Outcomes of the UN Expert Group Meeting on the Methodology and Lessons Learned to Evaluate the Completeness and Quality of Vital Statistics Data from Civil Registration

UN Population Division

UNSD Expert Group Meeting on Management and Evaluation of Civil Registration and Vital Statistics Systems
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Statistics Korea

EGM on "Methodology and lessons learned to evaluate the completeness and quality of vital statistics data from civil registration" on 3-4 Nov. 2016, New York

http://www.un.org/en/development/desa/population/events/expert-group/26/index.shtml

- Organized by the Population Division together with Statistics Korea (KOSTAT), Government of the Republic of Korea, as part of a joint technical cooperation agreement
- 25 international experts and academic researchers from 15 countries involved with the development and/or the application of **direct and indirect analytical methods** and **validation studies using record linkage between multiple data sources** to assess the completeness and quality of birth and death statistics from civil registration
- Two days meeting with 8 sessions (and on-demand video): 15 papers and 27 presentations, with forthcoming report and two background technical papers.

Topics covered

- **State of vital statistics data availability** based on CR and international reporting to UN and WHO
- Review of key concepts: **coverage vs. completeness**
- **Analytical methods** to evaluate the completeness and quality of birth registration:
  - UNICEF, South Africa (Nannan, Dorrington and Bradshaw), China (Chen), Latin America (de Lima and Queiroz)
- **Analytical methods** to evaluate the completeness and quality of death registration:
  - International experience for adult ages from IHME Global Burden of Diseases (Wang), Latin America (Palloni and Beltran-Sanchez), ESCWA region (Silva) and at older ages (Li and Gerland)
  - International experience for infant and child mortality: UNICEF-IGME (You), Central Asian republics by subnational characteristics (Guillot)
  - National and subnational experience: South Africa (Dorrington), Brazil (Queiroz and de Lima)
- **Record linkages and validation studies** to evaluate the completeness and quality of VR:
  - Overview and international experiences (Rao)
  - National experience: Oman (al Muzahmi), India SRS (Ohja), China Disease Surveillance Point system (Zhou), Thailand (Vapattanawonga), Brazil (Drumond), and Republic of Korea (Lee, Song and Hwang)
- **Criteria used to evaluate the quality of mortality data** from CRVS:
  - International experience from the Human Mortality Database (HMD) project (Shkolnikov and Zhdanov), Data for Health Initiative (D4H) project, and WHO assessment of CRVS quality for use in Global Health Estimates (Stevens)
  - National and subnational experience: South Africa (Joubert)

Questions

- What are the most appropriate methods available to evaluate the completeness and quality of birth or death records?
- What are the strengths and limitations of the various methods?
- What are the lessons learned from recent experiences with the application of these methods to different settings, including at the subnational level or for subpopulations disaggregated by various characteristics?
- What recommendations can be provided to national authorities in LMICs to best evaluate the completeness and quality of their vital statistics, both at the national and at the local level? - including with the forthcoming 2020 round of censuses and new sets of household surveys to monitor various SDGs indicators?
- What further methodological research would be desirable to address any pending needs?
- What are the practical next steps that you would recommend for further consideration and potentially cost-effective successful implementation of these approaches?
- In particular what practical operational guidelines should be recommended for other countries who would want to replicate approach(es) already used elsewhere?

Terminology

- **Coverage**: extent to which the population is served by the CRVS system as issue of access to the reporting system, and may be influenced by geography or other considerations such as the legal intent of the system, social or cultural influences.
- **Completeness**: measure the proportion of events in the population that are recorded by the CRVS: multiple ways exist to estimate the "true" number of events against which registered events are compared.

  If measures are to be calculated for sub-national populations, events should be classified by place of usual residence rather than place of occurrence, and populations by usual residence.
- **Content quality:** i.e., how complete and reliable (by variable) is the unit record data

  Minimum pieces of information that must be collected about recorded births and deaths if the data are to be of use for monitoring purposes are sex, age and cause of death, but additional pieces of information, such as place of residence, education and occupation will greatly enrich potential analyses

Overview of analytical methods available to evaluate the completeness and quality of birth or death records

- **Typology of Analytical Methods Used in Evaluation (Hill, 2017)**
  1. those that compare CRVS-based **estimates** to estimates for the same target population derived from other data presumed to be more accurate (e.g., surveys or census, ward records, health or education data)
  2. those that compare **patterns** in CRVS data (for example by age or by sex) to empirical regularities from populations with CRVS data presumed to be accurate
  3. and those that employ mathematically-derived relationships of population structure to compare CRVS information with other demographic indicators such as the population age distribution.

  Different method types tend to be used for **different age ranges**:
  - Birth evaluation rely on comparisons with other data or empirical regularities
  - Child (up to age 15) death evaluations rely on comparisons with other data or empirical regularities
  - Adult (15 and over) death evaluations tend to rely on mathematical relationships and to some extent on comparisons with other data and on empirical regularities
- **Analytical methods typically rely on aggregate level data analysis and include both direct and indirect estimation approaches**

Lessons learned to evaluate the completeness of birth registration

1. Use of direct questions about birth registration in surveys and censuses (UNICEF)

- **Nationally representative household surveys** (163 MICS, 123 DHS, 45 others): whether child under 5 has a birth certificate and if not, whether child's birth was registered with relevant civil authorities
- **Censuses** (26): for births in the last 12 months or for every person in the household, do they have a birth certificate or was the birth registered with the civil registry office
- [Possible extension to **school enrollment statistics** and enrolled students with a birth certificate]

Benefits: provides disaggregated data to extent possible (sex, age, urban-rural residence, wealth quintile, caregiver education, possession of birth certificate) and on barriers to registration (knowledge, place of residence etc.)

Challenges:

- prevalence rates sensitive to the way in which questions are asked:
  - Respondents not always clear on who the civil authorities in charge of recording births are in their country
  - May misinterpret birth notification for formal registration
  - Birth certificate may be confused with a health card or other identity document
- Under-reporting of infants and children in household rosters, and omission of infant and neonatal deaths
- Reference time period and comparability issues with CRVS data by place occurrence vs. place of registration, and with year of registration vs. year of occurrence (problem also applies to other methods): if it is impossible to align the period for the registry data with the comparison data, use the crude birth rate from an earlier period or for a more recent population estimate

Lessons learned to evaluate the completeness of birth registration

2. Use of direct demographic methods to assess birth registration

- Births from VR compared to births from census questions (e.g., Date of birth of last child born alive or births in the past 12 months) or surveys (e.g., full birth histories)
- Crude birth rates and fertility rates based on registered births and female population estimates compared to those from census and survey questions for the same time period and country/area
- Comparison of national VR counts and rates with intercensal and post-censal national estimates and projections and/or international sources

3. Use of indirect demographic methods to assess birth registration

A. based on population enumerated in censuses or administrative sources during the intercensal period (e.g., immunization headcounts, District Health Information System (DHIS) in South Africa, education enrolment and household registration in China)

- One data source: **Reverse survival** (Timæus et al. 2013) of infants and children (Dorrington and Nannan in South Africa) or **the Own-Children Method** (Retherford and Cho, 1978) to reconstruct fertility history and birth cohorts provide useful national assessment of completeness by age, but can be problematic at subnational level because a child who was born in a certain province may not be registered in the same province – need for additional and independent sources of data to corroborate
- Two data sources: **Preston integrated method** (1983) works well to estimate the average number of births between the two censuses using age distribution data from two censuses and generalized stable population models if the population age distributions at two censuses is accurate and the extent and pattern of misreporting or under-reporting by age remained similar between the two censuses (e.g., China extreme under-count at the very early ages and sub-regions subject to varying degrees of under-reporting and migration)

Both methods require some data or assumption about the mortality level and age pattern of mortality, and the performance of the methods are conditional to the accuracy of the enumerated populations

B. based on recent and lifetime fertility data from census or survey:

- One data source: Brass P/F ratio (Brass, 1967; United Nations, 1983) – not recommended in situations of changing fertility
- Two data sources: Synthetic Relational Gompertz (SRG) model (Moutrie et al. 2013) – recommended in situations of changing fertility

Combination of methods recommended as a tool to assess the completeness of births and estimate the "correct" fertility shape, particularly when fertility is changing

Lessons learned to evaluate the completeness of child death registration

Focus on under age 15, and especially under age 5 with growing interest on neonatal deaths

1. Comparisons with other estimates assumed to be more accurate (i.e., "gold standards")

- Full birth histories collected from household surveys (e.g., DHS or MICS) provide under-5 mortality (5q0) and its components, neonatal, postneonatal, infant (1q0) and child (4q1) for various retrospective periods and breakdown by various characteristics: ratio of the 5q0 calculated from CRVS data to that recorded for a comparable time frame (usually for sampling precision for a 5-year period) from a nationally-representative DHS or MICS.
- [Census questions collecting information on deaths by age and births in the 12 months before the census can provide basic counts to compare with CRVS events, and can be used to derive life table quantities but this information is typically of uncertain accuracy, and should be used with extreme caution and only as lower bound estimate likely to be downward biased].

2. Comparisons with empirical regularities

- Historical data from countries with high-quality CRVS systems and contemporary data from prospective studies indicate robust relationships between age and sex patterns of child mortality and the overall level of under-5 mortality.
- Calculation of ratios of early neonatal deaths to late neonatal deaths, neonatal deaths to postneonatal deaths, and even death rates (or probabilities of dying) under 1 to those between the ages of 1 and 5, and comparison with the ratios calculated from accurate data can reveal CRVS omissions that are age-dependent. An additional ratio that may be informative is that of stillbirths to early neonatal deaths.
- Additional regularities in child mortality that could be used for evaluation are the difference by sex, education of mother, socio-economic status and type of place of residence. However, real differences appear to exist in these relationships between populations, so they are less useful than age differences in the evaluation of CRVS data.

Lessons learned to evaluate the completeness of adult death registration

Focus on deaths that occur from age 15 onwards: 3 approaches

1. **Comparisons with other estimates assumed to be more accurate (but no "gold standards")**

A. [Use of direct demographic methods: comparison of national VR counts and rates with intercensal or post-censal national estimates and projections and/or international sources – easy, but depends on many assumptions, lag and reliability of the last census, and data on adult mortality and migrations]

B. Questions on recent household deaths included in a population census or very large household survey:

- If census data on deaths by age and sex are reliable or can be satisfactorily adjusted for data errors, the completeness of registered deaths can be assessed by direct comparison with the adjusted series, an assessment potentially applicable at the sub-national level.
- Due to various reporting errors, census data will in general under-estimate adult mortality, and can therefore be regarded as a plausible lower bound for mortality against which the CRVS data can be compared.
- Post-censal in-depth mortality inquiries based on a sample of households that experienced recent household deaths as reported in the most recent census can be used to validate census responses and to collect further details on causes of death (e.g., maternal causes in Indonesia 2010 census).
- In a standard household survey, sample sizes need to be in the hundreds of thousands in order to yield estimates with acceptable confidence intervals because of the rarity of adult deaths.

C. [Questions on survival of parents or siblings included in a population census or survey]

- Adult mortality estimates based on data from censuses or surveys on survival of parents (Timæus, 2013) or survival of siblings (Timæus, 2013) are not sufficiently accurate, and should be treated as lower bounds of plausible adult mortality ranges rather than as valid point estimates to evaluate adult mortality rates from CRVS.

Lessons learned to evaluate the completeness of adult death registration

Focus on deaths that occur from age 15 onwards: 3 approaches

1. **Comparisons with other estimates assumed to be more accurate (but no "gold standards")**

D. Intercensal survival using two census age distributions (UN 1949, 1967, 1983): with accurate recording and in the absence of migration, the ratio of the population of a cohort at a second census to the population of the cohort at the first census is equal to the intercensal survival ratio of the cohort

Pitfalls: Change in completeness of enumeration from one census to the next can have a huge effect on the estimates, migration may not be negligible and is usually less well recorded than deaths, intercensal interval may not be exactly 5 or 10 years, age reporting may not be accurate.

Workarounds:

- Use of model life tables (Courbage and Fargues, 1979), cumulation and stable population assumption (UN, 1967)
- Preston and Hill (1980) addressed the issue of change in census completeness, on the assumption that such completeness was proportionately constant by age, but the method is sensitive to age reporting errors.
- Palloni and Kominski (1984) proposed an extension of the Preston-Hill method, using forward and backward projection to reduce the effects of age reporting errors, but mortality estimates are affected by data errors, and backward projection will usually provide an estimate closer to true survivorship.
- Evaluation via cohort survival is most appropriate for older ages (higher mortality, lower migration) and higher mortality populations such as those of developing countries, but results are still sensitive to the quality of census data (Li and Gerland 2016).

Lessons learned to evaluate the completeness of adult death registration

1. Comparisons with other estimates assumed to be more accurate (but no "gold standards")

D. Intercensal survival using two census age distributions and age-specific growth rates:

Replace the direct use of cohorts by the use of population age structure and growth rates (Preston and Hill, 1980) and relaxing the stability assumption using age-specific growth rates for generalized closed populations (Preston and Bennett, 1983; Preston, 1983). The use of growth rates was seen as advantageous because they are unaffected by age reporting errors that are proportionately constant in both censuses, and it simplifies applications to censuses that are not exact multiples of five years apart.

Recommended more robust approaches:

- Preston-Bennett (1983) method: use cumulated intercensal age-specific growth rates to reduce an average of the two census age distributions to a stationary, life table age distribution from which all required summary measures can be derived.
- Preston Integrated Method (1983): estimate a life table from two census age distributions, and an assumption about the underlying mortality pattern (e.g., model life table pattern or life table derived from observed registered deaths and population, as long as death registration does not vary much by age) and, if available, an independent estimate of the probability of surviving to age 5.

Lessons learned to evaluate the completeness of adult death registration (DR)

2. Use of mathematical population relationships

Death Distribution Methods (DDM) are based on the relation between the age pattern of deaths in a population and the level of mortality, and require data on deaths from either CR or a question in the census together with census-based estimates of the population at risk by age at two points in time.

Two preferred methods using age-specific as opposed to constant growth rates to deal with non-stable populations:

- Generalized Growth Balance (GGB) method (Hill 1987) relies on mathematical expressions of population dynamics to relate population entry, growth and death rates – especially robust method to measure the relative completeness of the two censuses
- Synthetic Extinct Generations (SEG) method (Bennett and Horiuchi 1981, 1984) relate estimates of future cohort deaths from the number of deaths at any date to the population at the same date - especially robust method to measure the completeness of DR

Both methods provide estimates of completeness of death reporting and relative completeness of enumeration of the two censuses, but assume constant completeness of coverage of the censuses and reporting of deaths by age, negligible net migration over the period (or migrations should be taken into account, Hill & Queiroz 2010), and no major distortions of age reporting between 5-year age groups.

*** **Recommended GGB-SEG combined approach** (Hill 2009 and 2017, Palloni et al. 2016): **step 1: use GGB to estimate any change in census coverage (age 5 to 65), adjusting the population data for that change (alternatively if PES results are available for both censuses, adjust each census population using its PES), and step 2: apply the SEG (age 50 to 70) to the adjusted census data**; these age ranges should maximize the effectiveness of GGB for estimating completeness change, while minimizing SEG errors from migration.

DDM evaluations (Hill and Choi 2004; Dorrington and Timæus 2008; Hill et al. 2009; Murray et al. 2010; Palloni et al. 2016) with simulated errors (omission of population or deaths, misreporting of ages) or deviations from assumptions (non-proportionate completeness by age, migration) all conclude that DDM's work very well when applied to data that conform to their assumptions, but find them sensitive to migration and errors that are not proportional by age.

Note: choice of "age trim" has a substantial effect on completeness estimation. Hill and Choi (2004) recommended use of the age range 5 to 65 over 15 to 55. Murray et al. (2010) advocate for a standardized approach to DDMs – namely the application of SEG with a 55-80 age trim, GGB with a 40-70 age trim, and GGB-SEG combined with a 50-79 age trim to minimize migration effects.

Lessons learned to evaluate the completeness of adult death registration

3. Comparisons with empirical regularities

- Strong relationship between levels of mortality in childhood and in adulthood in model life tables (Coale and Demeny 1983; UN 1982; Wilmoth et al. 2012) provide ranges for plausible mortality levels in adulthood if child mortality is well-measured.
- Strong relationships between male and female mortality patterns by age can be used to assess plausibility of observed age-sex-specific mortality rates (e.g. Coale and Kisker 1986)
- Weaker regularities: mortality tends to decline over time and to vary negatively with socio-economic indicators; rising rates, or a positive association with socio-economic indicators, calculated from CRVS data could reflect effects of improving registration or differential completeness of registration.
- Only established empirical regularity specifically for adult deaths is that the overall pattern, from age 30 to age 80 or so, closely follows a Gompertz function, whereby the log of the force of mortality is linearly related to age (this pattern does not apply in populations with high prevalence of HIV). This regularity is of little use in assessing completeness of death reporting, however, since a proportional omission of deaths at all ages will not affect the linear relationship; this comparison is more useful for assessing quality.

Lessons learned to evaluate the quality of adult death registration

Focus on issues of age reporting, especially at older ages (e.g., ages 80 and over in low mortality populations)

- **Methods to quantify age misreporting:**
  - UN age-sex accuracy index on deaths and population
  - Digit preference: Whipple's Index of age accuracy (Whipple, 1919) on deaths and population
  - Systematic over- or under-reporting: simulated cohort survival ratios in the form of ratios of the predicted population at a second census age (x+t) and over (initial cohort population less cohort deaths) to the observed population at the second census to explore effects of different patterns of age misstatement (Dechter and Preston 1991). Such ratios increasingly rise above one by age, if age exaggeration is limited to the population data, but fall below one if proportionately similar age errors affect both populations and deaths.
  - But given the interactions of misstatement of ages of the living, of the dead, and of omission of events, all of which may be age variant, there is no definitive way of quantifying errors in reporting age at death beyond record linkage studies where one set of records is error free. See, for example, Elo and Preston (1994)
- **Comparisons with empirical regularities**
  - Age pattern of mortality, from age 30 to age 80 or so, closely follows a Gompertz function, whereby the log of the force of mortality (or age-specific mortality rates as an approximation) is linearly related to age (in the absence of any abnormal mortality conditions).
  - Extensive literature on other indicators of age at death reporting errors, such as the ratio of deaths at ages 105+ to deaths at 100+ (which should not exceed 5 percent (Bourbeau and Lebel, 2000), or can be compared to this ratio for Sweden (Jdanov et al, 2008)), or the ratio of the probability of dying at age 101 to that at age 100, or comparing the ratio T100 to T80 to that for a "gold standard" such as Sweden like for HMD (Shkolnikov and Zhdanov 2016).
  - Assessments of the quality of age reporting at older ages generally conclude that the **problem is more pronounced for the living (population) than for deaths**; methods for identifying and adjusting population data by age generally rely on extinct generation and survival ratio methods (Bourbeau and Lebel, 2000).

Recommendations about the choice of evaluation methods

- No universal method that's appropriate for all regions and **critical to apply standardized approaches, but in a country or region-specific manner**.
- Significant advantages to the use of multiple (independent) data sources (e.g., even an incomplete population register can be useful) and multiple methods: participants underscored that the results obtained by different methods could be very different. Important to understand the impact of the assumptions made by each method, and subsequently **select the most appropriate approach depending of the setting, data and resources availability, timing and complexity of the method(s) disaggregation requirements, and purpose of the assessment**.
- The uses of country-specific approaches were demonstrated by Korea's use of supplementary sources of data such as the Infant and Maternal Mortality Supplementary Survey. Compared to the regular death registration, the survey contained additional information on the infant, mother, and delivery, useful as well to support policies regarding healthy pregnancy and delivery.
- Standard Human Mortality Database (and Human fertility Database) methodology identified as an appropriate method of evaluation for countries with a full coverage of vital statistics information and continuous population statistics. After each new census, update intercensal population estimates and recompute vital rates. In the event of unreliable or unavailable intercensal population estimates, use uniform distribution of migration across intercensal periods.

Lessons learned with the application of various evaluation methods

- Many studies provide insufficient details about the method(s) and assumptions used (e.g., demographic analysis), and lack error margins and an evaluation of biases for their estimates.
- All methods of evaluation have strengths and limitations but they vary based on their complexity and resource requirements.
- Strengths and limitations are also dependent on factors such as the need for additional sources, level of detail of the data sources, independence of sources, need for migration assumptions, and reporting patterns by various groupings and in comparison to neighbouring regions.
- **Foster political will and drive, technical expertise, and collaboration among stakeholders, organizations, and researchers**: encourage stronger national ties, academic links, and funding for research to address the complexity of the evaluation methods, particularly for training in the application and understanding of the approaches (e.g. Thailand, South Africa, Brazil, Oman, D4H).
- Improve the priority of routinely estimating registration completeness within the national statistical office, including margins of error and biases.
- Issues regarding data protection often preempt data access for further evaluation of vital statistics: need to establish robust mechanisms in order to maintain ethical and privacy considerations, yet allow analytical research and record linkage under appropriate confidentiality protection safeguards.

Lessons learned about the application of analytical methods

Comparison of data with a standard data source identified as the simplest method to measure completeness. Commonly used to evaluate registration completeness in countries that lack a national coverage of births and deaths information.

Census data often play a critical role, especially for the analysis of sub-populations or at subnational level.

Advantages of analytical methods:

- Direct and indirect analytical methods only require limited amount of tabular data
- Cost-effective in term of time and resources

Limitations:

- **Timeliness** of estimates is problematic because these methods assess completeness for intercensal periods
- In general indirect methods relying on **two censuses** provide more robust estimates than those relying only on one census, but intercensal cohort analysis requires the two censuses to be **spaced at most by 10 to 15 years** and completeness is measured essentially in comparison to the **completeness of population data**.
- **Significant uncertainty levels**: due to underlying assumptions, results must often be interpreted with caution especially when applied at subnational level.
- Once completeness is high or very high, and especially when fertility or mortality are low, existing analytical methods are unable to measure completeness with sufficient accuracy (5-20% of more typical error rate when one or more underlying assumptions are violated) **and other approaches such as record linkage studies should be considered** (e.g., between registered infant death and birth registration in Brazil and Rep. of Korea)

Strengths and limitations of Dual/Multiple Record Systems and capture-recapture validation studies

Strengths:

- **Help to identify systemic weaknesses in the registration system, including in specific population sub-groups and at subnational level**
- **Enable age-specific measurements of completeness and data reconciliation**, especially among infants and young children and using additional fragmentary sources to help close gaps in CoD information
- **Potentially timelier** than indirect methods and for health surveillance based on routine data
- **More readily interpretable** by policy makers than indirect methods
- Linking two or more sources of data **facilitate the correction of incorrect variables** (i.e., can help to improve data quality) and the potential to merge additional variables of interest into an analysis
- Useful in the context of unreliable in and out-migration data, age misreporting, and incomplete death reporting constant by age
- 95% confidence intervals can be easily computed
- Probabilistic matching (e.g., Reclink in Brazil) can help to facilitate linkage of records and propensity score can help to deal with under-reporting and missing data (China DSP)

Strengths and limitations of Dual/Multiple Record Systems and capture-recapture validation studies

Constraints and Limitations:

- **Absence of out-of-scope events, homogenous capture probability, statistical independence of data sources, and accuracy of matching** (missing data, errors in spelling of name and errors in reporting of dates, local judgment critical for decision-making)
- **Applicable only in some settings given data requirements, time and resource-intensive nature**
- Many **challenges in data quality** contribute to reporting incompleteness: defects from various studies such as missing fields, frequent spelling mistakes, differences in the age or date of death, and differences in the sex of infants. The quality of age reporting (e.g., age heaping at ages ending in 0 and 5 significant problem for some countries and cities)
- Use of lengthy unique identifiers as the sole variable for linkage could be problematic because a long string of digits are prone to some degree of error. This could result in false positives and false negative linkages.
- Use of individuals' first and last name as a unique identifier can result in the inability to match many records in Thailand. This is mainly because of the different ways that were possible to spell a name and under-registration.

Recommendations about Dual/Multiple Record Systems and capture-recapture validation studies

- **Assess the performance of linking birth and death register information**
- **Emphasize the use of unique identifiers, validation, enforcement, the accuracy of the date of death, age, name spellings, and address variables to improve data quality**.
- Improve assessment of compatibility between data sources in order to minimize the matching of out-of-scope events.
- Employ different means of record matching within different settings. Although cross-matching is practical, it requires adjustments based on the context of the country.
- Improve uncertainty and bias reporting in record linkage studies
- If follow-up study or record linkage is planned using vital events collected from a census, then collect also the individual names in the census to check or to facilitate matching.
- **Conduct a field verification of events after record linkage using a sample of matched records**.
- **Utilize a defined hierarchy of study designs based on statistical independence, cost, sub-group analysis, and sample size to guide research**.
- **Invest time in developing an efficient study design when conducting record linkage analyses, and consider alternative methods of data collection and the scope of the desired outcome measures, such as disaggregation by age or geography**.
- Achieve a clear understanding of and definition of all data collection procedures, to facilitate consistent data quality assurance, problem investigation, and the evaluation of bias.
- Develop and disseminate free, simple, and easy record linkage methodologies.
- Increase the incorporation of statisticians and epidemiologists as trained health staff for future record linkage applications.

Summary of approaches to assessing registration completeness by certainty of results

(Karen Carter, Pacific Community)

Increasing certainty of result*

Approach	Application	Method allows for disaggregation by sub-group
Multiple-source record-linkage study	Births and Deaths	Yes
2 source record-linkage	Births and Deaths	Yes
Direct/Indirect Demographic Methods	Deaths (for ages >5 years)	No
DHS/MICS survey comparison	Births	No
Direct comparison with a "gold standard"	Births and Deaths	No

Can we create a sensible tool to help countries to select a method and encourage more frequent analysis?...

Karen Carter
Pacific Community