The use of Capture-Recapture Method for evaluating the completeness of Burial Surveillance in Addis Ababa

Biruk Tensou and Tekebash Araya

Addis Ababa Mortality Surveillance Program

Addis Ababa University, Faculty of Medicine

Addis Ababa, Ethiopia

Corresponding author: Biruk Tensou
Addis Ababa Mortality Surveillance Program
Faculty of Medicine, Addis Ababa University
Addis Ababa, Ethiopia P.O.Box 42988
Phone: +251 116 555-320
e-mail: Biruktensou@gmail.com

Abstract

A necessary component of public health strategies is to get accurate information. In this study we implemented capture-recapture method to evaluate the completeness of burial surveillance using an independent data source called Iddir surveillance. Iddirs are indigenous voluntary associations established to provide mutual aid in burial matters. All cemeteries within the city limit are included in the burial surveillance. The burial surveillance was initialized in 2001 and registers deaths continuously. Registration of deaths is also conducted on a random sample of 100 Iddirs in 2009. Socio demographic characteristics of the deceased are collected in both surveillance independently. We used the Iddir surveillance as capturing and the burial surveillance as re-capturing. The burial surveillance captured 97% of the deaths reported from Iddirs. Majority of the deaths not captured at the burial sites are buried outside of the city. Moreover, causes of deaths such as drowning are not captured at the cemeteries.

Introduction

A necessary component of the development and implementation of effective public health strategies is adequate information. Sound recording of vital statistics and cause of death data are public goods that enable progress towards Millennium Development Goals. Vital statistics are most effectively generated by comprehensive civil registration [1]. Registration of births, recording deaths and calculating mortality levels and differentials are fundamental to evidence-based health policy, monitoring and evaluation [2]. Observing and monitoring health trends requires a surveillance system that captures useful data. However, a concern with any surveillance system is the quality of the data collected. Therefore, to determine the usefulness of any surveillance system, there must be some way of assessing the quality of the data and completeness of ascertainment [3, 4].

Mortality registration is one of the forms of disease surveillance, and its importance for epidemiology and public health planning is obvious. Reliable information on causes of death is essential for prevention and control of disease [5]. Moreover, mortality statistics are an important resource for evaluating the effectiveness of programs such as Antiretroviral Therapy (ART) programmes [6].

The burial surveillance in Addis Ababa was initiated in February 2001 at all known cemeteries. The surveillance focuses on registering deaths at all known cemeteries within the city limit. The surveillance is assisted by cemetery-based staff and supervisors who oversee the data collection at the cemeteries. Relatives or close friends facilitating administrative procedures before the burial ceremony provide the clerks with the information. The quality of the burial surveillance is monitored on a continuous basis through annual trainings and well-instituted data management system [7, 8]. However, the completeness of the death registration has never been evaluated. Hence, this study used capture-recapture (CR) method to determine if all deaths in the city limit are captured in the burial surveillance using an independent data source called Iddir surveillance. *Iddirs* are indigenous voluntary associations established primarily to provide mutual aid in burial

matters but also to address other community concerns. In Ethiopia, Iddirs are the most widespread type, prevalent in both rural and urban settings and sometimes transcending divides of gender, generation, wealth, education, religion, and ethnicity. Households become members of the associations and pay fixed contributions monthly. Whenever death occurs among members, the association raises an amount of money (depending on the specific bylaws) and handles the burial and related ceremonies [9, 10]

The capture-recapture methodology has been applied in different scientific areas. It was first introduced by ecologists as a means of estimating the size of wildlife populations [11-13]. In demography, it has been used to adjust for undercounting in population censuses and to estimate birth and death rates and the extent of registration in developing countries [14]. By matching several sources of information coming from the same population, the capture-recapture method allows, if matches between sources can be identified, to estimate the number of cases not identified by any of the sources. The application of capture-recapture method is increasing in the fields of epidemiology to estimate the incidence and prevalence of diseases [15-18].

Methods

The basic assumption to be met in order to generate a reliable estimate using CR method is that data sources should be independent. The data used in this study is generated from two independent sources namely burial surveillance and Iddir surveillance. Currently, Addis Ababa is administered in to 10 sub cities and 99 Kebeles[1]. The sub cities are responsible for providing recognition and legal identity for Iddirs. A complete list of registered Iddirs (n=4535) were identified from the 10 sub cities of Addis Ababa. Prospective death registration was initiated on a random sample of 100 Iddirs as of January 1, 2009. The selected Iddirs contains more than 30,000 households. The Iddir surveillance form is designed in such a way that it will allow matching of records with the burial surveillance. We used the Iddir surveillance as capturing death and the Burial

[1] The smallest administrative unit

surveillance to recapture deaths. We merged the two datasets based on specific identifiers of the decedent basically name, age, sex, date of death and address (house number; Sub city; Kebele and telephone number). Merging of the two data sets has different stages. Firstly, we generated a unique identifier in both datasets. The unique identifier is generated from address structures (Sub city; kebele and house number) controlling for the difference on date of death reported from both surveillance to be less than a week. Secondly, we generated a string variable indexed from first few characters of name of the decedent. Finally, records of infants and children, whom do not have name, were merged based on fathers or surname.

The total number of deaths (N) is estimated using the Lincoln-Petersen method. In this method it is assumed that all deaths have the same probability of being captured in the second sample, regardless of whether they were previously captured in the first sample or not. In symbols, $\frac{O}{I} = \frac{B}{N}$

Where N= Estimate of the total number of deaths; O= Number of deaths captured on Iddirs that were then recaptured at cemeteries; B= Total number of deaths registered at cemeteries and I= Total number of deaths registered at Iddirs. The 95% confidence intervals are determined by calculating the limits for O/I:

$$\frac{O}{I} \pm 1.96\sqrt{\frac{\frac{O}{I} - (1 - \frac{O}{I})}{I - 1}}$$

Results

A total of 16,241 and 1070 deaths were registered from burial and Iddir surveillances, respectively. Male to female ratio at both surveillances is relatively equal (100:120). Mean age at death is 44 years at the burial sites while the mean age is 51 years at the Iddirs. The burial surveillance captured 97% (n=1038) of the deaths reported from *Iddirs*. The kappa index values for is higher for religion (kappa=0.85); ethnicity (kappa=0.75) and marital

status (kappa 0.78). In the round of capture-recapture we have I = 1070, O = 1038, B =16,241. The estimate of the total population size is 16,743 (95% CI: 16,567-16,920). Hence, the number of deaths not captured at the burials is estimated to be 502 (95% CI: 326-679).

Discussion

In this study we evaluated the completeness of the burial surveillance by using an independent sample based data source. We identified possible weakness of the burial surveillance. Firstly, the burial surveillance did not capture deaths in which the funeral ceremonies are performed outside of Addis Ababa. Secondly, few deaths such as drowning did not get buried because bodies were not identified and hence it is difficult to capture at cemeteries. This study demonstrated that few deaths have been buried in the city but not captured at the burial sites. For such cases we identified that municipal cemeteries did not capture deaths when buried over the weekend.

References

1 P. W. Setel, S. B. Macfarlane, S. Szreter, L. Mikkelsen, P. Jha, S. Stout and C. Abouzahr, 'A scandal of invisibility: making everyone count by counting everyone', *Lancet*, Oct 26 2007.

2 P. W. Setel, O. Sankoh, C. Rao, V. A. Velkoff, C. Mathers, Y. Gonghuan, Y. Hemed, P. Jha and A. D. Lopez, 'Sample registration of vital events with verbal autopsy: a renewed commitment to measuring and monitoring vital statistics', *Bull World Health Organ*, Vol. 83, no. 8, Aug 2005, pp. 611-7.

3 Debra J Nanan and Franklin White, 'Capture-Recapture: Reconnaissance of a Demographic Technique in Epidemiology', Vol. 18, no. 4, 1997.

4 A. Berghold, W. J. Stronegger and K. D. Wernecke, 'A model and application for estimating completeness of registration', *Methods Inf Med*, Vol. 40, no. 2, May 2001, pp. 122-6.

5 C. J. Murray and A. D. Lopez, 'Mortality by cause for eight regions of the world: Global Burden of Disease Study', *Lancet*, Vol. 349, no. 9061, May 3 1997, pp. 1269-76.

6 T. Diaz, G. Loth, J. Whitworth and D. Sutherland, 'Surveillance methods to monitor the impact of HIV therapy programmes in resource-constrained countries', *Aids*, Vol. 19 Suppl 2, May 2005, pp. S31-7.

7 T. Araya, G. Reniers, A. Schaap, D. Kebede, A. Kumie, N. Nagelkerke, R. Coutinho and E. Sanders, 'Lay diagnosis of causes of death for monitoring AIDS mortality in Addis Ababa, Ethiopia', *Trop Med Int Health*, Vol. 9, no. 1, Jan 2004, pp. 178-86.

8 E.J. Sanders, T. Araya, D. Kebede, A.J. Schaap, N.D. Nagelkerke and R.A. Coutinho, 'Mortality impact of AIDS in Addis Ababa, Ethiopia', *AIDS*, Vol. 17, 2003, pp. 1209–16.

9 Damen Haile Mariam, 'Indigenous social insurance as an alternative financing mechanism for health care in Ethiopia (the case of eders)', *Social Science & Medicine*, Vol. 56, 2003, pp. 1719–26.

10 Alula Pankhurst and Damen Haile Mariam, 'The Iddir in Ethiopia: Historical Development, Social Function, and Potential Role in HIV/AIDS Prevention and Control', *Northeast African Studies (ISSN 0740-9133)*, Vol. 7, no. 2, 2000, pp. 35-58.

11 DG Chapman, 'The estimation of wildlife populations', *Ann Math Stat*, Vol. 25, 1954, pp. 1-15.

12 Los Alamos National Laboratory., 'Capture-recapture and removal methods for sampling closed populations', *Los Alamos (NM)*, Vol. Cat LA-8787-NERP UC1, 1982.

13 Cormack RM., 'The statistics of capture-recapture methods. Oceanog Mar Biol Ann Rev', Vol. 6, 1968, pp. 455-506.

14 Deming EW Sekar C, 'On a method of estimating birth and death rates and extent of registration.' *J Am Stat Assoc* Vol. 44, 1949, pp. 1059-68. .

15 A. Gallay, A. Nardone, V. Vaillant and J. C. Desenclos, '[The capture-recapture applied to epidemiology: principles, limits and application]', *Rev Epidemiol Sante Publique*, Vol. 50, no. 2, Apr 2002, pp. 219-32.

16 C. M. Coeli, R. P. Veras and E. da Silva Freire Coutinho, '[Capture-recapture methodology: an option for surveillance of non-communicable diseases in the elderly]', *Cad Saude Publica*, Vol. 16, no. 4, Oct-Dec 2000, pp. 1071-82.

17 C. Stephen, 'Capture-recapture methods in epidemiological studies', *Infect Control Hosp Epidemiol*, Vol. 17, no. 4, Apr 1996, pp. 262-6.
18 B. L. Cadwell, P. J. Smith and A. L. Baughman, 'Methods for capture-recapture analysis when cases lack personal identifiers', *Stat Med*, Vol. 24, no. 13, Jul 15 2005, pp. 2041-51.