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Measuring cause-specific mortality burden in low-income countries: experiences from a feasibility study of a post-census mortality survey using verbal autopsy.

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September 2007

Measuring cause-specific mortality burden in low-income countries: experiences from a feasibility study of a post-census mortality survey using verbal autopsy.

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Mortality statistics are essential for measuring population health and well-being. However, there continues to be a paucity of reliable information, particularly on causes of death for the vast majority of low income countries. For countries with limited or no vital registration systems, national censuses present a unique opportunity to create a wealth of nationally representative cause-specific mortality statistics through the use of verbal autopsy methodologies.

This paper presents results of a feasibility study for this type of post-census cause-specific mortality survey conducted in 2006 in Mozambique. A sub-sample of four pilot sites was selected from the pilot census purposive sample. All households within the four test sites that reported deaths in the past 12 months during the Mozambican October 2006 pilot census were selected for follow-up verbal autopsy interviews. Selected indicators and results from the pilot study areas are presented, including a discussion on the challenges, lessons learned and key recommendations.

Background

Demographic and mortality data are essential for measuring population health and well-being. Accurate and reliable mortality statistics are needed to inform policy and decision-making processes, for evidence-based planning, and for monitoring and evaluation of intervention programs and their impacts. However, very few developing countries have functioning vital registration systems and there continues to be a paucity of reliable information, particularly on causes of death for the vast majority of low income countries (Lopez et al. 2002; Setel et al. 2005).

Implementing a form of vital registration with verbal autopsy (VA) at the national level in low income countries can address the information gap on age- and cause-specific mortality statistics. For example, India (Mahapatra and Rao 2001) and China (Yang et al. 2005) have established nationally representative sample vital registration systems using verbal autopsies to address the lack of cause-specific mortality information. In several others, one or more research demographic surveillance sites provide cause of death statistics (INDEPTH 2002, 2004), but these are not nationally representative.

For countries with limited or no vital registration systems, national population censuses present a unique opportunity to create a wealth of nationally representative cause-specific mortality statistics through the use of verbal autopsy methodologies. This paper presents results of a pilot/feasibility study for this type of post-census cause-specific mortality survey conducted in 2006 in Mozambique under the leadership of the National Statistics Institute (INE) in collaboration with the Mozambique Ministry of Health (MISAU). Technical assistance was provided with inputs from MEASURE Evaluation based at the University of North Carolina at Chapel Hill and the U.S. Census

Bureau. Preparations for and the implementation of a full national post-census cause-specific mortality survey representative to the provincial level, including training of fieldwork personnel and logistics requirements are currently underway. After completion of data collection for the 2007 national census and the determination of a sampling frame, field work began in October 2007 with follow-up of approximately 16,000 deaths.

Pilot Setting

The primary objective of the pilot post-census mortality survey was to assess the logistical, methodological, and financial feasibility of conducting a large-scale post-census mortality survey using verbal autopsy linked to a national census. The overall goal for implementing a national-level mortality survey is to produce provincial- and nationally-representative sample estimates of mortality rates by cause, based on a sample of deaths enumerated in the 2007 national population census.

According to the U.S. Census Bureau International Data Base, in 2007 the Mozambique crude death rate is estimated at 21 per 1000 population, with the infant mortality rate estimated at 110 per 1000 live births. Overall life expectancy at birth is estimated at 41 years. In 2005, it was estimated that 16.1% of the population aged 15–49 were infected with HIV/AIDS (UNAIDS 2006).

The pilot post-census mortality survey (INCAM in Portuguese—which stands for INquérito sobre CAusas de Mortalidade) was implemented in selected enumeration areas in 4 of Mozambique's 11 provinces, two urban: Maputo City and Beira city in Sofala province; and two rural areas in Gaza and Cabo Delgado provinces. This pilot INCAM

survey was conducted between October 2006 and March 2007 using modified Sample Vital Registration with Verbal Autopsy (SAVVY) methodologies (Setel et al. 2005).

Methodology

Sampling

The testing of the INCAM operations and procedures, including the field operations and verbal autopsy interviews, was conducted in conjunction with the Mozambique pilot census. INE undertook a pilot census in October 2006 to test all census operations, procedures and forms. A purposive sample of administrative posts was selected in all 11 provinces of Mozambique for the pilot census, covering both urban and rural areas. The pilot areas were selected based on criteria such as population density, socioeconomic, cultural and linguistic characteristics of the population, and operational and logistical considerations. The pilot census covered a sample population of approximately 350,000.

For the INCAM pilot a subsample of four pilot census sites were selected: two rural areas in the provinces of Cabo Delgado and Gaza and two urban areas in Maputo City and Beira (Sofala province). These four INCAM pilot sites were chosen taking into consideration HIV/AIDS prevalence and geographic representation. One objective was to obtain a sample of about 800 to 1000 deaths to provide a good test of the verbal autopsy methodology and to have a good representation of the major causes of death. A total of 109 enumeration areas were selected in the four sites with a total estimated population of 52,400 – 37 from Cabo Delgado, 16 from Gaza, 24 from Maputo City, and

32 from Sofala. It is important to note that the sample for the pilot INCAM was not designed to be random or representative of Mozambique.

In the pilot census, households were asked to report all deaths that had occurred in the 12 months prior to the pilot census field work. Thus, the reference date for deaths was October 1, 2005 through September 30, 2006. All households within the four selected sites that reported deaths in the past 12 months were selected for follow-up verbal autopsy interviews. In the selected areas in the four provinces, a total of 979 deaths were identified in the pilot census.

Verbal autopsy

Verbal autopsy (VA) is a simple indirect technique for ascertaining probable cause of death. The technique relies on the clinical assessment of signs and symptoms during the terminal illness, based on the assumption that most causes of death can be distinguished by their signs and symptoms, and that these can be accurately recognized, recalled, and reported by lay respondents. In the pilot INCAM, verbal autopsy interviews were conducted for all deaths which occurred in the households within the pilot enumeration areas in the 12 months prior to the October 1, 2006 pilot census reference date.

Three types of SAVVY verbal autopsy questionnaires were used in the mortality follow-up: a VA form for infants and neonatal deaths (0-28 days), a VA form for death of children aged 29 days to less than 5 years, and a VA form for older children and adult deaths (5 years and above). A total of 42 interviewers were trained on the VA tools and field methodology at the Manhiça demographic surveillance site. The VA field methodology training included both theoretical and practical aspects on how to identify

an 'eligible' death and conduct VA interviews in the selected households. During the pilot INCAM field work, the appropriate VA questionnaire was administered to caregivers/family members of the deceased to elicit signs and symptoms of illnesses and their durations, and other pertinent information (e.g. use of health services) in the period before death. From the 979 deaths identified in the death frame, a total of 731 verbal autopsy questionnaires were completed and cause of death coding was completed for all of these deaths.

Death certification and ICD coding

A panel of Mozambique Ministry of Health physicians completed the international form of medical certificate of causes of death using the information in the VA questionnaires. For this activity, ten medical doctors selected by MISAU were trained on how to certify a death from verbal autopsies and to code a certified death into International Classification of Diseases (ICD-10). These doctors were selected by the Mozambique Ministry of Health. Each VA questionnaire was independently reviewed by two physicians, who each filled out an international death certificate based on the information recorded on the questionnaire. Each cause of death recorded in the certificate was then assigned an ICD-10 code according to the principles and guidelines of the International Classification of Diseases (ICD-10) second edition. In particular, a single underlying cause was assigned to each death. During the pilot INCAM, each doctor could review, certify, and code to ICD-10 approximately 30–50 VA questionnaires per day. About 40-50% of the death certificates produced independently by the two doctors did not match. To resolve the mismatched death certificates, consensus had to be reached by the two physicians who

reviewed the discrepant diagnoses together, and where possible, agreed upon the probable cause of death.

Results

The INCAM survey will be able to provide sex- and cause-specific mortality data at the provincial level, disaggregated by broad age groups, and by urban/rural designation, and poverty measures. In this paper, we only provide a sample of outputs from the pilot INCAM survey to illustrate the type of information that can be generated from such mortality surveys using verbal autopsies. It is very important to note that the results from the INCAM pilot study are not representative of Mozambique at the national or provincial level. Results are specific only to the pilot areas, and are provided here for illustrative purposes only. No conclusions about the level of mortality, the distribution of deaths, or overall burden of disease in Mozambique may be drawn from these pilot data.

Of the 731 reported deaths and completed VAs, 389 (53%) were males. Table 1 presents the distribution of deaths by broad age categories in the selected areas of the four provinces included in the pilot study. There were 242 deaths reported in sample areas from Cabo Delgado, 243 in sample areas from Sofala, 118 in sample areas from Gaza and 128 deaths in sample areas from Maputo City. In the selected urban areas, a large proportion of deaths in the period of observation occurred among adults in their most productive ages (15–59 years). About 56 percent of all deaths in sample areas from Maputo City were among adults in this age group, whereas in Sofala this proportion was

about 64 percent. In the two rural provinces, more than a third of all deaths were in children under five years.

For tabulation purposes, the underlying causes of death coded to ICD-10 were aggregated to a short list of 57 broad causes (see appendix A). Tables 2*a–d* present the distribution of causes of death in the four pilot INCAM provinces. In the sample areas from the four pilot provinces, the leading causes of death were HIV/AIDS and malaria, causing more than half of all deaths which occurred between October 2005 and September 2006. In Beira, Sofala province, more than half of all deaths in the reference period were due to HIV disease alone. The proportion of deaths due to malaria from all causes of death ranged from 16.4% in sample areas from Maputo City (urban) to 25.6% in sample areas from rural Cabo Delgado.

Table 3 presents use of health services in the period leading to death. The deceased may have utilized more than one type of health service listed during her or his illness before death. Use of government hospitals at some point in the period leading to death was more common than other facilities in urban areas (Maputo and Beira cities). In Cabo Delgado and Gaza, the government health posts seems to be the most used health facility. At this point we are unable to tell what proportion of individuals used formal health services as their first choice of contact for the illness that led to death.

Discussion

Both important successes and significant challenges were observed following the implementation of the pilot INCAM. We present some of these observations and their

implications here. Overall, there was wide acceptance of VA interview in the pilot areas. The overall quality of training provided to VA interviewers and the supervisors was very good. All interviews were conducted following the procedures and guidelines for undertaking such interviews. This assessment is supported by the fact that during pilot INCAM field work, the VA interviewers were able to identify deaths that were out of range of the reference period and also they were able to identify infant deaths that were not captured by the pilot census. Nevertheless, the number of infant deaths below one year appeared to be much lower than expected, indicating an undercount in mortality in this age group (0–1 yrs). As a result, infant mortality rates based on census mortality modules will be under-estimated, and life table calculations, including estimates of life expectancy at birth will be affected by the undercount. It was also observed that a significant number of deaths reported during the pilot census for VA follow-up actually took place outside of the 12-month reference period. Inclusion of deaths outside the reference period will over-estimate measures such as the crude death rate.

Another challenge encountered during the implementation of pilot INCAM was in the location of households that had reported a death in the pilot census. Inconsistencies in cartographic variables between urban and rural areas of the country led to incorrect information needed to identify households in which a death occurred. This made it more difficult to locate households in some areas, for example in Beira province, leading to lower coverage rates in some locations.

One of the objectives of the pilot was to assess the financial feasibilities of undertaking a post-census mortality survey. From the pilot INCAM experience, the total cost was estimated to be only about 5-6% of the census cost in Mozambique. Although

this is not an insignificant increase in the overall costs, the benefits of conducting a post-census mortality follow-up are extensive.

In conclusion, information gaps that mortality surveillance with verbal autopsy could fill include cause and age-specific mortality rates and other measures of mortality. Such an approach would allow the estimation of the cause of death structure for a particular country which can be updated during every census period. In addition to national estimates, and depending on the survey design and available resources, estimates of cause-specific mortality measures can be calculated that are representative at the sub-national level. Data collected from INCAM implementation are useful for production of many key mortality indicators. This information can be used at many levels of the health system and other sectors for planning, monitoring and evaluating programs, and for priority setting. A national mortality survey may serve as a first step towards sample-based longitudinal vital registration, as recommended by Sample Vital Registration with Verbal Autopsy (SAVVY)[1].

Overall, verbal autopsy methodologies can play a key role in resolving a mortality information paradox: countries with the greatest need for cause-specific mortality data are often those which have the largest burden of mortality, and which have the least reliable data. In Mozambique, preparation and field work for full implementation of INCAM is underway. Other low-income countries should take advantage of the upcoming 2010 census round by implementing post-census mortality surveys to generate high-quality, cause-specific mortality statistics using sample-driven verbal autopsy methods.

[1] SAVVY is a system that registers vital events and attributes an underlying cause to registered deaths in a nationally representative sample. This system has been developed by MEASURE Evaluation at the University of North Carolina, and the International Programs Center of the U.S. Census Bureau.

Key Recommendations

The pilot INCAM study has provided useful suggestions to INE regarding census enumerator training and census questionnaire content of the recently completed 2007 national census. Decennial censuses are often thought to under-report total mortality. Experiences from INCAM yielded valuable input and several recommendations in the preparation for the 2007 national census and in the scale-up of the post-census mortality survey in Mozambique, particularly on how reporting and recording of deaths in the past 12 months could be improved. These recommendations included adding a prompt in the census questionnaire to help detect unreported infant deaths, and to clarify and emphasize the death reporting period. Additionally, to help reduce the degree to which any local variation in mortality was affected by a particular enumerator or enumerator team, and to give a more accurate picture of the diversity of mortality conditions in Mozambique, it was recommended that special attention should be paid during training, supervision, and quality assurance to how enumerators are collecting information using the mortality section of the census. During the 2007 census training, the INCAM staff from INE who participated in the pilot INCAM assisted in the facilitation of the central and provincial level census enumerator training to ensure that additional information and emphasis were communicated to the census enumerators on how to identify and report deaths in the reference period.

Additionally, experiences from the pilot INCAM revealed some important revisions to undertake in preparation for full INCAM—from field work activities to data processing and analysis. Updated mortality estimates based on the pilot survey were prepared, sampling was revised based on the lower mortality estimates from the pilot, and

financial aspects of implementing a full INCAM were revisited based on the lessons learned. Based on the pilot, it is recommended that more time be allocated for training on specific aspects of conducting interviews. International standard WHO verbal autopsy questionnaires will be used for the full INCAM. It is recommended that these forms be pre-tested on a small sample prior to the commencement of training and field data collection. Furthermore, in order to improve data processing and ultimately data analysis, a quality control team will be added for the full INCAM. Changes were also made to data processing procedures, for example, a unique identification variable will be carried through all stages of data processing in order to ensure that cause of death can be linked to household characteristics.

ACKNOWLEDGMENT

This work was partly funded by support from the U.S. Agency for International Development (USAID) to the MEASURE Evaluation project through Cooperative Agreement GPO-A-00-03-00003-00.

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Table 1. Deaths by Broad Age Categories, Mozambique Pilot INCAM Survey

	Cabo Delgado		Sofala		Gaza		Maputo City		Total	
Age	**No**	**%**	**No**	**%**	**No**	**%**	**No**	**%**	**No**	**%**
< 1 month	19	7.9	18	7.4	9	7.6	4	3.1	50	6.8
1 – 59 months	75	31.0	48	19.8	31	26.3	16	12.5	170	23.3
5 – 14 years	21	8.7	7	2.9	4	3.4	7	5.5	39	5.3
15 - 59 years	82	33.9	155	63.8	54	45.8	71	55.5	362	49.5
60+ years	44	18.2	12	4.9	19	16.1	30	23.4	105	14.4
Unknown age	1	0.4	3	1.2	1	0.8	0	0.0	5	0.7
Total	**242**	**100**	**243**	**100**	**118**	**100**	**128**	**100**	**731**	**100**

Notes:

1. The sample for the INCAM pilot was not designed to be random or representative. Data are provided for illustrative purposes only.
2. Target reference date for deaths was October 1, 2005 through September 30, 2006.

Table 2a: Distribution of Causes of Death in CABO DELGADO Province, Mozambique Pilot INCAM Survey

Cause of death	deaths	%
Human Immunodeficiency Virus (HIV)	94	38.8
Malaria	62	25.6
Unspecified causes of mortality	24	9.9
All other conditions originating in the perinatal period	13	5.4
Pneumonia	10	4.1
Intestinal infectious diseases	5	2.1
Tuberculosis	5	2.1
Remainder of malignant neoplasms	5	2.1
All other diseases	5	2.1
Measles	2	0.8
Cerebrovascular diseases	2	0.8
Disorders of the kidney	2	0.8
Maternal haemorrhage	2	0.8
Prematurity and low birth weight	2	0.8
Birth asphyxia and other respiratory disorders	2	0.8
Improperly coded causes (bites, alcohol poisoning)	2	0.8
Other infectious and parasitic diseases	1	0.4
Malnutrition	1	0.4
Meningitis	1	0.4
Hypertensive diseases	1	0.4
Accidental poisoning by and exposure to noxious substance	1	0.4
All causes	**242**	**100.0**

Notes:

1. The sample for the INCAM pilot was not designed to be random or representative. Data are provided for illustrative purposes only.
2. Target reference date for deaths was October 1, 2005 through September 30, 2006.

Table 2b: Distribution of Causes of Death in SOFALA Province, Mozambique Pilot INCAM Survey

Cause of death	deaths	%
Human Immunodeficiency Virus (HIV)	122	50.2
Malaria	41	16.9
All other conditions originating in the perinatal period	9	3.7
Tuberculosis	9	3.7
Pneumonia	8	3.3
Intentional self-harm	7	2.9
All other diseases	5	2.1
Unspecified causes of mortality	5	2.1
All other external causes	4	1.6
Transport accidents	4	1.6
Birth asphyxia and other respiratory disorders	4	1.6
Cerebrovascular diseases	3	1.2
Intestinal infectious diseases	3	1.2
Still births	2	0.8
Other maternal causes	2	0.8
Remainder of malignant neoplasms	2	0.8
Accidental poisoning by and exposure to noxious substances	1	0.4
Accidental drowning and submersion	1	0.4
Fever of unknown origin	1	0.4
Abdominal pain	1	0.4
Prematurity and low birth weight	1	0.4
Complications predominantly related to the puerperium	1	0.4
Maternal haemorrhage	1	0.4
Hypertensive disorders of pregnancy	1	0.4
Disorders of the kidney	1	0.4
Chronic obstructive pulmonary diseases	1	0.4
Hypertensive diseases	1	0.4
Malignant neoplasm of oesophagus	1	0.4
Tetanus	1	0.4
All causes	**243**	**100.0**

Notes:

1. The sample for the INCAM pilot was not designed to be random or representative. Data are provided for illustrative purposes only.
2. Target reference date for deaths was October 1, 2005 through September 30, 2006.

Table 2c: Distribution of Causes of Death in GAZA Province, Mozambique Pilot INCAM Survey

Cause of death	deaths	%
Human Immunodeficiency Virus (HIV)	44	37.3
Malaria	27	22.9
Pneumonia	9	7.6
Tuberculosis	8	6.8
All other diseases	5	4.2
Intestinal infectious diseases	4	3.4
Still births	3	2.5
Meningitis	2	1.7
Hypertensive diseases	2	1.7
Prematurity and low birth weight	2	1.7
All other conditions originating in the perinatal period	2	1.7
Remainder of infectious and parasitic diseases	1	0.8
Remainder of malignant neoplasms	1	0.8
Cerebrovascular diseases	1	0.8
Birth asphyxia and other respiratory disorders	1	0.8
Other maternal causes	1	0.8
Intentional self-harm	1	0.8
All other external causes	1	0.8
Ischaemic heart diseases	1	0.8
Pregnancy with abortive outcome	1	0.8
Improperly coded causes (bites, alcohol poisoning)	1	0.8
All causes	**118**	**100.0**

Notes:

1. The sample for the INCAM pilot was not designed to be random or representative. Data are provided for illustrative purposes only.
2. Target reference date for deaths was October 1, 2005 through September 30, 2006.

Table 2d: Distribution of Causes of Death in MAPUTO CITY Province, Mozambique Pilot INCAM Survey

Cause of death	deaths	%
Human immunodeficiency Virus (HIV)	43	33.6
Malaria	21	16.4
Hypertensive diseases	10	7.8
Tuberculosis	7	5.5
Intestinal infectious diseases	6	4.7
Unspecified causes of mortality	5	3.9
All other diseases	5	3.9
Ischaemic heart diseases	5	3.9
Cerebrovascular diseases	4	3.1
Transport accidents	4	3.1
Remainder of malignant neoplasms	3	2.3
Pneumonia	2	1.6
Birth asphyxia and other respiratory disorders	2	1.6
Remainder of infectious and parasitic diseases	1	0.8
Malnutrition	1	0.8
Meningitis	1	0.8
Accidental poisoning by and exposure to noxious substances	1	0.8
Malignant neoplasm of oesophagus	1	0.8
Complications predominantly related to the puerperium	1	0.8
Still births	1	0.8
Pregnancy with abortive outcome	1	0.8
Malignant neoplasm of stomach	1	0.8
Malignant neoplasm of liver and intrahepatic bile ducts	1	0.8
Gastric and duodenal ulcer	1	0.8
All causes	**128**	**100.0**

Notes:

1. The sample for the INCAM pilot was not designed to be random or representative. Data are provided for illustrative purposes only.
2. Target reference date for deaths was October 1, 2005 through September 30, 2006.

Table 3 Use of Health Services Prior to Death, Mozambique Pilot INCAM Survey in Percent, by Sample Province

Type of Health Service	Total: all sites	Cabo Delgado	Sofala	Gaza	Maputo City
Government Health Post/SNS	37.9	55.0	24.7	58.5	11.7
Government Hospital/SNS	37.9	15.7	55.6	15.3	67.2
Was given traditional medicine	26.9	31.4	30.5	15.3	22.7
Government Health Center/SNS	23.7	9.1	38.3	29.7	18.0
Went to a traditional medicine practitioner	23.0	29.3	27.2	16.1	9.4
Was given modern medicine	16.4	1.7	32.5	6.8	22.7
Household remedies	13.4	14.9	14.8	11.0	10.2
Government pharmacy	9.0	2.1	16.9	0.8	14.8
No Service	8.3	12.4	3.7	10.2	7.8
Sample Size (N =)	**731**	**242**	**243**	**118**	**128**

Notes:

1. The sample for the INCAM pilot was not designed to be random or representative. Data are provided for illustrative purposes only.
2. Target reference date for deaths was October 1, 2005 through September 30, 2006.
3. Totals sum to more than 100.0% - respondents were asked to name all health care service providers used.

Appendix A: Cause of Death List Collapsed into 57 Categories

Code57	Cause of Death List into 57 categories
VA:001	Intestinal infectious diseases (including diarrhoeal diseases)
VA:002	Tuberculosis
VA:003	Tetanus
VA:004	Measles
VA:005	Viral hepatitis
VA:006	Human immunodeficiency virus [HIV] disease
VA:007	Malaria
VA:008	Leishmaniasis
VA:009	Remainder of infectious and parasitic diseases
VA:010	Malignant neoplasm of lip
VA:011	Malignant neoplasm of oesophagus
VA:012	Malignant neoplasm of stomach
VA:013	Malignant neoplasm of small intestine
VA:014	Malignant neoplasm of colon
VA:015	Malignant neoplasm of liver and intrahepatic bile ducts
VA:016	Malignant neoplasm of trachea
VA:017	Malignant neoplasm of breast
VA:018	Malignant neoplasm of cervix
VA:019	Remainder of malignant neoplasms
VA:020	Nutritional anaemias
VA:021	Diabetes mellitus
VA:022	Malnutrition
VA:023	Mental and behavioural disorders
VA:024	Meningitis
VA:025	Hypertensive diseases
VA:026	Ischaemic heart diseases
VA:027	Cerebrovascular diseases
VA:028	Pneumonia
VA:029	Chronic obstructive pulmonary diseases
VA:030	Gastric and duodenal ulcer
VA:031	Cirrhosis liver
VA:032	Disorders of the kidney
VA:033	Pregnancy with abortive outcome
VA:034	Hypertensive disorders of pregnancy
VA:035	Maternal haemorrhage
VA:036	Obstructed labour
VA:037	Complications predominantly related to the puerperium
VA:038	Other maternal causes
VA:039	Prematurity and low birth weight
VA:040	Birth trauma
VA:041	Birth asphyxia
VA:042	Still births

VA:043	All other conditions originating in the perinatal period
VA:044	Congenital malformations of the central nervous system
VA:045	Abdominal pain
VA:046	Fever of unknown origin
VA:047	Convulsions
VA:048	Unspecified causes of mortality
VA:049	All other diseases
VA:050	Transport accidents
VA:051	Falls
VA:052	Accidental drowning and submersion
VA:053	Exposure to smoke
VA:054	Accidental poisoning by and exposure to noxious substances
VA:055	Intentional self-harm
VA:056	Assault
VA:057	All other external causes