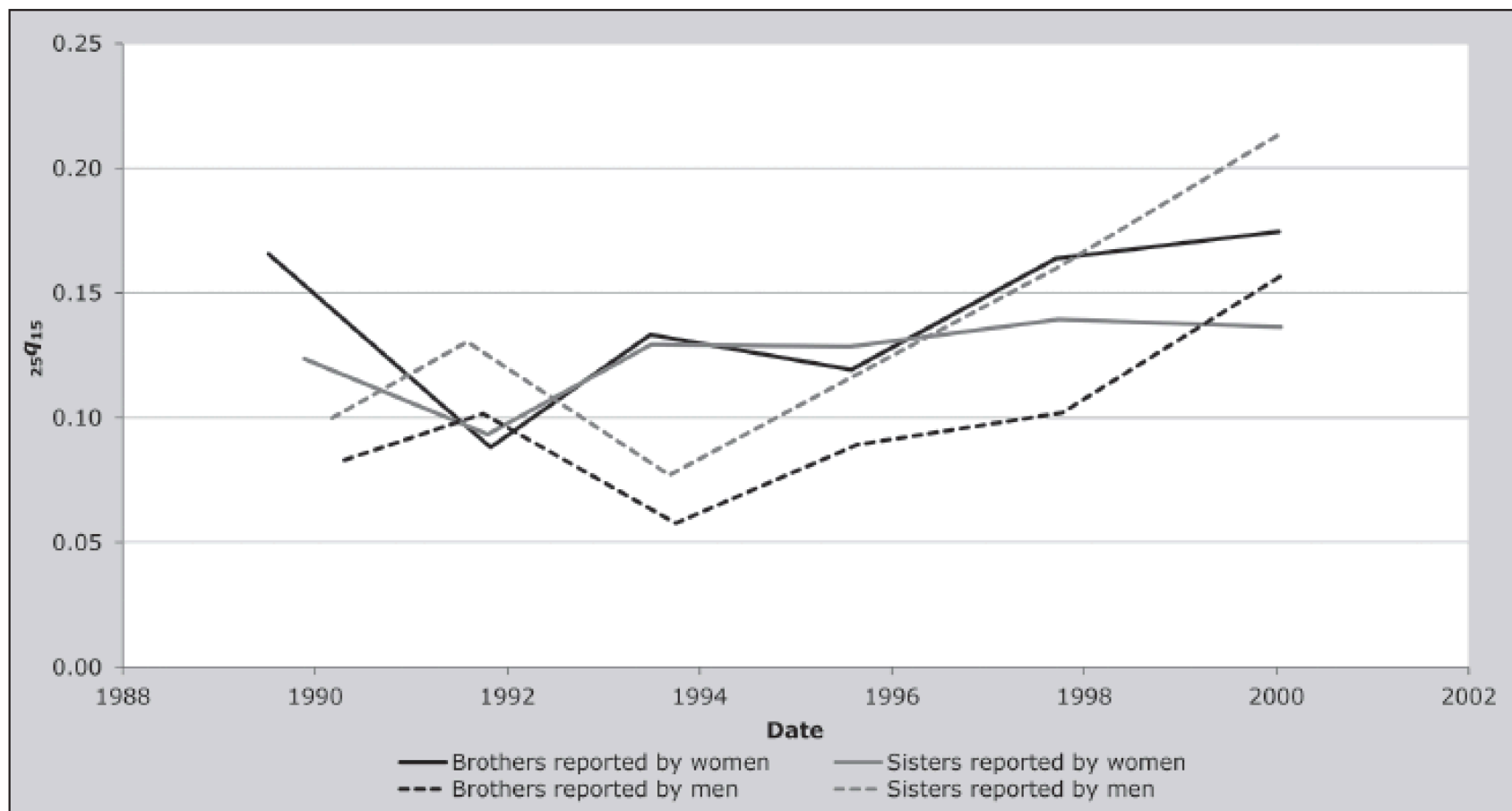
Tentative Conclusions

- Kuwait, Bahrain
 - Limited insight from application of DDMs
 - Published DR data only available for nationals (~1/3 of resident population)
 - DDMs sensitive to reporting errors/bias given small pop size
- Morocco
 - Notable sex differential in DR completeness
 - Likely a rural phenomenon linked to patrilineal inheritance and weaknesses in burial permit process in rural areas, but need internal migration data
- Methodological
 - Subjective-choice of age-trim
 - Effects of assumption violations
 - Completeness of death registration is constant across age range
 - Non-negligible Migration or detailed migration data available

Simple disaggregated analysis of survey data lead to important DQ insights

All mortality validation data from surveys/censuses are not created equal. Caution and customized data quality analysis are critical!

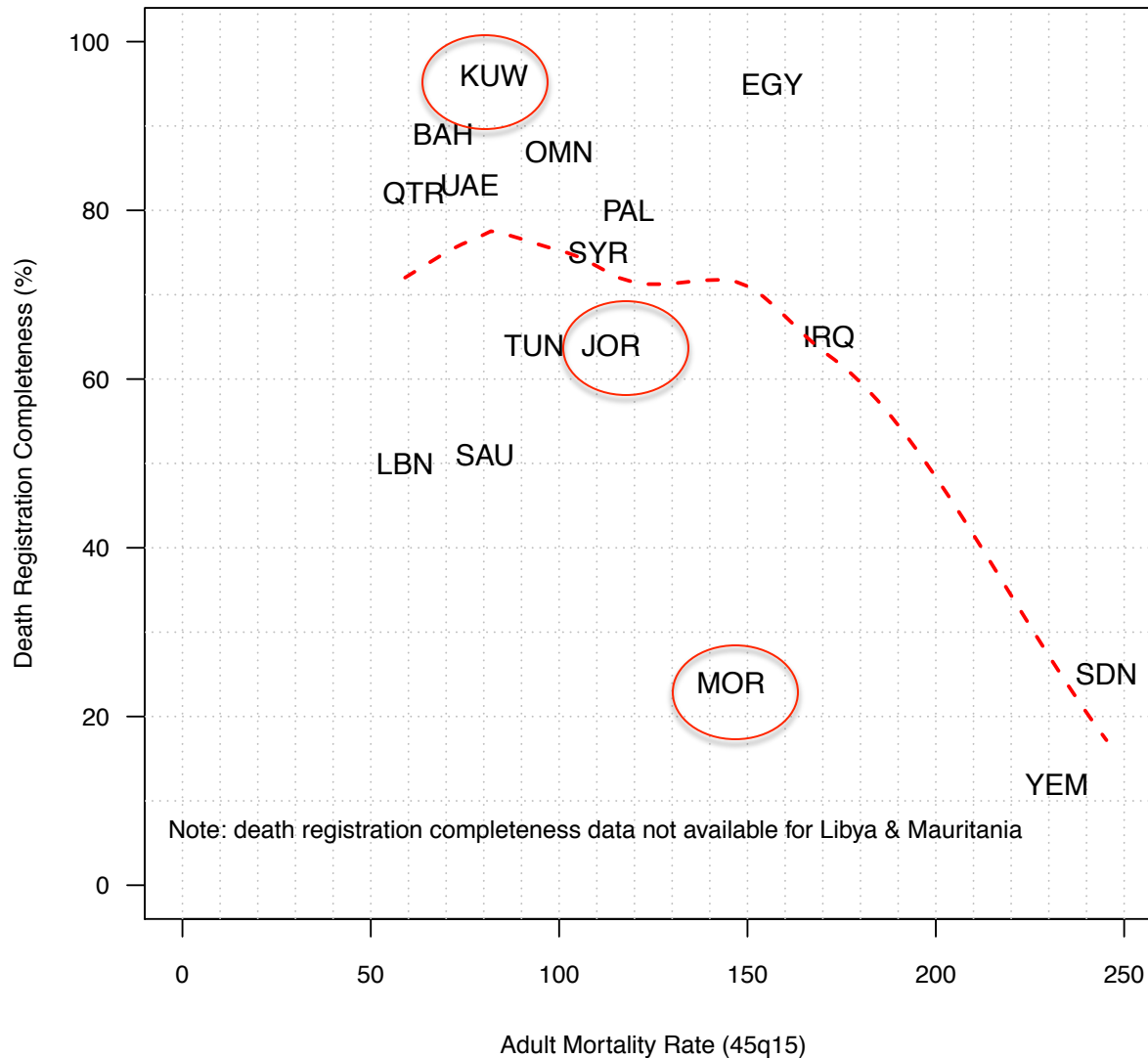
FIGURE 23.1 Trends in the probability of dying between exact ages 15 and 40 estimated from adult siblings, Bangladesh, 2003 World Health Survey



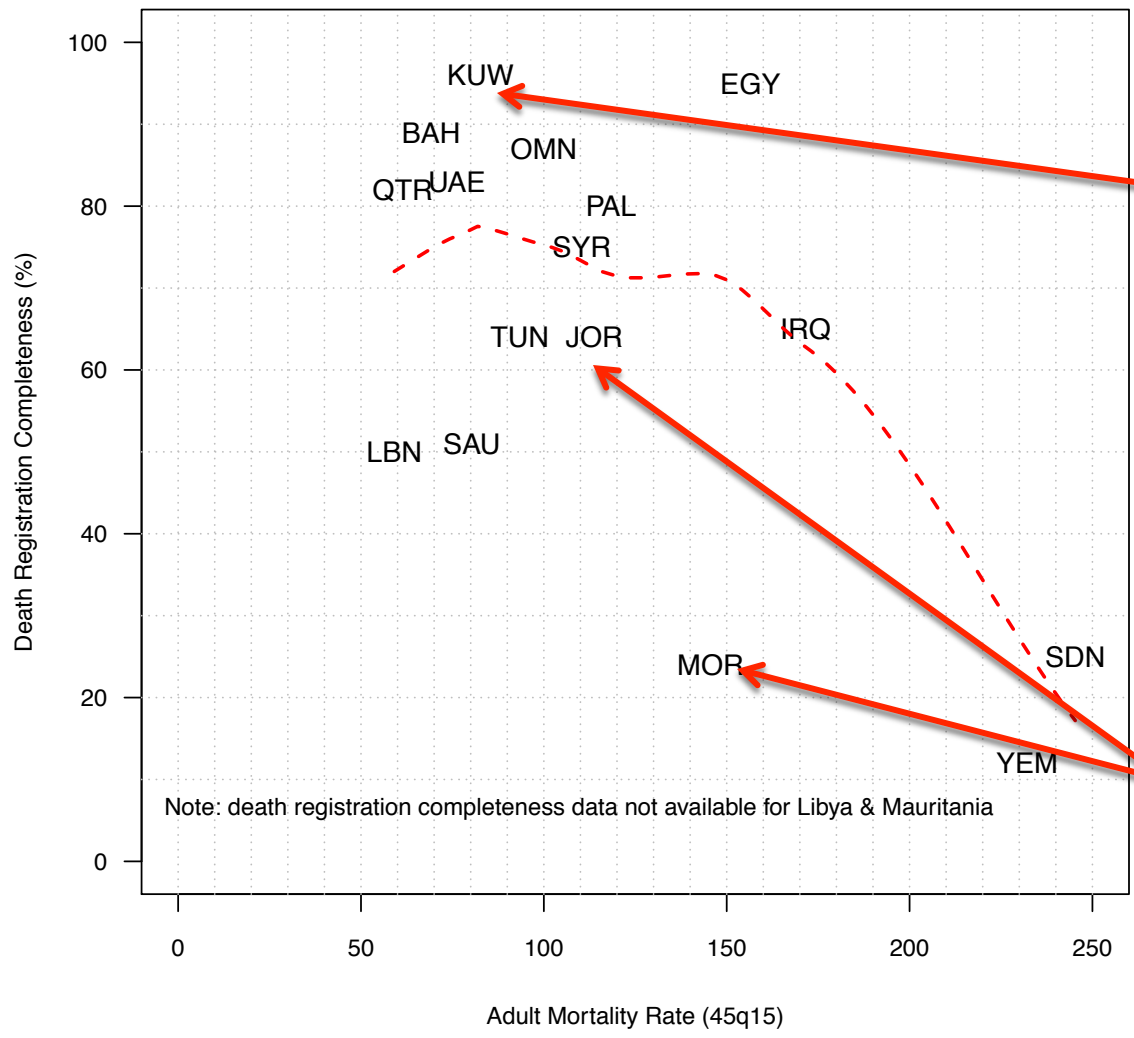
Better scientific standards of reporting needed when using E(births), E(deaths) method to estimate completeness

- Surveys are subject to sampling and non-sampling error
 - E(births) and E(deaths) should be reported with C.I.'s,
 - Hence ranges of completeness are a more meaningful way of reporting/comparing such DR-completeness estimates (esp. at subnational levels)
- Implication = for countries/areas with high completeness this method is unlikely to lead to important insights to guide improvement of the death registration system
 - Need more customized studies (e.g. record-linkage)

One Size does not fit all: More customized approaches to DR Completeness M&E



More customized approaches to DR Completeness M&E



Perhaps more focused study needed – looking at male (18-40 yrs) accident hump deaths and CoD codes (e.g. RTAs)

Perhaps focus on better validation mortality data sources from upcoming surveys and Census2020 round

Record Linkage and Dual Systems Estimation Method: Technique

TABLE 1. Two-source model

		Source Y		Total
		Yes	No	
Source Z	Yes	a	b	$a + b = Z_0$
	No	c	x	
Total		$a + c = Y_0$		$N = a + b + c + x$

Estimated values		Maximum likelihood estimator (MLE)
Unobserved cell:	\hat{x}	bc/a
Completeness of source Y:	\hat{Y}_c	$a/(a + b) = a/Z_0$
Completeness of source Z:	\hat{Z}_c	$a/(a + c) = a/Y_0$
Total population:	\hat{N}	$a + b + c + (bc/a)$ or, $(a + b)(a + c)/a$

$$\text{Completeness of Y} = \frac{a+c}{a+b+c+x}$$

$$\text{Completeness of Z} = \frac{a+b}{a+b+c+x}$$

Record Linkage and Dual Systems Estimation Method: Assumptions

1. Error-free matching of vital events
 - Use of semi-automated matching that draws on machine-learning techniques
2. Homogeneity of capture of vital events within each data system (e.g. CR system, Census HH Deaths data, etc.)
 - Stratification by key variables (sex, ethnicity, governorate) prior to matching
3. Independence of the data systems (i.e. inclusion in one dataset is not dependent on inclusion of the second data source)
 - Use more than 2 sources – examples from Brazil, Thailand, ...
4. Negligible in/out-migration (or available migration data or plausible migration model)

Record Linkage and Dual Systems Estimation Method: Possibilities

Births

1. Palestine
 - Registered births (April 2017 – March 2018)
 - 2018 Population Census: indivs <1yr & reg'd inf deaths
2. Jordan
 - Registered births in 2015
 - 2015 Population Census: indivs <1yr & reg'd inf deaths
3. Sudan
 - Registered births(April 2017 – March 2018)
 - 2018 Population Census: indivs <1yr & reg'd inf deaths

Deaths

1. Palestine
 - Registered deaths (April 2017 – March 2018)
 - 2018 Population Census – deaths in last 12-months
2. Jordan
 - Registered Deaths in 2014+2015
 - 2015 Population Census – deaths in last 24-months
3. Sudan (perhaps Khartoum only)
 - Registered deaths (April 2017 – March 2018)
 - 2018 Population Census – deaths in last 12-months

Record Linkage and Dual Systems Estimation Method: Jordan Census 2015

جدول 1.9: توزيع الوفيات خلال 24 شهراً السابقة حسب الفئات العمرية وقت الوفاة والجنس وحالة التبليغ عن الوفاة والمحافظات

Table 9.1: Distribution of Deaths During the Last 24 Months by Age Groups at Time of Death, Sex, Death Reporting Status and Governorate

Age Groups at Time of Death & Governorate	Sex & Death Reporting Status								الجنس وحالة التبليغ عن الوفاة				الفئات العمرية وقت الوفاة والمحافظات
	Female				Male				Total				
	لا أعرف Don't Know	لا No	نعم Yes	المجموع Total	لا أعرف Don't Know	لا No	نعم Yes	المجموع Total	لا أعرف Don't Know	لا No	نعم Yes	المجموع Total	
Jordan													الأردن
<1	26	98	876	1000	38	117	1157	1312	64	215	2033	2312	>1
1-4	16	60	1020	1096	36	66	1265	1367	52	126	2285	2463	4-1
5-9	3	8	364	375	11	18	549	578	14	26	913	953	9-5
10-14	2	10	249	261	10	8	381	399	12	18	630	660	14-10
15-19	4	3	243	250	16	33	519	568	20	36	762	818	19-15
20-24	6	3	272	281	32	24	758	814	38	27	1030	1095	24-20
25-29	6	8	261	275	16	24	633	673	22	32	894	948	29-25
30-34	0	6	328	334	23	21	695	739	23	27	1023	1073	34-30
35-39	3	8	350	361	12	17	790	819	15	25	1140	1180	39-35
40-44	9	9	528	546	20	14	1164	1198	29	23	1692	1744	44-40
45-49	4	11	631	646	19	13	1486	1518	23	24	2117	2164	49-45
50-54	5	4	940	949	23	20	2003	2046	28	24	2943	2995	54-50
55-59	4	14	930	948	24	33	2102	2159	28				
60-64	21	21	1344	1386	20	18	2580	2618	41				
65+	50	101	7571	7722	108	128	12290	12526	158				
Total	159	364	15907	16430	408	554	28372	29334	567				

Deaths Among Household Members										
No, skip to section four. 2 Yes, cont. .1 Dose any of the household died during the late 24 months? 301										
302 303 304 305 306 307 308 309 310 311										
ONLY For Females Ages 13-54 years, at the time of death										
Serial number of deceased person	Name of deceased person	Sex of deceased 1.Male 2.Female	Age at the time of death	Is the event of death has been registered? 1. Yes 2. No 8. Don't know	Marital status at death 1. never married, yes go to next person if last go to next section 2.Married 3.Divorced 4.Widowed 5.Separated	Was she pregnant at time of death? 1.yes, go 311 2.No 8.Don't, know	Did she die during delivery? 1.yes, go to 311 2.No 8.Don't, know	Was the death during the 42 days of the birth? 1.yes, go to 311 skip to next individual else, go to next section 2.No 8.Don't, know	Was death due to an accident? 1. Yes 2. No	
x		x	**	x	x	x	x	x		
.1										
.2										
.3										
.4										

Some Conclusions & Suggestions...

1. Indirect Completeness Estimation Methods are very fragile
 - strong simplifying assumptions,
 - very limited ability to make subnational completeness estimates
2. However simple demographic data quality assessment/analysis can be very useful – sex ratios, age ratios, Whipple's Indices, etc.
3. Need for customized approach to Completeness Assessment – one size/method does not fit all
4. Limited number of Record Linkage/Dual Systems Estimation Methods have been conducted in the region
 - For example - Recent work in Oman, and some studies in Egypt and Morocco from 30+ years ago
 - Opportunities to better exploit available HH-deaths data from 2010 & 2020 Census Rounds

Thank you



UNITED NATIONS

الاستسها
ESCWA

Romesh Silva, Ph.D.
Demographic and Social Statistics Section
Economic and Social Commission for Western Asia
United Nations

Email: silva22@un.org
Tel: +961-1-278-727
Twitter: @Romesh_Silva