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Fellowship report:
Analysis of causes of death in Myanmar using verbal autopsies

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Contents

Acronyms and abbreviations

AIDS/HIV	Acquired Immune Deficiency Syndrome/Human Immuno-virus
AMW	auxiliary midwife
BHS	basic health staff
CCBDR	Coordination Committee on Birth and Death Registration
COD	cause of death
CRVS	civil registration and vital statistics
CSMF	cause specific mortality fraction
CSO	Central Statistical Organization
D4H	Bloomberg Philanthropies Data for Health Initiative
DSW	Department of Social Welfare
GAD	General Administrative Department
GBD	Global Burden of Disease
HA	health assistant
HMIS	Health Management Information System
IAWG	Internal Agency Working Group
IHME	Institute of Health Metrics and Evaluation
LHV	Lady Health Visitor
MCCOD	Medical Certificate of Cause of Death
MOHS	Ministry of Health and Sport
MS	medical superintendent
ODK	Open Data Kit
PCVA	Physician Certified Verbal Autopsy
PHS II	Public Health Supervisor II
RHC	rural health center
TB	tuberculosis
THD	Township Health Department
TMO	Township Medical Officer
UHC	urban health center
UNICEF	United Nations Children's Fund
UoM	The University of Melbourne
UN	United Nations
VA	verbal autopsy
WHO	World Health Organization

Fellowship report: Analysis of causes of death in Myanmar using verbal autopsies

Between November 2017 and February 2019, Dr. Nway Nway Thet Kywal from Myanmar, completed a fellowship funded by the Bloomberg Philanthropies Data for Health Initiative at the Melbourne School of Population and Global Health, The University of Melbourne, to analyse the causes of deaths in Myanmar using verbal autopsy data. This *CRVS Fellowship Report* provides an overview of the civil registration and vital statistics system in Myanmar, including the implementation of verbal autopsy, and provides summary results of causes of deaths using verbal autopsy and hospital data from 14 townships collected from January to December 2017, contrasted with Global Burden of Disease (GBD) results for Myanmar.

Background

The civil registration and vital statistics system in Myanmar

Vital statistics data in Myanmar are collected by basic health staff (BHS) (i.e. midwives), who sit under the Ministry of Health and Sport (MOHS). These data are reported directly to the Central Statistical Organization (CSO) within the Ministry of Planning and Finance, for compiling, coding, analysis and reporting. The CSO is mainly responsible for the production of reliable, accurate and timely mortality data and disseminating through annual statistical year books. The Health Management Information System (HMIS) is particularly responsible for data quality assurance, analysis of cause of death (COD) distribution at the population level, and COD trends including the management of verbal autopsy (VA) data, and maximisation of the usage of data by respective townships and departments. HMIS staff are required to have the skills and experience to perform these tasks as well as provide technical support to other civil registration and vital statistics (CRVS) stakeholders and decision makers for sustainable health planning in Myanmar.

The performance of the CRVS system in Myanmar has been generally poor, with completeness of registration low due to lack of law enforcement for registration and awareness of its importance. Therefore, births and deaths are incompletely registered. According to the annual statistical year book produced by the CSO, the completeness of birth registration was 81% in 2014 and the completeness of death registration was 59% in 2015.[1] Birth registrations are more complete than death registrations, because of the requirement of birth certification for the school enrolment. For deaths, not only the completeness of registration, but also the cause of death information for community deaths and tracing the COD trends are still remaining challenges for the vital registration system.[2]

1 Statistical year book 2016 and 2017: https://www.mmsis.gov.mm

2 Bloomberg Data for Health Initiative; *Myanmar Baseline Evaluation Report* (2017)

Death registration in Myanmar

The process for death registration in Myanmar differs for rural and urban community deaths, and involves a number of steps which provide significant opportunities for error and oversight (**Figures 1 and 2**). The process for registration of hospital deaths is the same for urban and rural areas. In public hospitals, doctors certify the COD and fill the death registration forms, and the medical superintendents complete the registration book, death certificate, and burial certificate. Death and burial certificates are signed by the medical superintendents and handed directly to the families.[3] Private hospitals provide relevant documents and refer the families of decedents to the Township Medical Office (TMO) for death registration, where a Health Assistant or Public Health Supervisor (PHS) fill out the death registration form and the registration book. The TMO validates the COD data, and prepares and signs the burial and death certificates. This information is sent on to the CSO and the death registration books are stored at the Township Health Department (THD). Private hospitals are obligated to report both birth and death data to HMIS.[4]

Figure 1: Process of death registration in Myanmar for rural, community deaths

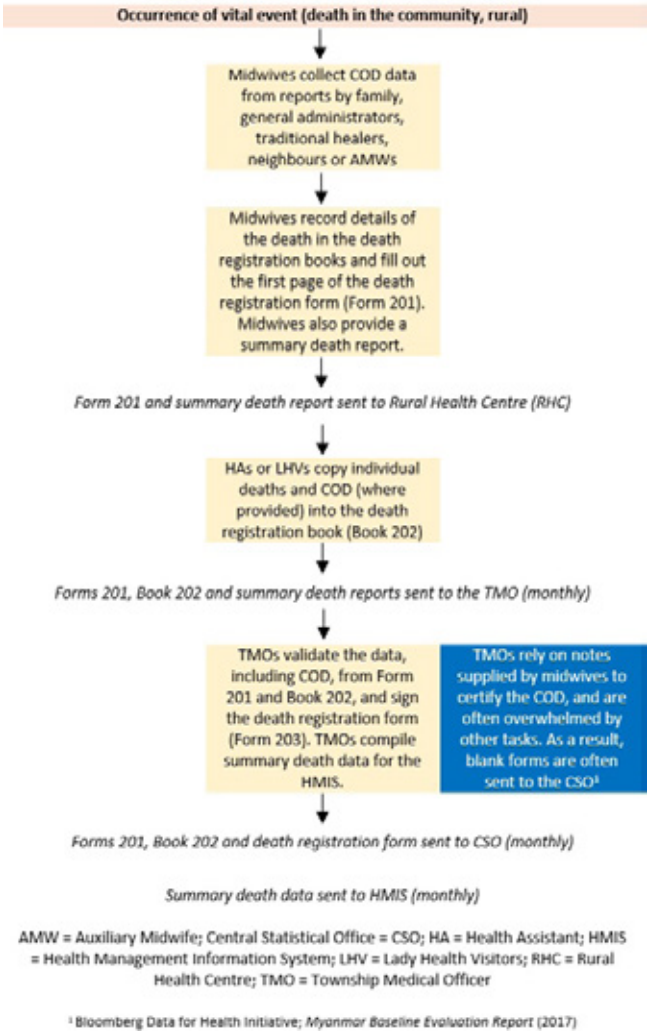
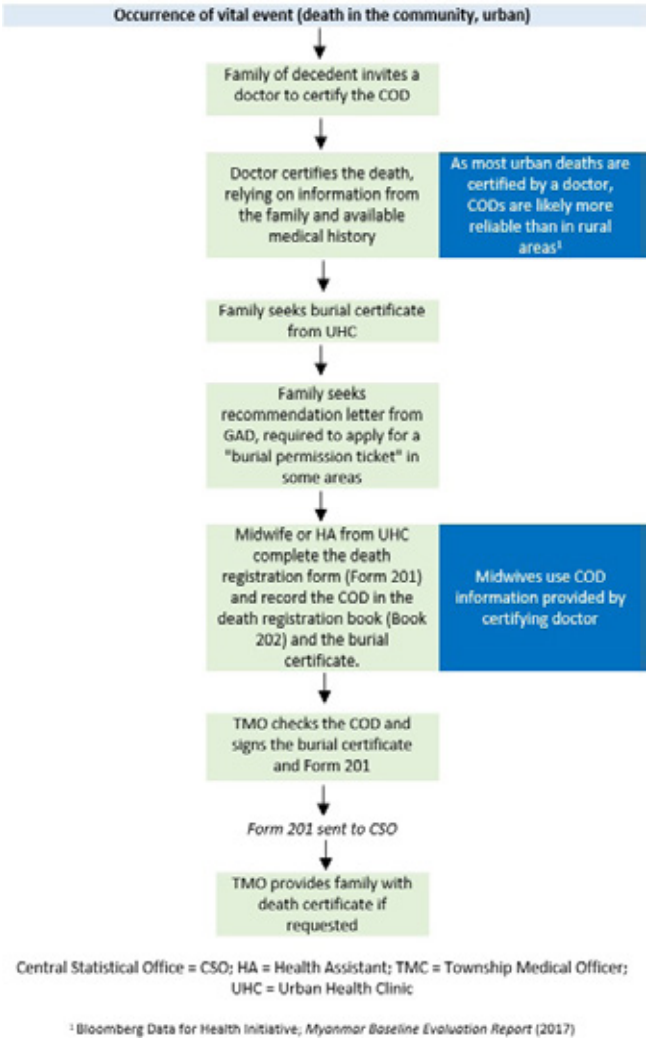


Figure 2: Process of death registration in Myanmar for urban, community deaths



3 Bloomberg Data for Health Initiative; *Myanmar Baseline Evaluation Report* (2017)
4 Ibid

An assessment of COD data found that COD was not regularly reported in Myanmar, particularly for rural home deaths.[5] In 2015, the death registration completeness rate was 59% in Myanmar, of which only 16% of deaths (hospital and urban home deaths only) had available COD information.[6] There are a myriad of factors impacting completeness rates in Myanmar, particularly in rural and isolated areas, where registration offices are scarce and burial certificates rarely required.[7] Families are further disincentivised to register deaths due to the cost and long wait times involved in registration, as well as a general lack of trust in the state.[8] Socio-cultural barriers also persist in some communities, where cultural practices necessitate the removal of a relative from hospital back to the community just before their death, reducing the number of facility deaths where a COD can be more readily ascertained, and the death registration process supported.[9] Additionally, cultural practices often require all records of the deceased (including medical records) to be burned along with the deceased's body – a significant barrier to the traceability of COD in Myanmar.

The MOHS in Myanmar recognises the importance of a highly-functioning CRVS system, and has taken a number of steps to address the key challenges, most prominently, attempting to replace the paper-based system with an electronic system.[10] A number of issues have arisen, however, including technical limitations, extensive training needs for Basic Health Staff (BHS) in the use of the electronic systems, and limited availability of electricity and internet connections outside of urban centers.[11]

In 2016, a national level Coordination Committee on Birth and Death Registration was re-formed, chaired by the Union Minister of the MOHS and comprised of director generals from 13 concerned ministries. Held quarterly, the meetings are focused on increasing CRVS coverage and coordination among departments, and aim to provide strategic direction for the CRVS system nationally.[12]

An Internal Agency Working Group (IAWG) for vital registration, consisting of technical officials from key government departments, was formed in 2006 to facilitate close collaboration among CRVS stakeholders and to improve coverage of birth and death registration. Representatives from the Department of Public Health (within the MOHS), CSO, Department of General Administration (GAD), Department of Population and Immigration, Department of Social Welfare (DSW), Department of Human Resource and Education Planning, and UNICEF participate in this working group.[13]

5 Bloomberg Data for Health Initiative; *Myanmar Baseline Evaluation Report* (2017)
6 Statistical year book 2016 and 2017; https://www.mmsis.gov.mm
7 Bloomberg Data for Health Initiative; *Myanmar Baseline Evaluation Report* (2017)
8 Health Metrics Network (2013)
9 Bloomberg Data for Health Initiative; *Myanmar Baseline Evaluation Report* (2017)
10 Ibid
11 Ibid
12 Ibid
13 Ibid

Verbal autopsy in Myanmar

With the vast majority of deaths occurring in the community without an attending physician, rather than in hospital, other methods of ascertaining COD are necessary. Verbal autopsy (VA) has proved to be both a viable and reliable method of diagnosing the most probable COD, and when implemented at scale, provides valuable population-level information on trends and patterns of leading causes of death and the disease burden **(Box 1**).

Box 1: What is verbal autopsy?

Verbal Autopsy (VA) is a method of collecting information about an individual's signs and symptoms prior to their death from their family or next of kin, and interpreting these to diagnose the likely or most probable cause of death (COD).[14] The principal purpose of a VA is to describe the cause composition of mortality at a population level through the estimation of cause-specific mortality fractions (CSMFs). CSMF is the fraction of all deaths due to a specific cause. This allows us to know the distribution of COD among the population. Using this information, policy makers can make more informed health policy and programmatic decisions.

The VA process consists of three basic steps:

1. Setting-up an interview by a trained VA staff member at the household level (or other appropriate place);
2. Conducting a structured interview to collect information on signs and symptoms of illnesses/events that the deceased suffered before death; and
3. Interpreting the interview data to diagnose the most probable COD.[15]

Since January 2016, the Bloomberg Philanthropies Data for Health Initiative (D4H) at the University of Melbourne (UoM) has been providing technical support for VA implementation and integration in Myanmar. A pilot program began in 2016, introducing VA to 14 townships across Myanmar. Following an evaluation in 2017, it was decided to extend this to a further 28 townships, covering 16% (approximately 8.5 million people) of the total population of Myanmar.[16]

The procedure established for integrating VA involved training BHS, such as midwives, as interviewers. Following notification of a death, the trained BHS conduct an interview with the decedent's family using the VA questionnaire installed on a tablet. There are three sets of questionnaires: adult (12 years and above), child (29 days to 11 years), and neonatal (0-28 days). Collected data are then automatically reported via a server to the CSO, then on to HMIS.

14 De Savigny et al. Integrating community-based verbal autopsy into civil registration and vital statistics (CRVS): system-level considerations. *Global Health Action*. 2017;10:1272882.

15 Bloomberg Philanthropies Data for Health Initiative: Introducing automated Verbal Autopsy: Responding to technical and transcultural adaptation challenges. C*RVS Development Series*; University of Melbourne, August 2017

16 Naing, End of the project evaluation of Data for Health Initiative, Empower Consultancy Limited, March 2019

Figure 3: Integrating automated VA data collection into a CRVS system, example flow diagram

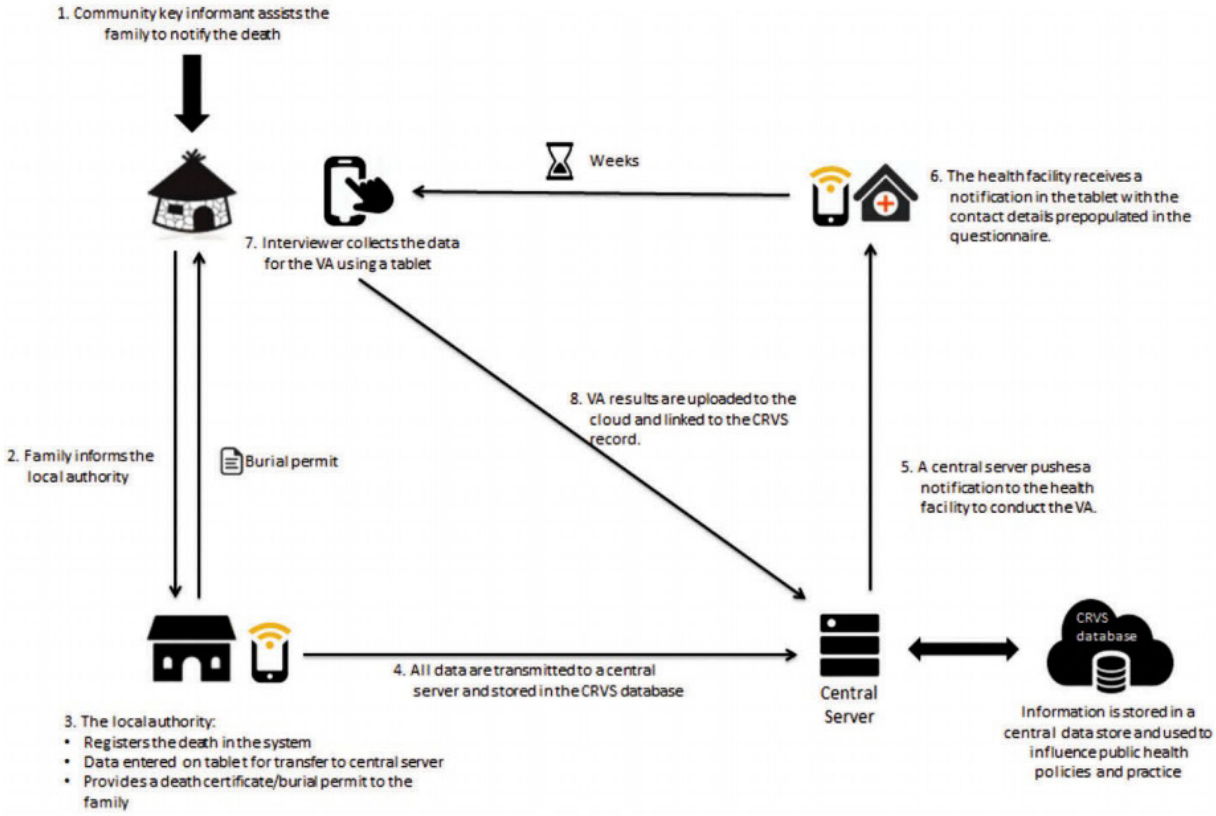


Figure 3 source: De Savigny et al. Integrating community-based verbal autopsy into civil registration and vital statistics (CRVS): system-level considerations. Global Health Action. 2017;10:1272882.

Master training for VA began in December 2016 with 45 CRVS staff trained in total. This included 28 BHS, six regional doctors, four staff from the CSO, three from the Department of Medical Research and four from the Public Health Department.

Township-level trainings followed the master training, conducted in the 14 townships involved in the pilot implementation. A total of 975 BHS, mainly midwives and Health Staff (PHS II) were trained. Among 14 townships, 233 tablets were distributed proportionate to the number of BHS. Between January to December 2017, a total of 11,238 VAs were collected by BHS across the 14 townships involved in the pilot.

The Fellowship project

Part 1: Analysing verbal autopsy data

Methods

This study analysed the causes of deaths in Myanmar using verbal autopsy and hospital data, contrasting these results against COD data from other sources, including hospital data and Global Burden of Disease (GBD) results to assess plausibility. The Tariff (2.0) Method running through SmartVA (**Box 2**) was used to analyse VA data collected over 12 months from January to December 2014 from 14 townships (**Table 1**), generating COD data disaggregated by age and sex. These 14 townships in three regions/states represent 4% of the total population in Myanmar, and are majority rural (89%) with a male and female population composition of 55% and 45% respectively. VAs were analysed for an estimated half of all deaths occurring in these townships in 2017.

Box 2: What is SmartVA?

Once a VA is collected, it is necessary to analyse it in order to diagnose the COD. Originally, this process was done through physician-review of the VA, known as Physician Certified Verbal Autopsy (PCVA). One or more physicians would review the VA and diagnose a COD based on their assessment of the information. However, this approach has a number of disadvantages limiting its usefulness. PCVAs are time consuming, and are therefore an uneconomical method, and are also subject to interpreter bias with the possibility of the same VA read by different doctors resulting in two different assigned CODs.

Eliminating physician bias or misinterpretation, automated VA (or SmartVA Analyse) uses an algorithm known as Tariff 2.0 to recognise patterns in VA data between reported symptoms and causes of death. Developed by researchers at the Institute of Health Metrics and Evaluation (IHME) using a database of 'gold standard' deaths on which VA was conducted and for which an accurate cause of death had already been established,[17] SmartVA uses the Tariff Method which assigns a score (or 'tariff') to an item in the VA questionnaire according to the number of times a respondent answers 'yes' to a symptom question. The sum of the Tariff scores produce a ranking of likely causes of death, with the highest ranked cause the assigned cause of death for that deceased individual.[18]

Table 1: 14 townships involved in pilot implementation of VA

Sagaing Region	Magway Region	Kapasia
Myinmu	Salin	Thanphyuzayat
Myaung	Myothit	Paung
Ayardaw	Kamma	
Pale	Yesagyo	
Shwebo	Seikphu	
Yinmarbin		
Salingyi		

17 Population Health Metrics Research Consortium gold standard verbal autopsy validation study: design, implementation, and development of analysis datasets: http://www.healthdata.org/research-article/population-health-metrics-research-consortium-gold-standard-verbal-autopsy

18 Improving performance of the Tariff Method for assigning causes of death to verbal autopsies: http://www.healthdata.org/research-article/improving-performance-tariff-method-assigning-causes-death-verbal-autopsies

This report begins by presenting an estimate of the completeness of VAs in each township; that is, the proportion of all deaths in each township in 2017 for which a VA was conducted. The estimate is made using a method developed by the UoM to estimate completeness of reported deaths using limited data, which, for the purposes of this study, was the number of reported deaths, divided by the population, multiplied by 100; the percentage of the population aged 65 and over; and an estimate of the true under-five mortality rate using census and DHS data.[19]

Next, the age-sex distribution of VA deaths across all townships was analysed. Results were then presented without redistribution of undetermined VA deaths, by age groups 12 to 44, 45 to 64, 65 to 74 and 75 and over for adults, as well as for children (29 days to 11 years) and neonates (0 to 28 days). Comparison is then made against GBD results using VAs with redistribution of undetermined deaths, including comparison by three broad causes of death (communicable, non-communicable and injuries) as well as broad non-communicable diseases. Finally, the hospital deaths are presented.

Results

Age and sex distribution of VA deaths

Between January to December 2017, 11,238 verbal autopsies were conducted across 14 townships in three states in Myanmar. The number conducted and the predicted completeness for each township are shown in **Table 2**. VA completion rates covered between 35% (Yesagyo, Magway Region) and 82% (Thanphyuzayat, Mon State) of deaths across the 14 townships.

Table 2: VA numbers - completeness by township

No.	Township	VAs (No.)	Predicted completeness 2017 (%)	Adult	Child	Neonate	Stillbirth
	Sagaing Region	5553		5374	105	74	25
1	Myinmu	710	71%	709	5	5	0
2	Myaung	773	78%	757	11	7	2
3	Shwebo	1147	51%	1108	29	10	3
4	Ayardaw	811	57%	794	17	10	2
5	Yinmarbin	800	68%	759	16	26	13
6	Salingyi	624	55%	613	10	5	2
7	Pale	660	49%	634	17	11	3
	Magway Region	3589		3438	91	100	63
1	Salin	1165	54%	1125	31	20	12
2	Myothit	784	51%	706	25	58	44
3	Kamma	393	60%	398	7	0	0
4	Yesagyo	883	35%	863	13	16	4
5	Seikphyu	364	38%	346	15	6	4
	Mon State	2046		2012	27	17	3
1	Thanphyuzayat	939	82%	930	11	3	0
2	Paung	1107	69%	1082	16	14	3
	Total	**11238**	**56%**	**10824**	**223**	**191**	**92**

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19 Adair T, Lopez AD (2018) Estimating the completeness of death registration: An empirical method. PLoS ONE 13(5): e0197047 https://doi.org/10.1371/journal.pone.0197047

Where conducting a COD analysis by age group, verbal autopsies were divided into three primary age groups (neonates, children and adults), with the adult group further divided in four sub-groups: 12 to 44 years, 45 to 64 years, 65 to 74 years and 75 years and above (**Table 3**) in accordance with the GBD age groups. The subdivision of the adult group was intended to address the likely difference in COD patterns across different age brackets, for instance, adolescents, young adults, and elder adults.

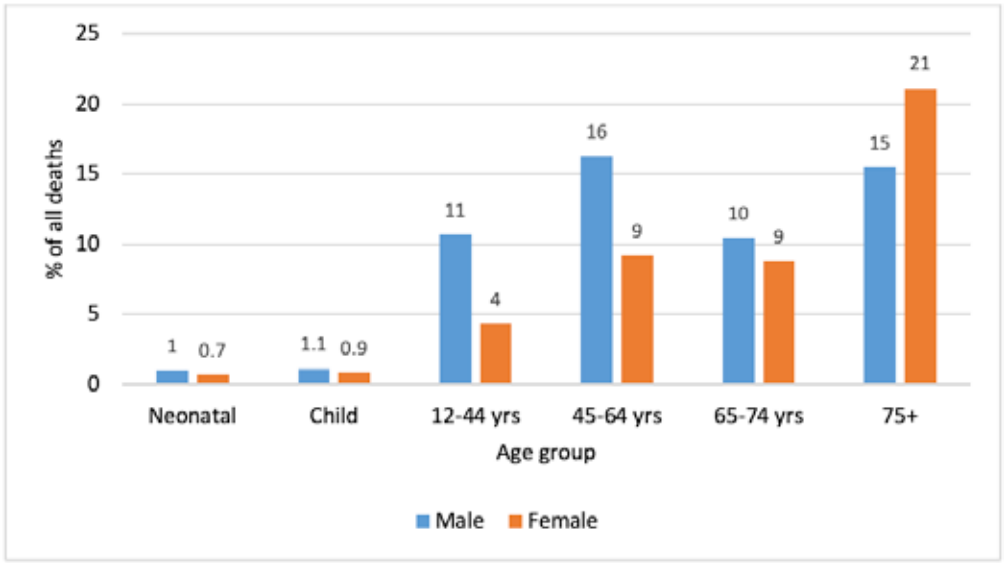
Table 3: VA numbers for 14 townships by age group

Age	Number
Neonatal (0 to 28 days)	191
Child (29 days to 5 years)	223
All adult (12 years and above)	10,824
- 12-44 years	(1,680)
- 45-64 years	(2,867)
- 65-74 years	(2,162)
- 75 years and above	(4,115)
Total	**11,238**

While it is noted that death distribution patterns would be likely be more accurate if more specific age sub-groups were analysed (e.g. an adult sub-group for every ten-year interval), it was not possible to do so for this study as only a limited number of VAs were available for certain age groups, rendering the analyses less reliable and representative of broader population trends (Appendix Figure 1).

Figure 4 shows the percentage of deaths distributed by age and sex, demonstrating a general trend of an increased occurrence of death with increased age. The lowest occurrence of death was recorded for the neonatal age bracket, and the highest recorded in the oldest bracket (75 years and above). Of the adult age groups between 12 to 64 years, largely representative of those of working age, the occurrence of male deaths was quite high, particularly when compared to female deaths.

Figure 4: Distribution of death (%) among age groups by sex, VA data, (N=11,238)

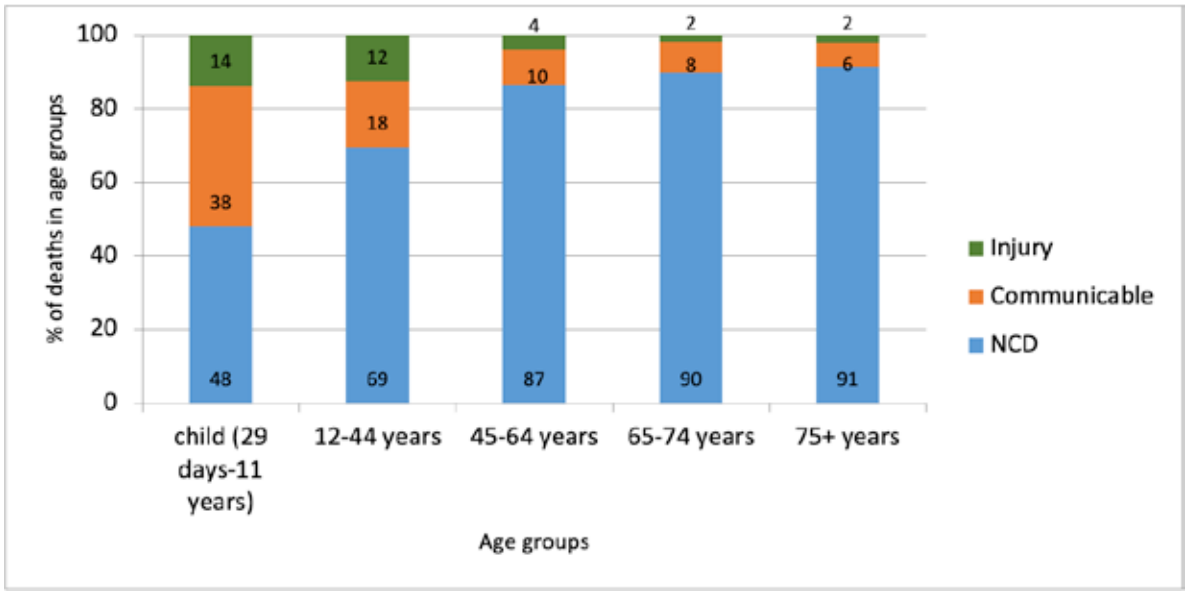


Analysis of VA in three broad disease groups

The GBD study groups diseases into three broad categories to assist with assessing general mortality patterns: non-communicable diseases (NCDs)[20], communicable diseases, and injuries.[21]

Figure 5 shows the three COD categories for Myanmar across all age groups (excluding neonates[22]), produced from VA data. NCDs are the dominant causes of death across all age groups.

Figure 5: Distribution of three categories of COD by age group



Analysis of adult VAs

Figure 6 shows the leading causes of deaths in all adults, according to the analysis of VA data (N=10,824). The leading COD was stroke (22.3%), followed by *chronic respiratory diseases, ischemic heart disease, cirrhosis, diabetes and other NCDs. Pneumonia and tuberculosis (TB)*, both communicable diseases, were found as the seventh and eighth most common COD in all adults. Leading causes of death for males and females separately (**Figures 8 and 9** respectively) were consistent, with the exception of sex-specific causes (breast and cervical cancer for women and prostate cancer for men) which do feature in the leading cause lists. Cause proportions for all VA causes (for each age group) are shown in Appendix Table 1, and by township in Appendix Table 2.

20 For the purpose of this evaluation, NCDs were categorised into seven COD groups: (1) *cardiovascular diseases* (in which stroke and ischemic heart disease were combined); (2) *chronic respiratory diseases;* (3) *neoplasm* (in which all specific cancers, leukemia and other cancer were included); (4) *cirrhosis*; (5) *diabetes*; (6) *renal failure*, and; (7) *other NCD*.

21 Global, regional, and national age-sex specific mortality for 264 causes of death, 1980-2016: a systematic analysis for the Global burden of disease Study 2016: http://www.healthdata.org/research-article/global-regional-and-national-age-sex-specific-mortality-264-causes-death-1980%E2%80%932016

22 Neotates were excluded because the five COD assignments for neonates in Tariff (birth asphyxia, congenital malformation, meningitis/sepsis, pneumonia, and preterm delivery) cannot be integrated with the broad GBD COD categories.

Figure 6: Leading COD (%) in all adults (12 years and above), VA data (N=10,824)

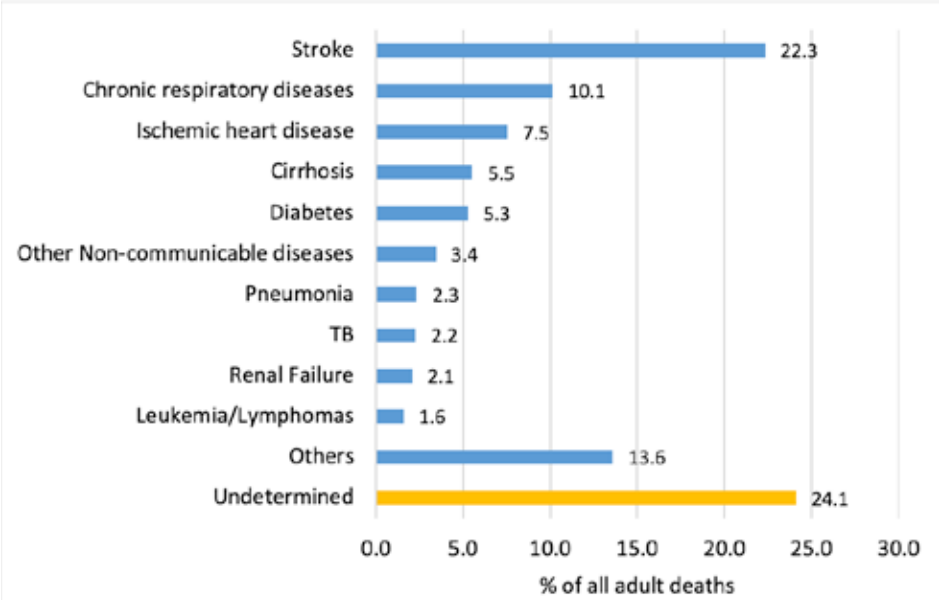
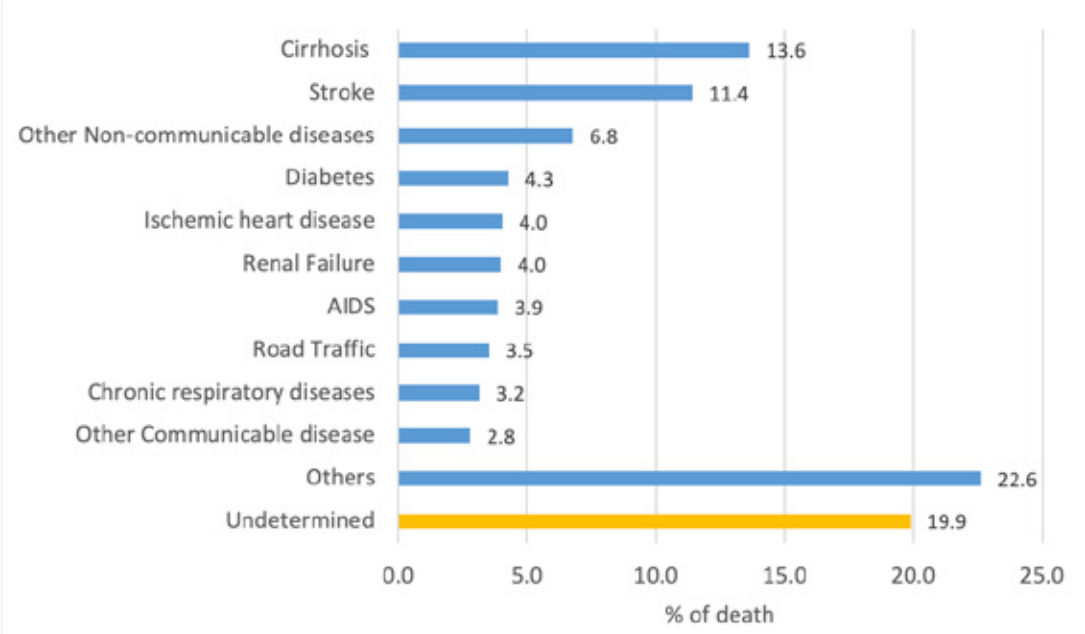


Figure 7 shows the leading causes of death in the 12 to 44 age group for both sexes, of which the majority are NCDs. *Cirrhosis, stroke, other non-communicable diseases and diabetes* emerged as the leading causes of death, with AIDS the seventh leading COD and the first leading communicable COD.

Figure 7. Leading causes of death (%) in 12 to 44 year age group, VA data (N=1,680)



Cirrhosis, stroke, and *road traffic accidents* emerged among the top ten leading causes of death for males, while for females, *ischemic heart disease* was the leading cause followed by *maternal deaths*. *Road traffic accidents* for females did not appear in the ten leading causes.

Figure 8: Leading causes of death (%) in the 12 to 44-year age group, male, VA data (N=1,198)

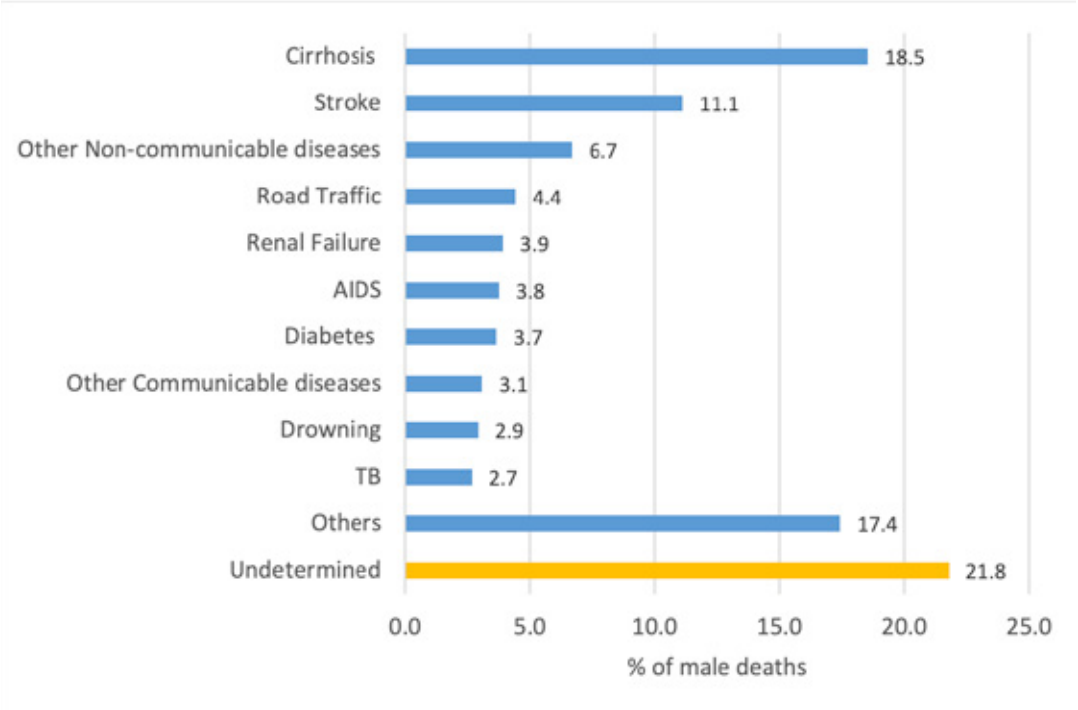
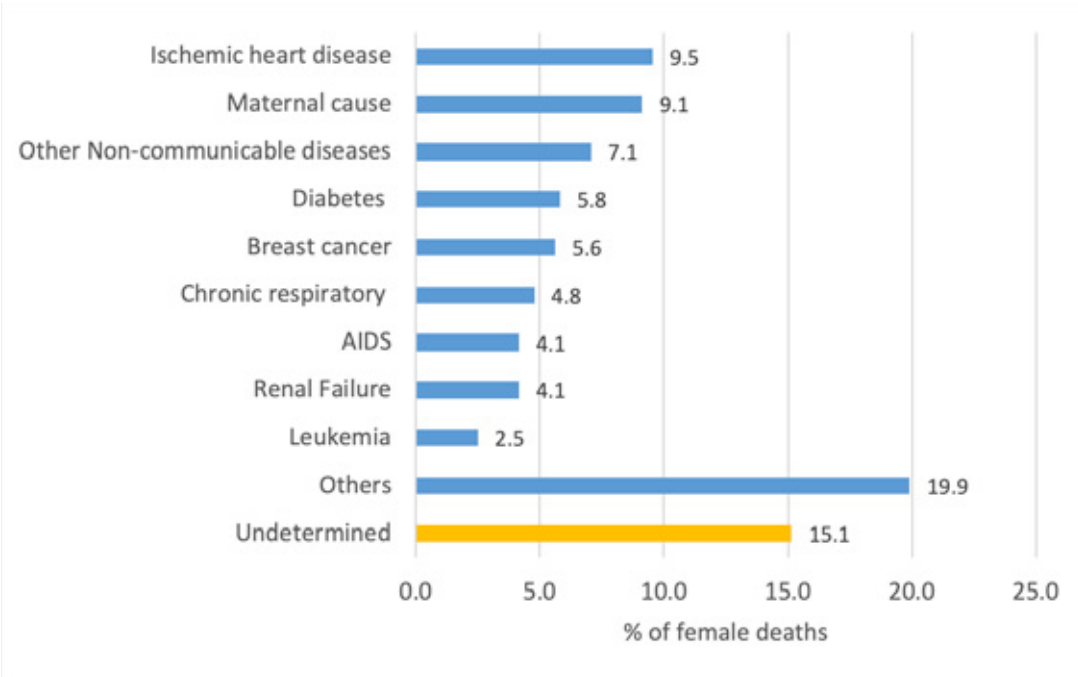


Figure 9: Leading causes of death (%) for 12 to 44-year age group, female, VA data (N=482)



The leading causes of death for the 45 to 64 year age group are shown in the **Figure 10**, with *stroke* the leading COD, followed by *cirrhosis, diabetes, chronic respiratory diseases, ischemic heart disease*. *TB* and *pneumonia* emerged as the top causes of death for males, but not females (Appendix Figures 4 and 5 for male and female figures respectively).

Figure 10: Leading causes of death (%) in the 45 to 64-year age group, VA data, (N=2,867)

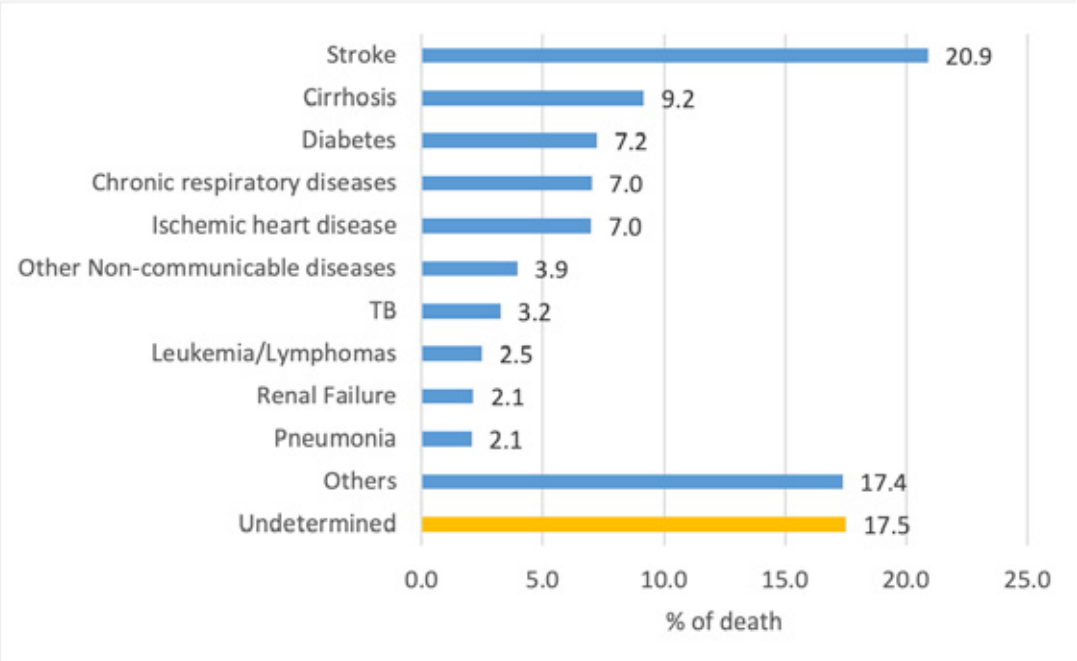


Figure 11 shows the leading causes of death for the 65 to 74-year age group. *Stroke, chronic respiratory diseases* and *ischemic heart disease dominate*, accounting for almost 50% of deaths in this age-group. Cirrhosis deaths became less significant in this age group when compared to the 45 to 64-year group. Lung and esophageal cancer also appear as leading causes of death, although account for a small proportion of overall deaths (<4%) (Appendix Figures 6 and 7 for male and female figures respectively).

Figure 11: Leading causes of death (%) in the 65-74 year age group, VA data (N=2,162)

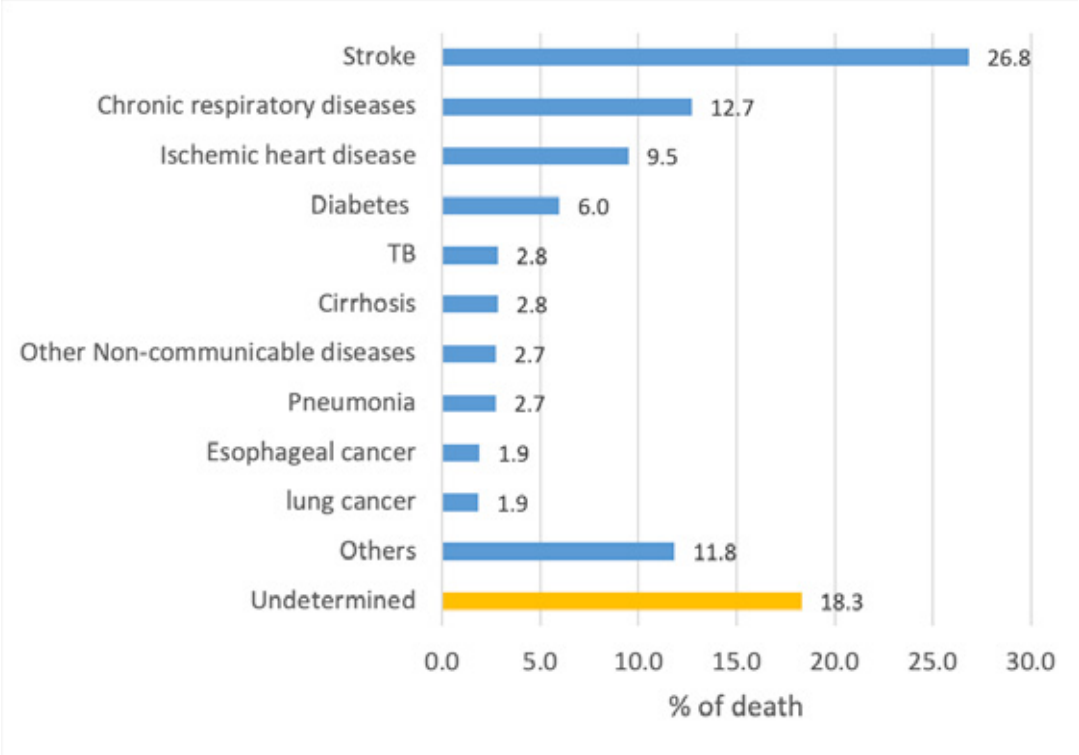
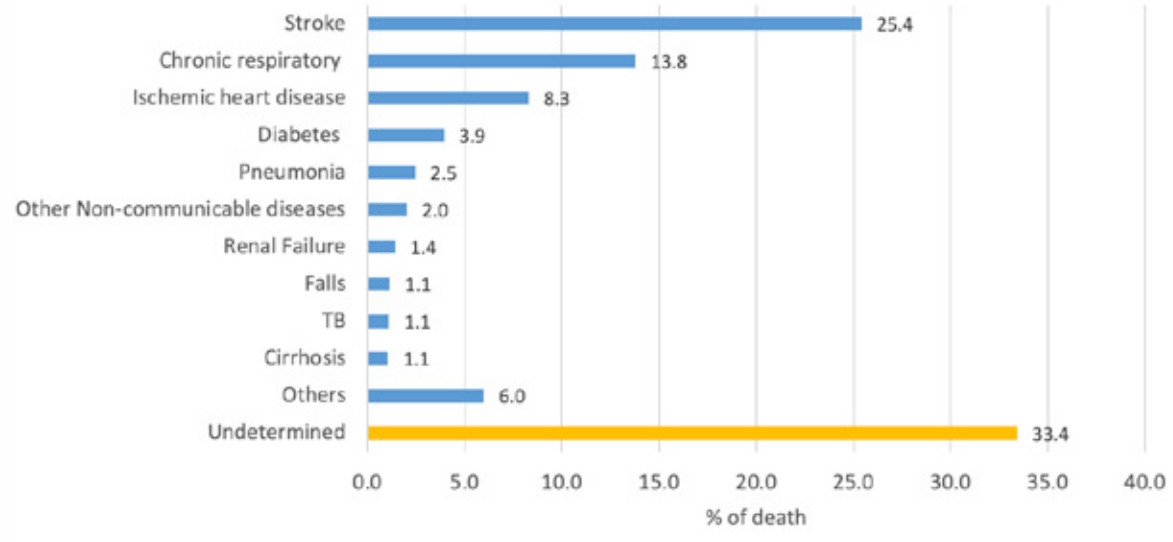


Figure 12 shows the leading causes of death for the 75 years and above age group. *Stroke* appears as the leading COD, followed by *chronic respiratory diseases*, and then *ischemic heart disease*, *diabetes* and *pneumonia* (Appendix Figures 8 and 9 for male and female figures respectively).

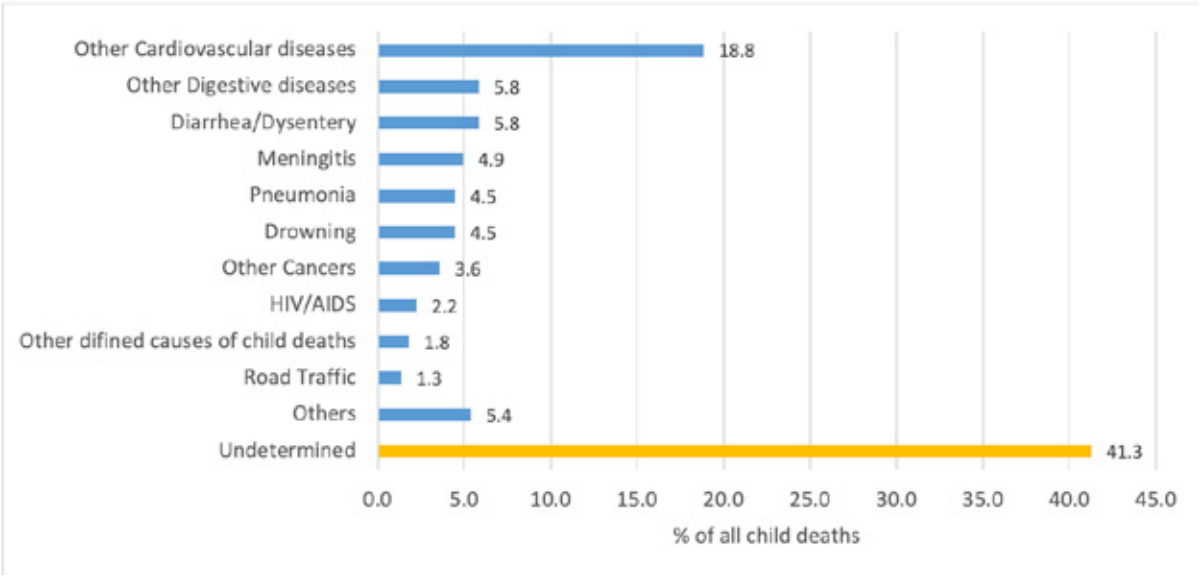
Figure 12: Leading causes of death (%) in 75 years and above age group, VA data, (N=4,115)



VA analysis of child (29 days to 11 years) deaths

Figure 13 shows the results of tariff analysis of VA data for children (29 days to 11 years). *Other cardiovascular diseases* emerged as the leading COD (18.8%), followed by *other digestive diseases* (5.8%), and then *diarrhea/dysentery*, *meningitis, pneumonia* and *drowning*.

Figure 13: Leading causes of death (%) in children (29 days and 11 years), VA data (N=223)

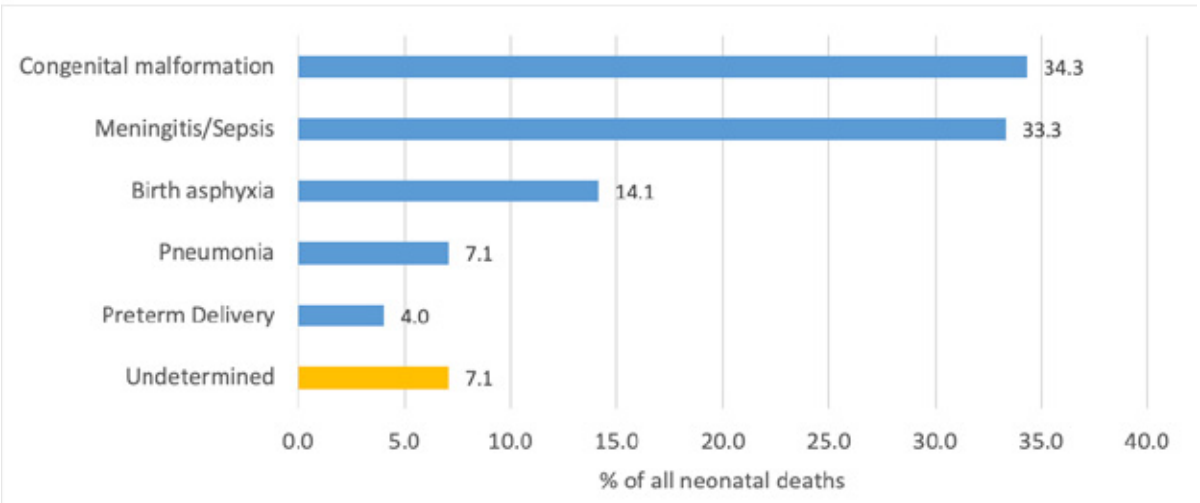


VA analysis of neonatal (0-28 days) deaths

The number of neonatal deaths (0 to 28 days) according to the tariff analysis was 191. Of these, 92 were stillbirths, placing the number of the true neonatal deaths[23] at 99. Stillbirths are another issue for further research. Given this, for the purpose of identifying the causes of death for neonatal deaths, the analysis was conducted on true neonatal deaths only.

Figure 14 shows all neonatal causes of death. The leading cause was *congenital malformation* followed by *meningitis/sepsis, birth asphyxia, pneumonia* and *preterm delivery*.

Figure 14: Leading causes of death (%) in neonates (0-28 days), VA data (N=92)



23 Stillbirths are fetal, or perinatal deaths.

Smaller age-group disaggregation of causes of death are shown in Appendix Table 1, demonstrating some unusual results particularly for young age groups. For instance, *stroke* was the leading COD in males in the 12 to 19-year age group (18.6%), and *cirrhosis* emerged as the COD for 12.2% of male deaths in 20 to 29-year age-group and 20% of male deaths in the 30 to 39-year age group.

Part 2: Comparison of VA data with GBD estimates

For assessing the plausibility of the first VA data for Myanmar, the COD results were assessed against the 2016 GBD data for Myanmar. It should be noted that GBD is a national estimate of all deaths whereas the VA dataset is only for community deaths in 14 townships in three states/regions.

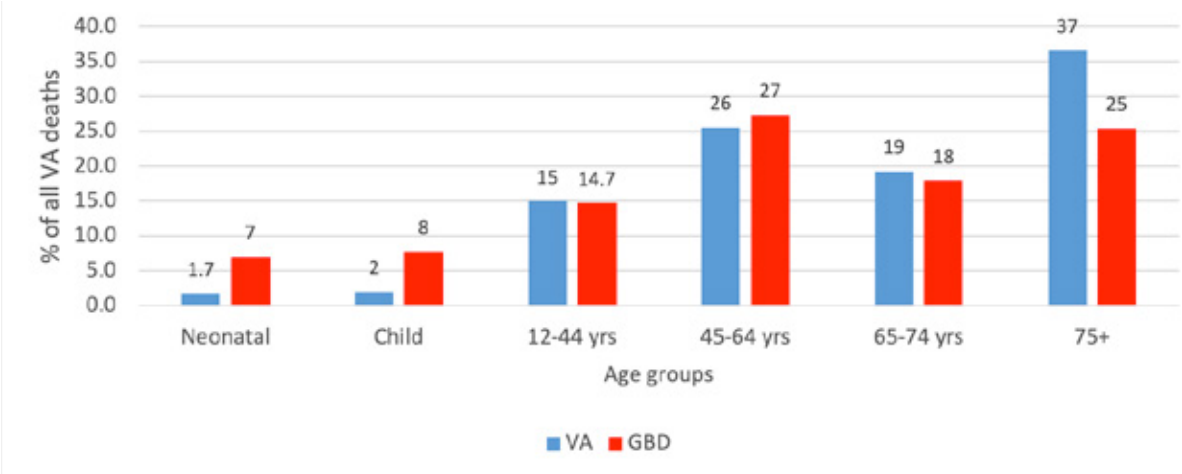
The Global Burden of Disease Group have revolutionised global health with their work that examines whether human beings are living longer and getting healthier. The GBD Study, co-founded by the Director of the group, Laureate Professor Alan Lopez at the University of Melbourne works in partnership with the Institute for Health Metrics and Evaluation (IHME) at the University of Washington, Seattle.

The study provides comprehensive, consistent estimates of mortality and morbidity and is now internationally recognised and applied to measure premature mortality and disability for major diseases or disease groups within countries. The GBD framework provides a road map of health challenges, charting past progress to provide direction in preparing for the challenges ahead.

Because causes of death vary by age, and so differences in age patterns may contribute to differences in distribution of causes of death between VA and GBD, the data were divided by age groups to conduct the comparisons. GBD is modelled, estimated data, and therefore it cannot be assumed that this data is highly accurate. However, significant variations in patterns of mortality between VA and GBD data do indicate a need for further investigation.

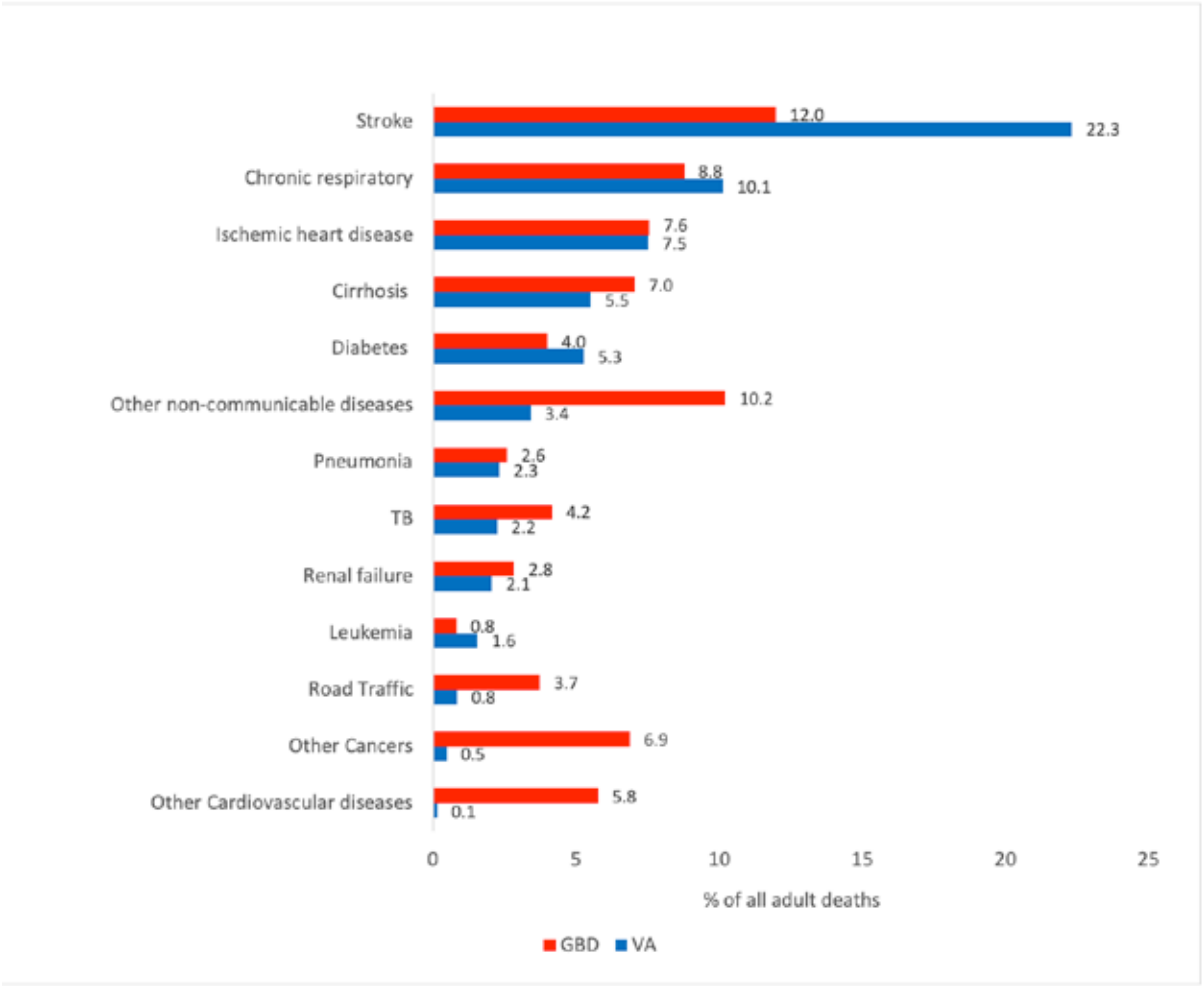
Figure 15 shows relatively slight differences between VA and GBD data for neonatal, child and 75 years and above age groups. In the neonatal and child groups, VA deaths were less than GBD but for the 75 years and above age group, VA deaths were more than GBD. VA deaths in the other adult age groups were quite similar to GBD, and adult male and female groups were also similar (Appendix Figures 10 and 11).

Figure 15: VA and GBD comparison of cause of death distribution, both sexes, all ages



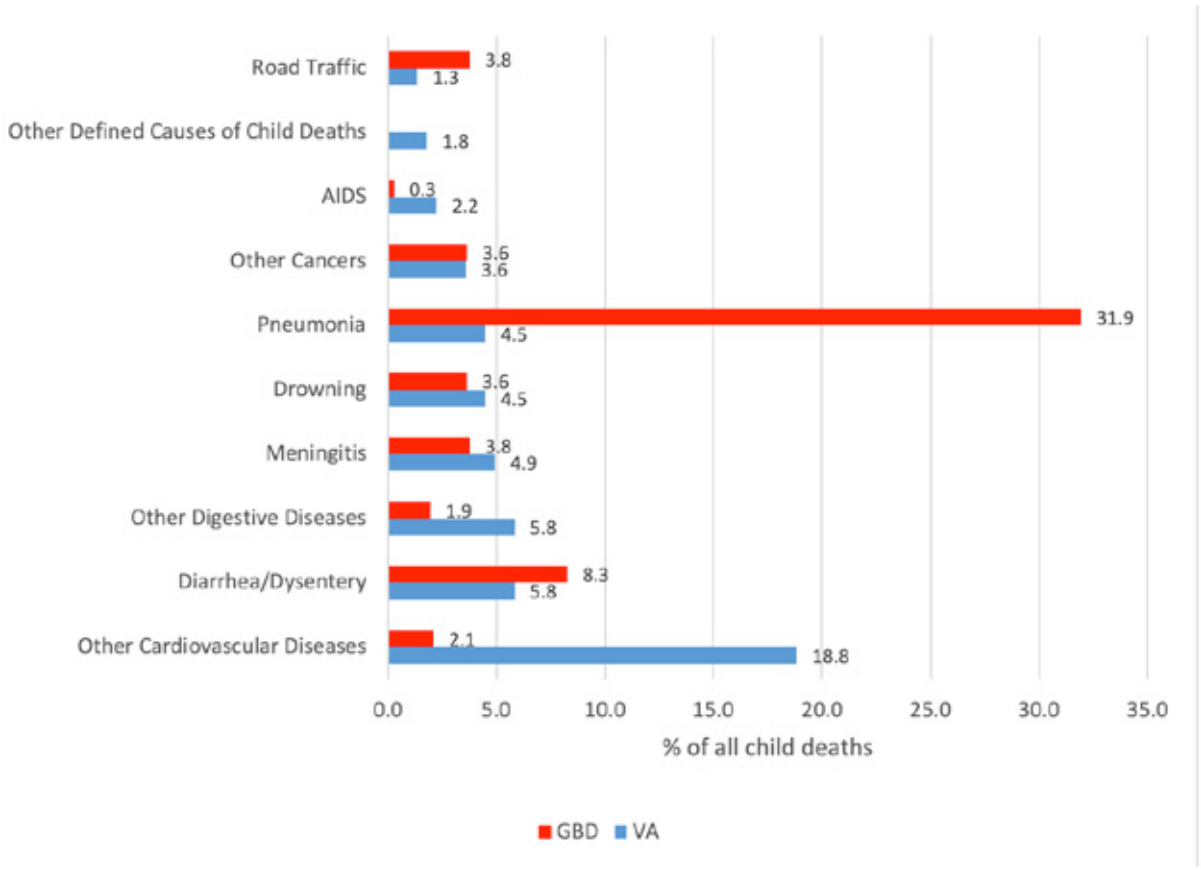
For VA and GBD comparison of leading causes of death, the CSMF output of VA was used because GBD has no undetermined cause. Overall (both sexes) for all adults, the first leading COD was stroke, however, stroke in VA (22%) was almost double that of GBD (12%) at 22% (**Figure 16**). It was found that other leading causes of death across VA and GBD were greatly different, with the exception of *other non-communicable diseases*, which were 3% in VA and 10% in GBD. In the GBD dataset, *other cancers, other cardiovascular diseases* and *road traffic accidents* were found as the leading causes of death, but occurred less in the VA data. See Appendix Figures 10 and 11 for sex disaggregated results.

Figure 16: VA and GBD comparison of leading causes of death, both sexes



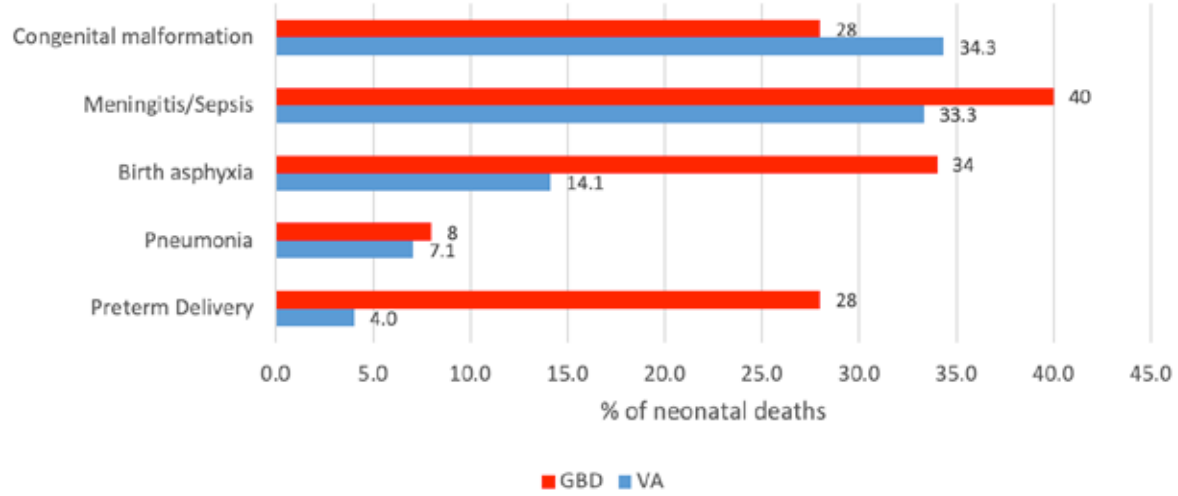
The VA and GBD comparison of leading causes of death for children (29 days to 11 years) is shown in **Figure 17**, using the CSMF output of VA to compare against GBD data. The primary differences can be seen between the output for *pneumonia* which was the first leading COD in the GBD estimate, and *other cardiovascular diseases* which was the leading COD in the VA dataset. Other slight differences can be seen for *road traffic accidents*, *AIDS* and *other digestive diseases*. It should be noted that the very small number of child deaths (223) included in the VA dataset increased the uncertainty of these results.

Figure 17: VA and GBD comparison of leading causes of death in children (29 days to 11 years)



In the comparison of VA and GBD neonatal causes of death (**Figure 18**), the first leading VA COD, was *congenital malformation* (34.3%), which appeared as the third leading COD (28%) in the GBD results. In contrast, the first leading GBD COD was *meningitis/sepsis* (40%), which was the second leading COD for VA (33.3%). For *birth asphyxia*, the GBD data showed this as being almost double as high as the VA results (34% to 14.1% respectively). Additionally, the GBD estimate of *neonatal preterm birth complications* was seven times higher than the findings from VA (28% to 4% respectively).

Figure 18: VA and GBD comparison of neonatal causes of death (%)



For the comparison of the distribution of three broad GBD COD categories (*injury, communicable diseases* and *NCDs*), the VA results were based on the CSMF outputs of the Tariff analysis of adult and child. VA and GBD results emerged as similar for the "all adult" group (**Figure 19**) while for the "child" group, the leading causes were not the same, with *communicable diseases* (66%) the leading COD for the GBD results, and *NCDs* (48%) for VA (**Figure 20**).

Figure 19: VA and GBD comparison of three broad categories of causes of death, all adults

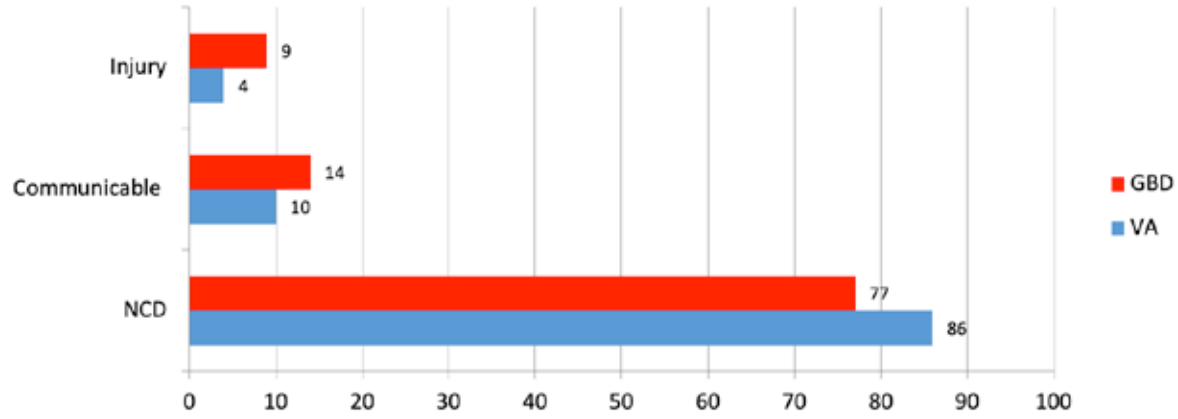


Figure 20: VA and GBD comparison of three broad categories of causes of death, children

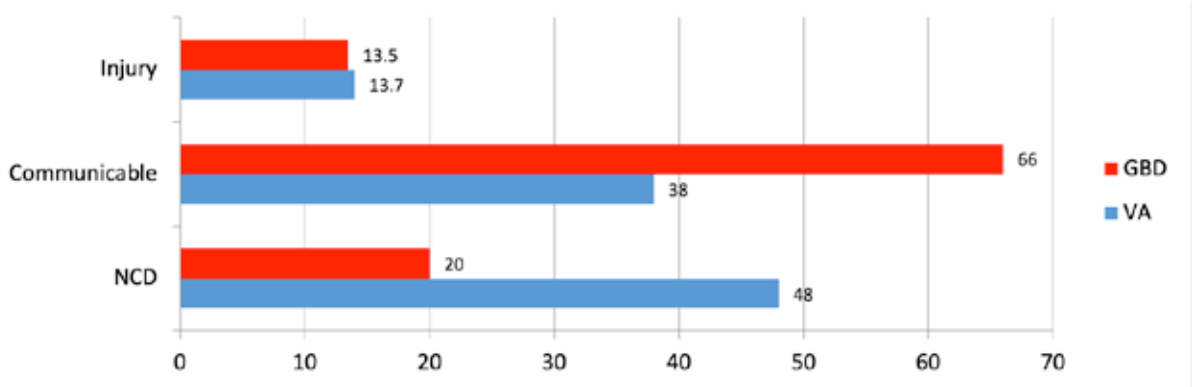
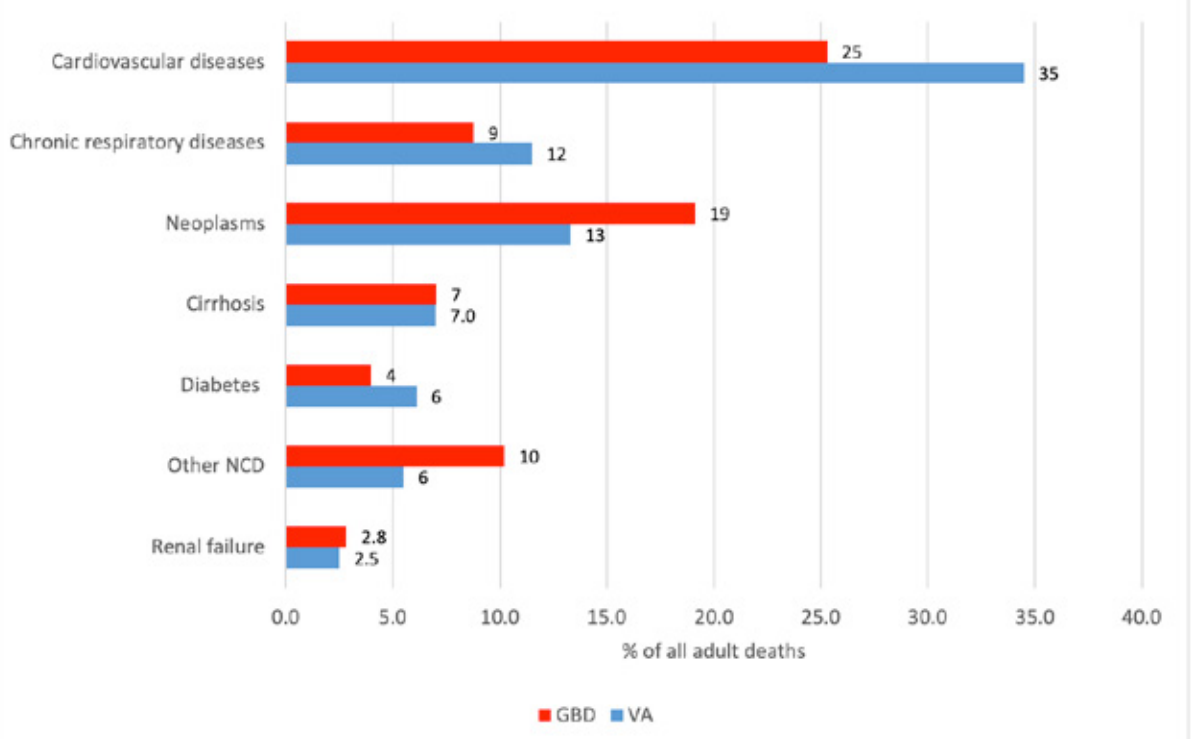


Figure 21 shows the results of the NCD comparison between VA and GBD results. The first leading COD was *cardiovascular diseases* in both VA (35%) and GBD (25%), the second leading VA cause was *chronic respiratory diseases* (12%), while for GBD this was *neoplasm* (19%) (the third leading cause at 13% for VA). *Other non-communicable diseases* appeared higher up the order of the GBD COD estimates than for VA, at 10% and 6% respectively. VA results estimated *diabetes* at 6% and GBD at 4%. *Renal failure* emerged as almost identical for both VA and GBD, at nearly 3% each.

Figure 21: NCD comparison of VA and GBD (%)



Part 3: Analysis of hospital inpatient deaths

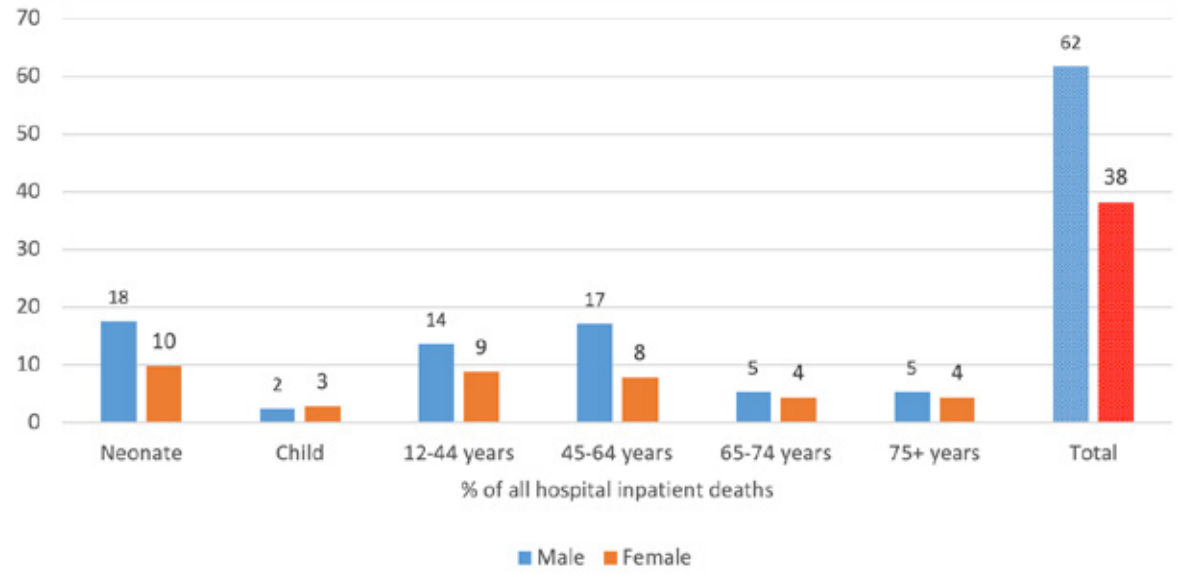
Few hospital inpatient deaths were recorded over the January to September 2017 period: 204 in 12 townships[24], equating to only 1% of all deaths in the 14 townships in 2017. This meant that while an analysis of this data was conducted, it was difficult to draw conclusions due to the limited sample. **Table 4** shows the number of hospital inpatient deaths by age group.

Table 4: Number of deaths, hospital inpatient

Age	Number
Neonatal (0 to 28 days)	56
Child (29 days to 5 years)	11
All adult (12 years and above)	137
- 12-44 years	(46)
- 45-64 years	(51)
- 65-74 years	(20)
- 75 years and above	(20)
Total	**204**

Figure 22 shows the distribution of deaths by sex and by age groups, and **Figure 23** the leading causes of death for all hospital deaths. The first leading COD was *unspecified injury of head* (12%), followed by *intracerebral hemorrhage*, *unspecified* and *cardiogenic shock* (5.8% respectively). The vast proportion of hospital deaths emerged as NCDs, followed by injuries due to road traffic accidents.

Figure 22: Distribution (%) of causes of death by sex and by age groups (N=204)



24 Two townships, Paung and Salin, did not report completely

Figure 23: Leading causes of death (%) for all adults, hospital inpatient (N=137)

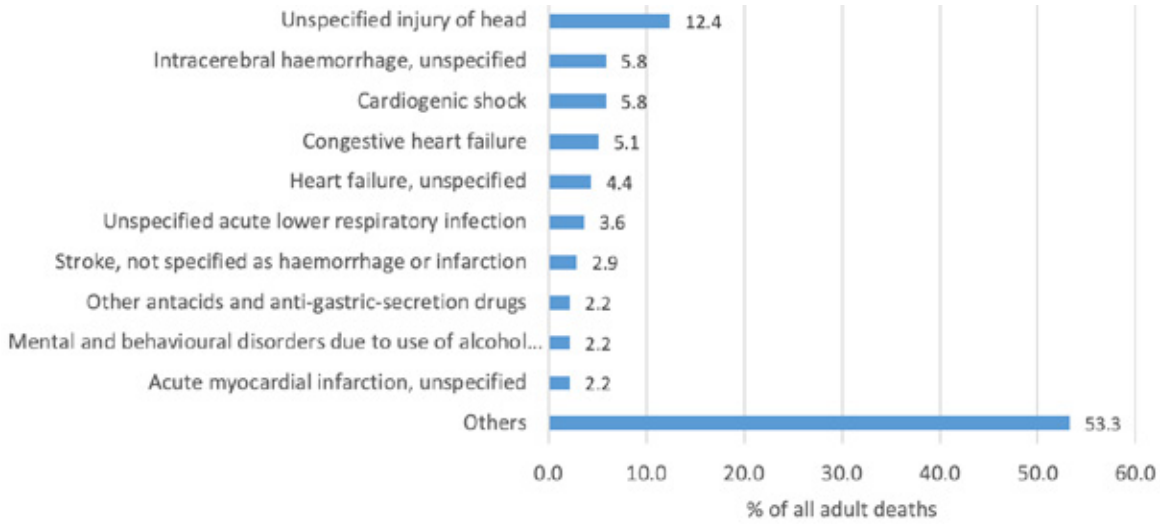


Table 5 shows inpatient child deaths. Due to the limited number of these deaths (11) over the January to September 2017 period, the usefulness of this data is limited.

Table 5: Causes of child (29 days to 11 years) death, hospital inpatient (N=11)

	Causes	Number
1.	Pneumonia, organism unspecified (Severe)	3
2.	Diarrhoea and gastroenteritis of presumed infectious origin (Severe)	2
3.	Congenital malformation of heart, unspecified	2
4.	Unspecified acute lower respiratory infection	1
5.	Beriberi	1
6.	Disseminated intravascular coagulation [defibrinating syndrome]	1
7.	Other and unspecified convulsions	1
	Total	**11**

Figure 24 shows the five leading causes of neonatal inpatient deaths. Conclusions were also difficult to draw due to the limited number of deaths in this category (N=56).

Figure 24: Leading causes of neonatal death (%), hospital inpatient (N=56)

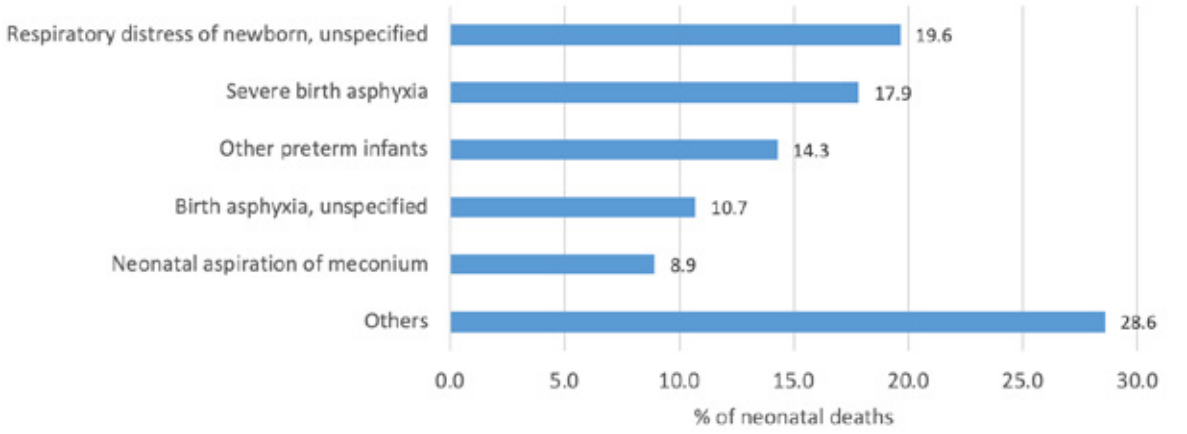


Figure 25 shows the distribution of the three broad COD categories as well as the unspecified causes from hospital deaths, labelled as "R" codes. The first two columns of this graph show the distribution of child and adult (12 years and above) deaths. Of the child deaths, it can be seen that communicable diseases were the most prevalent (64%), with injuries not featuring at all. Of the adult deaths, approximately half (48%) of causes of death were NCDs, followed by injuries (23%) and then communicable diseases (17%).

The final four columns show the sub-age groups of adults. In the 12 to 44-year age group, injuries were the leading COD (41%), followed by NCDs and then communicable diseases. As the groups progressed in age, NCD-related deaths increased in prevalence, while communicable disease and injury-related deaths decreased.

Figure 25: Three categories of CODs (%) distribution in all age groups of hospital (inpatient)

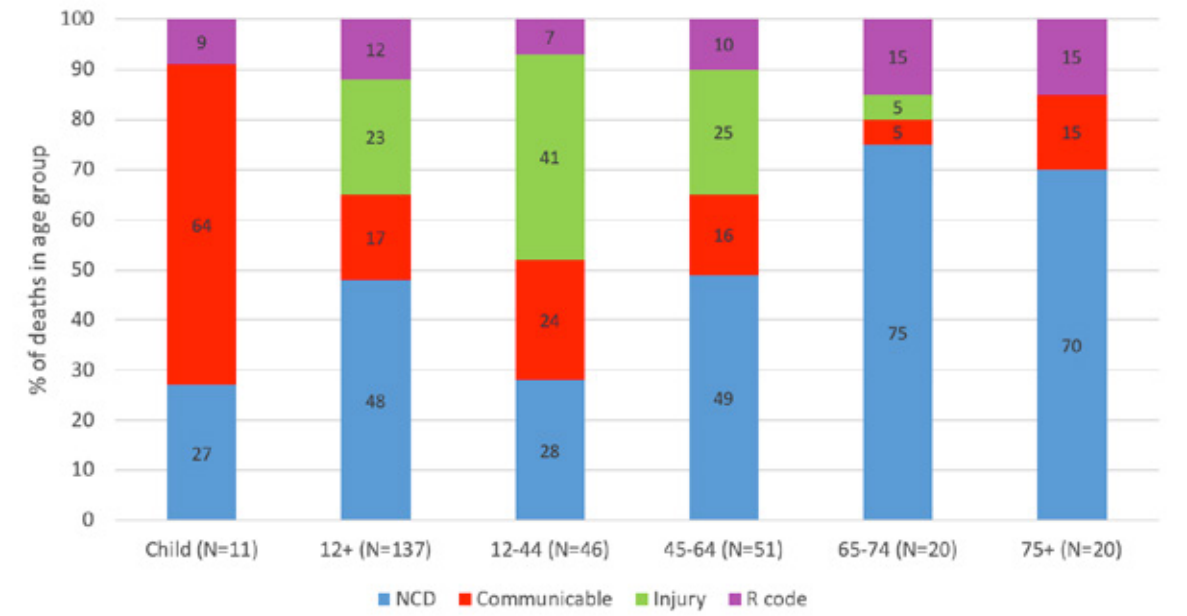
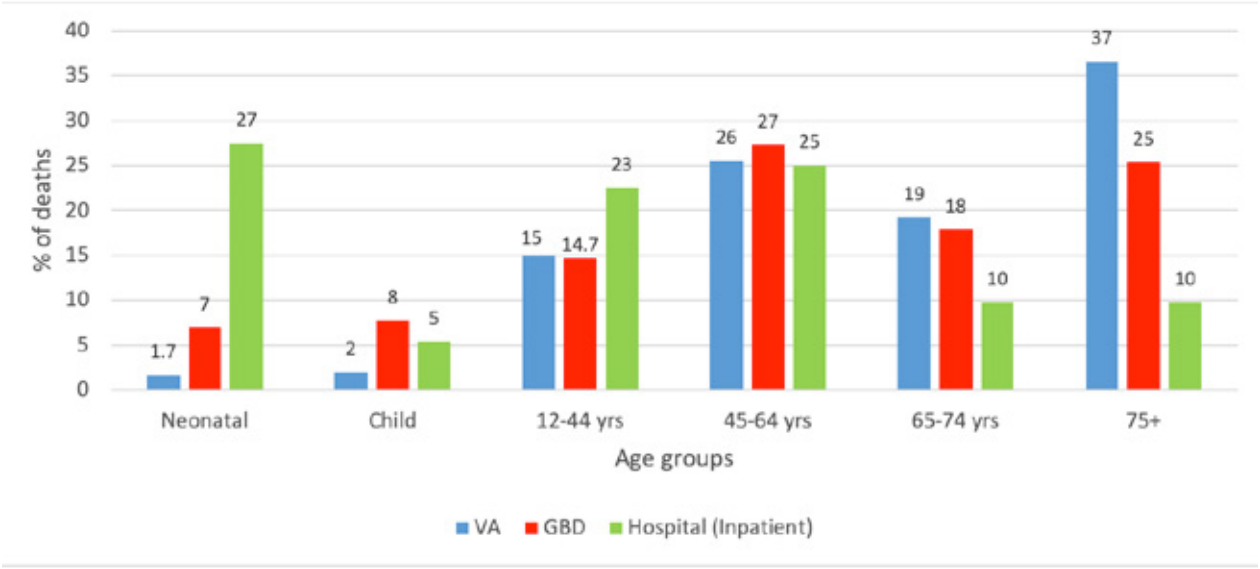


Figure 26 shows the VA, GBD and hospital inpatient distribution of causes of death by age group. This data shows that hospital neonatal deaths were the most common, while hospital child deaths were the least. VA data (at home deaths) captured the highest proportion of deaths in the 75 years and above age group, and lowest in the neonatal group.

Figure 26: Comparison of VA, GBD and hospital COD distribution (%) in all age groups



Figures 27 and 28 compare the distribution of all deaths across the three broad COD categories from GBD, hospital and VA data. This comparison shows that NCD causes are the most prevalent in these sources. Death by injury is the most prevalent in hospital data, as well as communicable diseases by a small margin. Injury-related deaths were not found in the hospital data for child deaths (**Figure 28**). The relatively higher proportion of injuries in the hospital data for adults is expected given the nature of this death and the higher proportion of deaths in the 12 to 44-year age group in the hospital data compared to GBD and VA.

Figure 27: VA, GBD and hospital comparison of three categories of COD distribution (%), adults

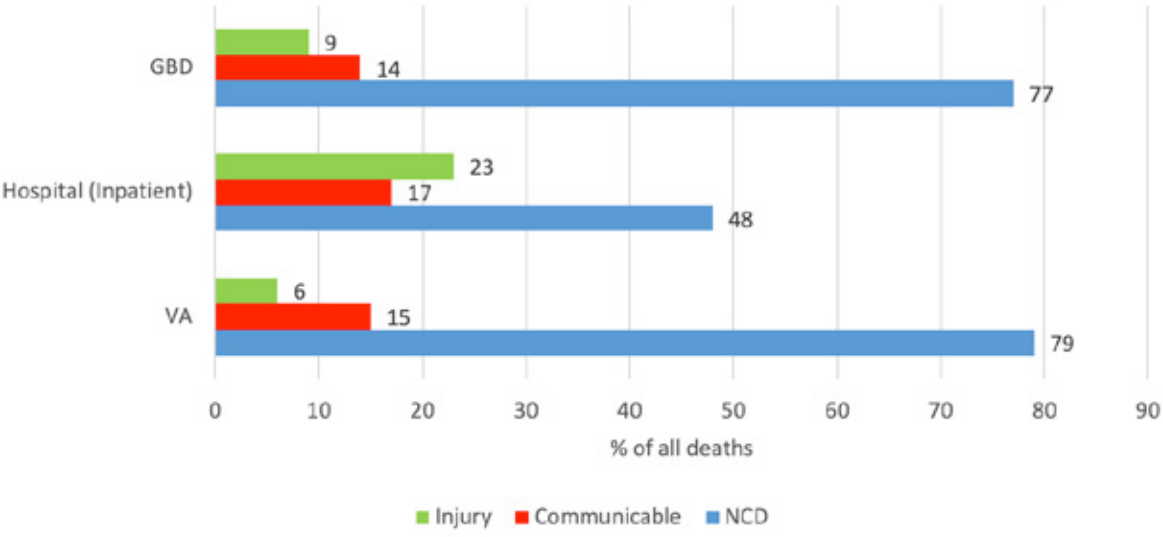
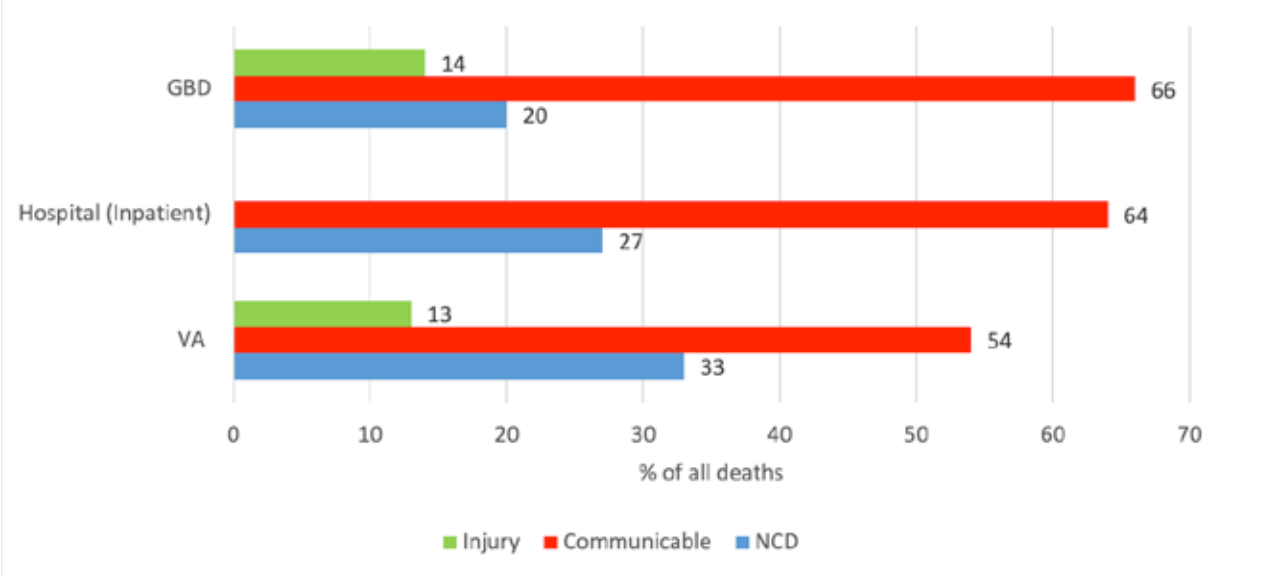


Figure 28: VA, GBD and hospital comparison of three categories of COD distribution (%), children



Discussion

A number of interesting insights were drawn from this comparative analysis, and the usefulness of VA data as a tool to aid health policy and decision makers in Myanmar highlighted. Where previously, health policy and planning were guided largely by GBD estimates alone, this analysis shows that it is now plausible for community deaths to be effectively captured and analysed, thereby ensuring the largest proportion of deaths in Myanmar are included in the country's vital statistics reporting. Whilst acknowledging the limitations, this analysis has demonstrated that leading causes of death and patterns of disease captured through VA are useful as reliable evidence-based information for health planning.

Smart VA analysis of the data for the 12 to 44-year and 45 to 64-year age groups from the 14 townships revealed NCDs to be the leading COD, with *stroke*, *chronic respiratory diseases*, *ischemic heart disease*, *cirrhosis* and *diabetes* the leading causes. It should be noted, however, that the results in younger age groups (i.e. 12 to 44-years) may be slightly unreliable due to the proportionally smaller number of deaths, reinforcing the need for larger VA data sets to obtain useful results. Male deaths (55%) were more prevalent than female deaths (45%), and typically occurred at younger age (see Appendix Figures 10 and 11). Communicable disease-related causes of death were far less prominent than NCDs, broadly consistent with GBD estimates.

Similarly to adult deaths, NCDs were the leading cause in children aged 29 days to 11 years (48%), followed by communicable diseases at 38%. These results differ in comparison with the GBD data, likely due to the high number of undetermined causes (41%) in this group from the VA data. Of the communicable diseases, *diarrhea/dysentery* (5.8%), *meningitis* (4.9%) and *pneumonia* (4.5%) were the leading causes. Undetermined deaths were very high for this age-group, likely due to a combination of the small number of deaths and interviewer inexperience or error.

Smart VA analysis showed that nearly half of neonatal deaths (48%) were actually perinatal deaths (stillbirths), with the leading causes of true neonatal death *congenital malformation* (34%), *meningitis/sepsis* (33%), *birth asphyxia* (14%), *pneumonia* (7%) and *preterm delivery* (4%).

The comparison of Smart VA results with GBD estimates for Myanmar showed both similarities and differences. One reason for this might be due to GBD estimates being modelled data, whereas VA analysis is drawn from individual deaths. Further, GBD estimates are modelled on the whole country, while the VA analysis was based on data from 14 townships only.

Recommendations

The following recommendations relate to the future implementation of VA in Myanmar:

- Prior to the introduction of VA, health policy decision making in Myanmar was based entirely on mortality estimates. Smart VA, if implemented well, could generate valid causes of deaths for the 84% of deaths that occur outside of a health care institution. Expanding and embedding the use of Smart VA in Myanmar would greatly improve the generation of evidence-based data to inform public health decision making.
- This pilot was conducted in only 14 townships, and requires a phased, national expansion in order to ensure greater reliability and representativeness of the data. At the time of writing this report, a roll-out of Smart VA to a further 34 townships has begun.
- A reduction in the number of undetermined causes is needed to improve the quality of VA data generated. This can be achieved through capacity building of interviewers; establishment of monitoring and evaluation mechanisms, and; establishment of supervisory mechanisms.
- Efforts should be undertaken to improve the completeness of both CRVS registration and SmartVA. Advocacy approaches should attempt to convey the importance of CRVS systems to health authorities and policy makers, as well as the general public. Additionally, laws to enforce the registrations of vital events need to be in place to incentive completeness.

Appendix

Causes of Death	12-19 years (%)		20-29 years (%)		30-39 years (%)		40-49 years (%)		50-59 years (%)		60-69 years (%)		70-79 years (%)		80+ years (%)		Total Number of Deaths by cause	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
1. AIDS	0.0	0.0	1.5	1.9	4.4	5.1	3.4	4.3	1.3	1.2	0.6	0.5	0.2	0.2	0.0	0.0	76	37
2. Bite of Venomous Animal	5.1	0.0	1.0	3.8	1.0	0.5	0.6	1.0	0.6	0.6	0.1	0.4	0.1	0.0	0.1	0.0	24	14
3. Breast Cancer	0.0	0.0	0.0	1.9	0.0	5.6	0.0	10.6	0.0	6.3	0.0	2.1	0.0	1.6	0.0	1.1	0	132
4. Cervical Cancer	0.0	0.0	0.0	1.0	0.0	3.6	0.0	3.7	0.0	6.3	0.0	2.4	0.0	2.2	0.0	1.1	0	114
5. Chronic Respiratory	3.4	0.0	3.4	2.9	2.0	7.1	2.8	6.3	6.6	7.5	11.2	11.8	12.2	14.5	14.6	12.8	534	562
6. Cirrhosis	0.0	1.9	12.2	0.0	20.0	2.0	23.2	1.7	11.3	3.0	5.2	2.7	1.8	2.4	0.2	0.9	506	91
7. Colorectal Cancer	1.7	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.0	0.2	0.0	0.1	0.3	0.3	0.2	0.2	9	10
8. Diabetes	1.7	5.8	2.4	3.8	3.4	6.6	4.1	8.6	7.5	8.9	5.2	9.5	3.8	5.5	4.9	3.2	281	289
9. Diarrhea/Dysentery	0.0	1.9	1.0	0.0	0.3	0.0	0.5	0.0	0.3	0.8	0.3	0.4	0.4	0.7	1.0	0.8	30	29
10. Drowning	13.6	3.8	3.4	0.0	2.5	0.5	1.5	1.0	0.3	0.0	0.3	0.0	0.2	0.1	0.0	0.1	50	8
11. Oesophageal Cancer	0.0	1.9	0.5	1.0	0.8	1.5	1.3	2.7	1.5	2.0	2.5	1.8	1.5	0.9	1.3	0.6	89	60
12. Falls	1.7	0.0	1.5	0.0	0.7	0.0	1.3	1.0	1.0	0.4	0.5	0.2	1.2	0.5	1.1	1.4	59	36
13. Fires	0.0	0.0	0.5	0.0	0.5	0.0	0.3	0.3	0.0	0.0	0.1	0.2	0.1	0.0	0.0	0.0	8	3
14. Homicide	0.0	0.0	1.0	0.0	0.3	1.5	0.1	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	5	4
15. Ischemic Heart Disease	1.7	9.6	2.4	8.7	1.8	10.2	2.3	8.6	5.1	9.9	5.6	13.6	8.5	10.5	7.6	8.1	328	486
16. Leukaemia/Lymphomas	5.1	1.9	2.0	0.0	2.0	2.0	2.2	4.3	2.2	3.4	1.8	2.4	0.9	1.0	0.8	0.4	95	73
17. Lung Cancer	0.0	0.0	1.0	0.0	0.8	0.5	0.8	1.0	1.7	1.0	3.5	1.1	2.1	0.7	0.2	0.2	94	30
18. Malaria	0.0	0.0	0.0	1.0	0.7	0.0	0.3	0.0	0.3	0.2	0.2	0.0	0.1	0.0	0.0	0.1	12	3
19. Maternal	0.0	19.2	0.0	18.3	0.0	4.6	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	47
20. Other Cancers	0.0	0.0	1.0	0.0	0.5	0.5	0.6	1.7	0.9	2.0	0.4	1.2	0.1	0.2	0.1	0.0	24	28
21. Other Cardiovascular Diseases	0.0	0.0	0.5	0.0	0.5	0.0	0.1	0.0	0.2	0.0	0.1	0.0	0.2	0.3	0.1	0.1	11	5
22. Other Infectious Diseases	1.7	7.7	4.4	4.8	4.2	0.0	0.9	1.3	0.9	0.0	0.2	0.0	0.0	0.1	0.1	0.0	53	14
23. Other Injuries	0.0	0.0	1.0	0.0	0.2	0.5	0.4	0.0	0.1	0.2	0.2	0.1	0.3	0.2	0.0	0.1	13	7
24. Other Non-Communicable Diseases	8.5	11.5	7.8	10.6	6.4	5.6	5.2	4.3	5.9	2.6	2.8	1.5	3.0	2.1	3.0	1.4	253	116
25. Pneumonia	1.7	1.9	1.5	1.9	2.9	2.0	1.1	1.7	2.2	1.8	3.6	2.0	3.5	2.0	3.0	1.5	165	87
26. Poisonings	1.7	1.9	0.5	0.0	0.2	1.0	0.1	0.0	0.1	0.0	0.1	0.1	0.0	0.1	0.0	0.0	6	5
27.Prostate Cancer	1.7	0.0	1.0	0.0	1.0	0.0	0.9	0.0	2.8	0.0	3.5	0.0	2.5	0.0	1.3	0.0	122	0
28. Renal Failure	11.9	1.9	6.8	6.7	3.0	4.1	3.2	3.3	1.6	2.4	1.7	1.5	1.7	2.0	1.2	1.1	130	93
29. Road Traffic	6.8	3.8	12.2	1.9	3.5	1.0	0.8	1.0	1.1	1.0	0.4	0.4	0.3	0.0	0.0	0.0	74	17
30. Stomach Cancer	0.0	1.9	0.0	0.0	0.5	1.5	0.6	1.0	1.3	1.4	1.4	1.1	1.3	0.6	0.2	0.4	52	36
31. Stroke	18.6	9.6	6.3	10.6	10.9	11.2	14.4	14.6	19.8	20.8	25.3	25.8	27.6	27.7	24.4	25.1	1258	1158
32. Suicide	0.0	0.0	1.5	0.0	0.8	1.0	0.3	0.3	0.3	0.0	0.1	0.1	0.1	0.0	0.0	0.0	15	4
33. TB	1.7	1.9	3.4	1.9	2.5	4.1	3.2	0.0	4.6	1.8	4.2	1.2	2.3	1.9	1.6	0.6	180	63
34. Undetermined	11.9	11.5	18.5	17.3	21.6	15.8	23.3	12.3	18.5	14.1	19.1	15.8	23.8	21.9	33.2	39.1	1387	1220
Total Number of Deaths	**59**	**52**	**205**	**104**	**596**	**196**	**785**	**301**	**870**	**496**	**1125**	**844**	**1183**	**1188**	**1120**	**1700**	**5943**	**4881**

	Sagaing						Magway							Mon		
Causes of Death	Myinmu (%)	Myaung (%)	Shwebo (%)	Ayardaw (%)	Yinmarbin (%)	Salingyi (%)	Pale (%)	Salin (%)	Myothit (%)	Kamma (%)	Yesagyo (%)	Seikphyu (%)	Thanphyuzayat (%)	Paung (%)	Total (%)	Female
Stroke	27.7	22.9	19.9	19.9	21.3	25.3	26.6	21.4	19.2	22	21.5	23	23.4	21.7	22.3	0.0
Chronic respiratory diseases	10	11.4	9.2	10.7	11.7	9.2	7.8	9.9	13.5	14.8	9.7	5	9.1	9.8	10.1	0.0
Ischemic heart disease	8.6	5.3	10.1	4.7	6.2	6.6	11.9	5.8	4.1	6.7	6.9	5.8	9.9	10	7.5	1.1
Cirrhosis	7.7	5.3	7.4	5.4	5.4	4.1	7.1	5.3	5.4	3.9	5.3	4.1	2.9	6.5	5.5	1.1
Diabetes	4.9	4.1	5.1	5.4	5.9	5.4	5.1	5.1	4.1	4.1	4.7	6.4	6.2	6.8	5.3	12.8
Other Non-communicable diseases	3.1	3	3.2	3.7	2.6	3.3	2.4	2.7	3.1	4.1	4.3	1.7	3.6	5.6	3.4	0.9
Pneumonia	2	1.3	3.5	1.3	1.3	1.6	3.2	2.8	3.6	3.4	2.8	1.2	1.7	1.9	2.3	0.2
TB	2.3	1.6	2.4	2.2	1.8	2.6	0.8	2.5	2.4	3.4	1.1	2	2.9	3	2.2	3.2
Renal Failure	2.7	1.6	2	1.3	2.1	1.8	2.8	2.2	2.7	2.6	1.9	1.5	1.4	2.3	2.1	0.8
Leukaemia/Lymphomas	1.4	2.5	0.9	1.3	1.6	1.8	0.8	0.9	1.7	1.8	2.3	1.5	1.7	1.9	1.6	0.1
Others Causes	13.5	14	12.7	12.6	15.3	15.3	11.7	10.9	12	11.2	14.9	14	16.9	14.6	13.6	0.6
Undetermined	16.1	27	23.6	31.5	24.8	23	19.8	30.5	28.2	22	24.6	33.8	20.3	15.9	24.1	1.4

Figure 1. Distribution of deaths by age group (%)

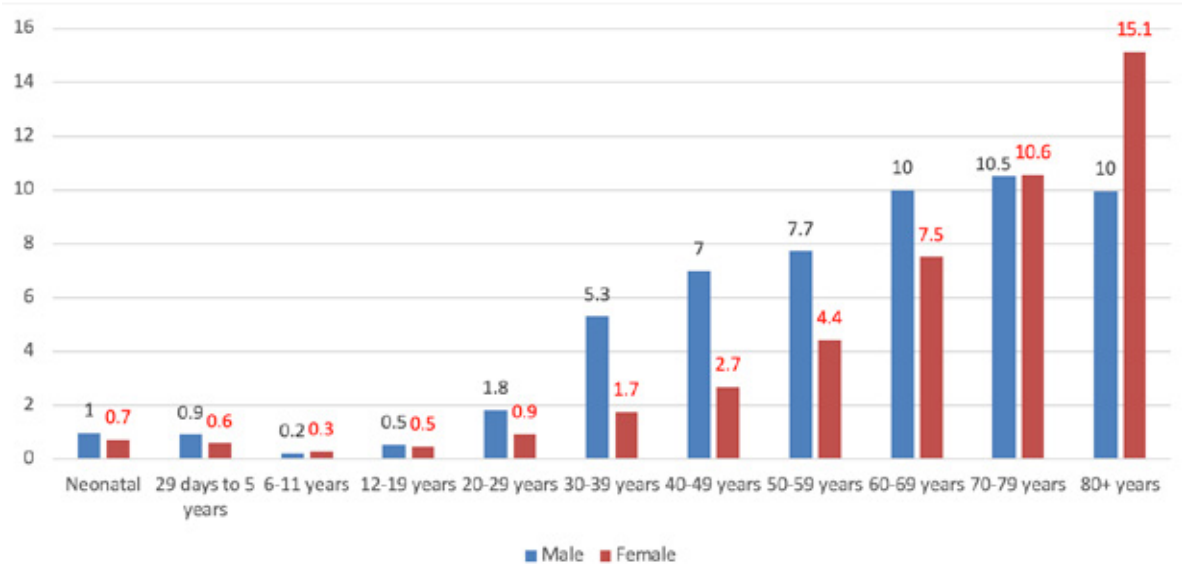


Figure 2. Leading causes of death (%) for all adults, Male (VA data), N=5943

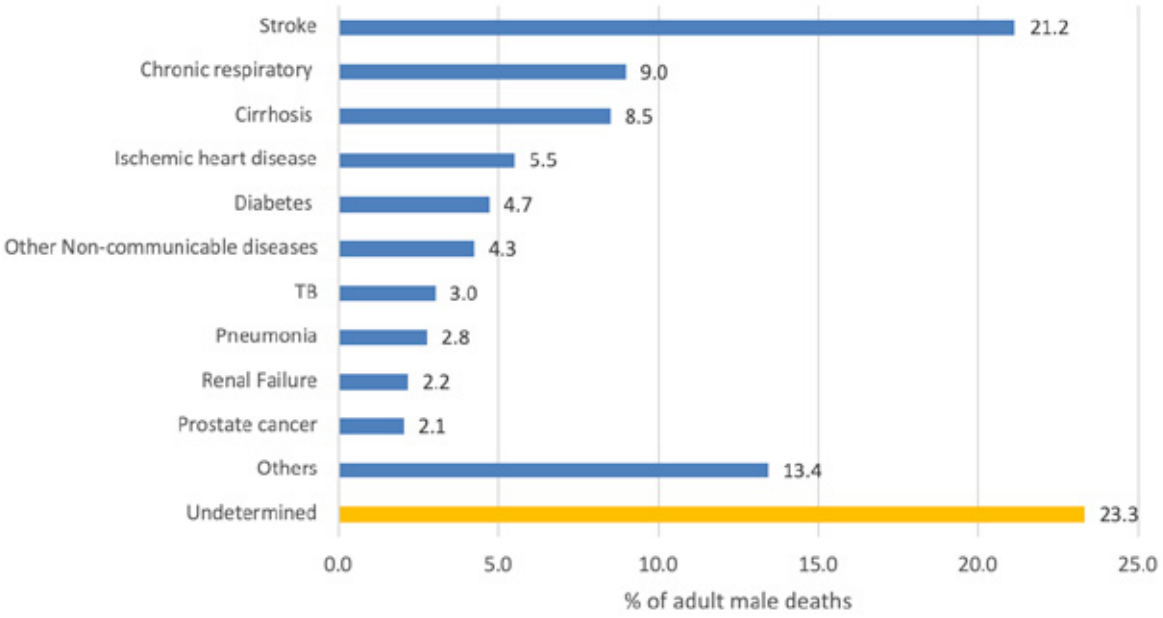


Figure 3. Leading causes of death (%) for all adults, Female (VA data), N=4881

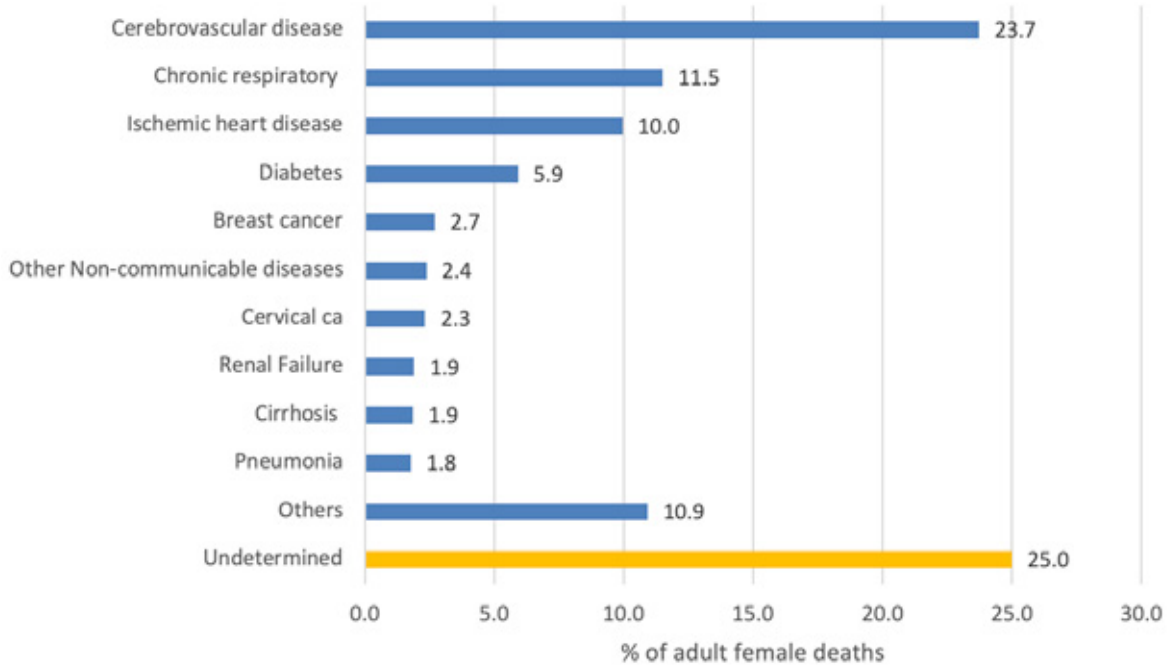


Figure 4. Leading causes of death (%) for 45 to 64-year age group, male (VA data), N=1830

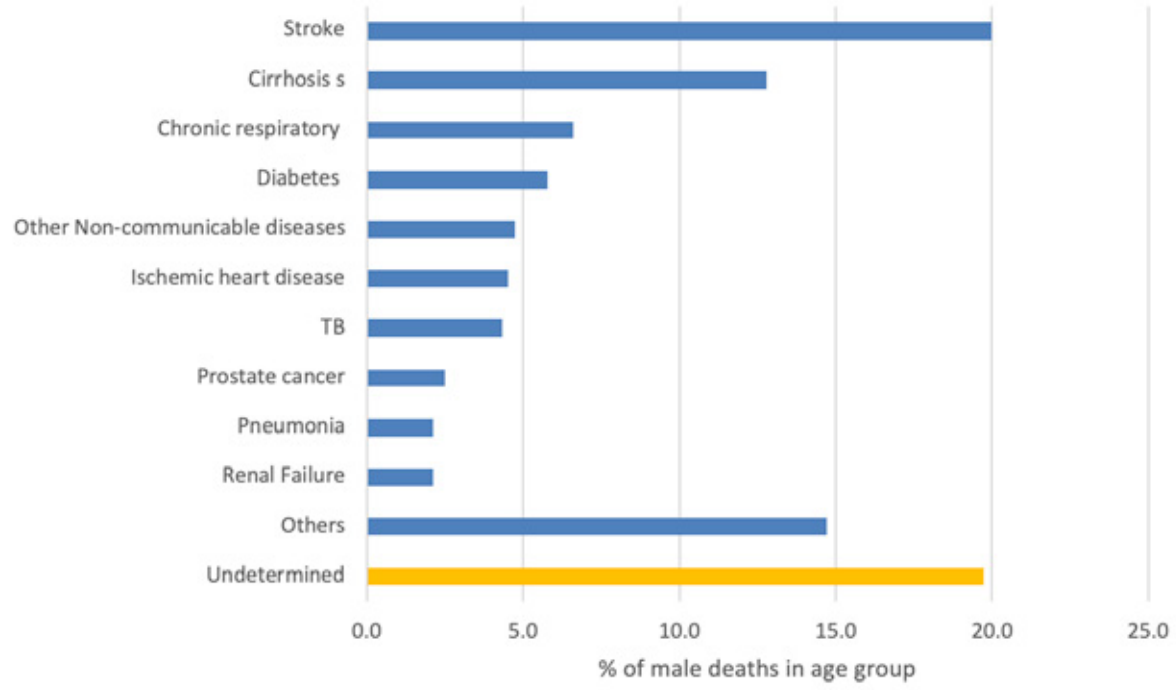


Figure 5. Leading causes of death (%) for the 45 to 64-year age group, female (VA data), N=1037

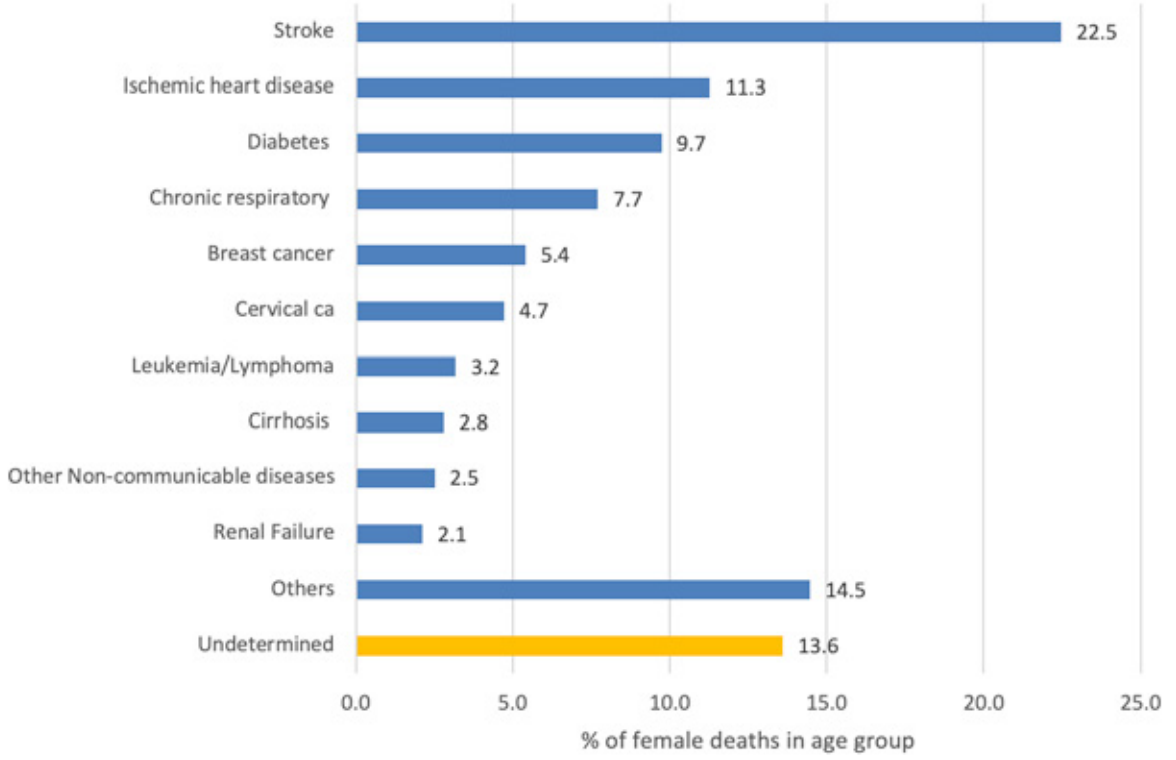


Figure 6: Leading causes of death (%) for the 65 to 74-year age group, male (VA data), N=1174

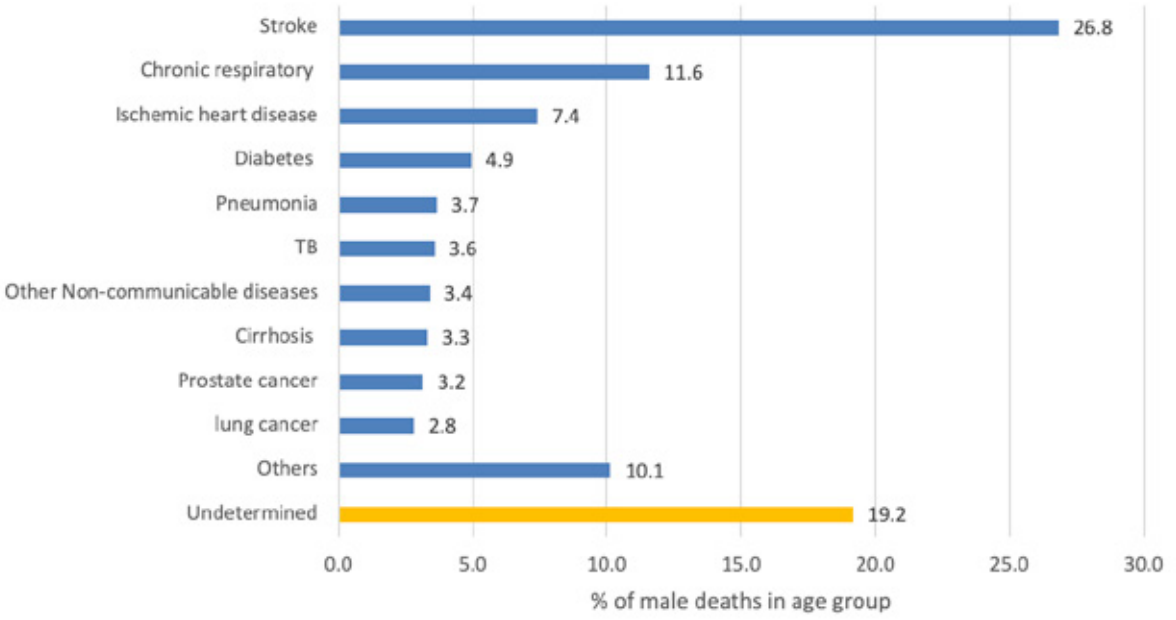


Figure 7: Leading causes of death (%) for the 65 to 74-year age group, female (VA data), N=988

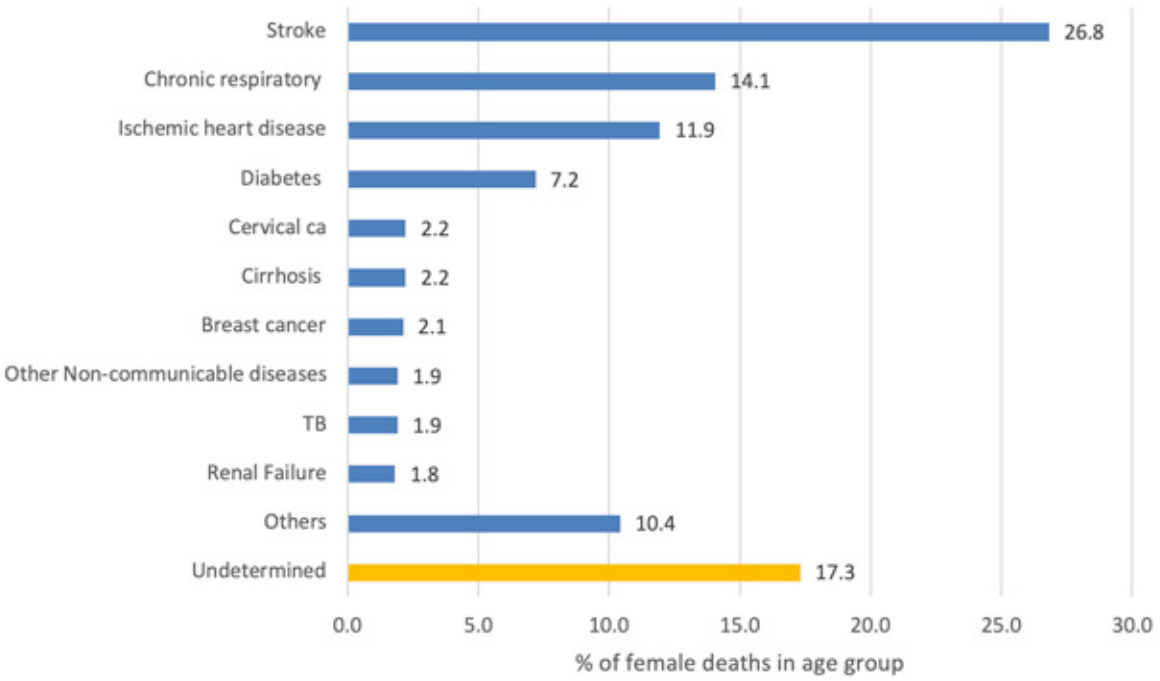


Figure 8: Leading causes of death (%) for 75+ years age group, male (VA data), N=1741

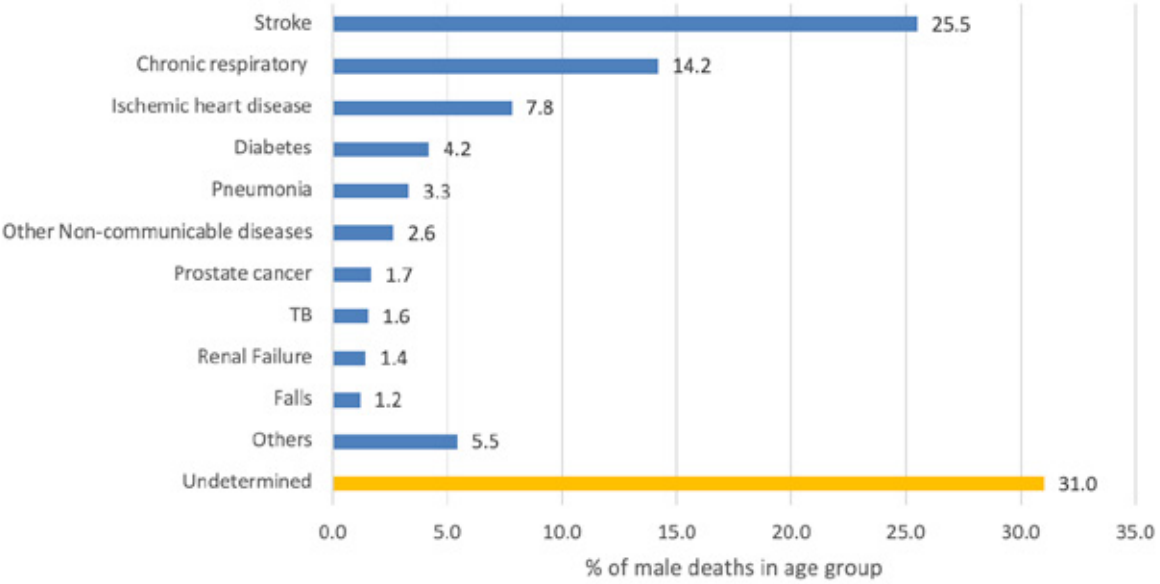


Figure 9: Leading causes of death (%) for 75+ years age group, female (VA data), N=2374

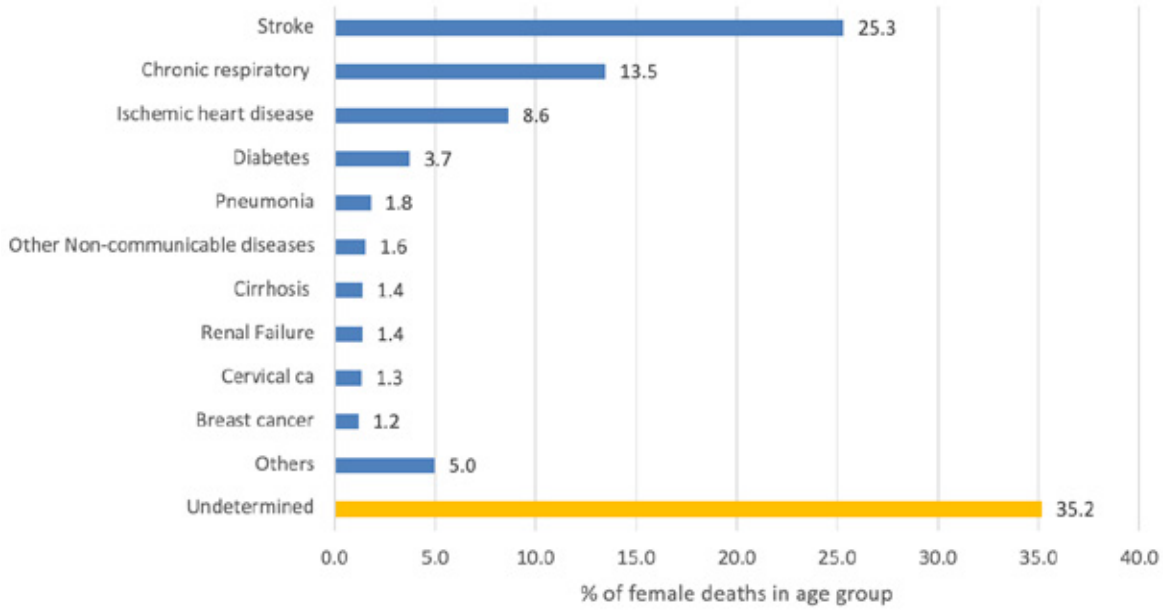


Figure 10. Comparison of death distribution of VA and GBD, male (%)

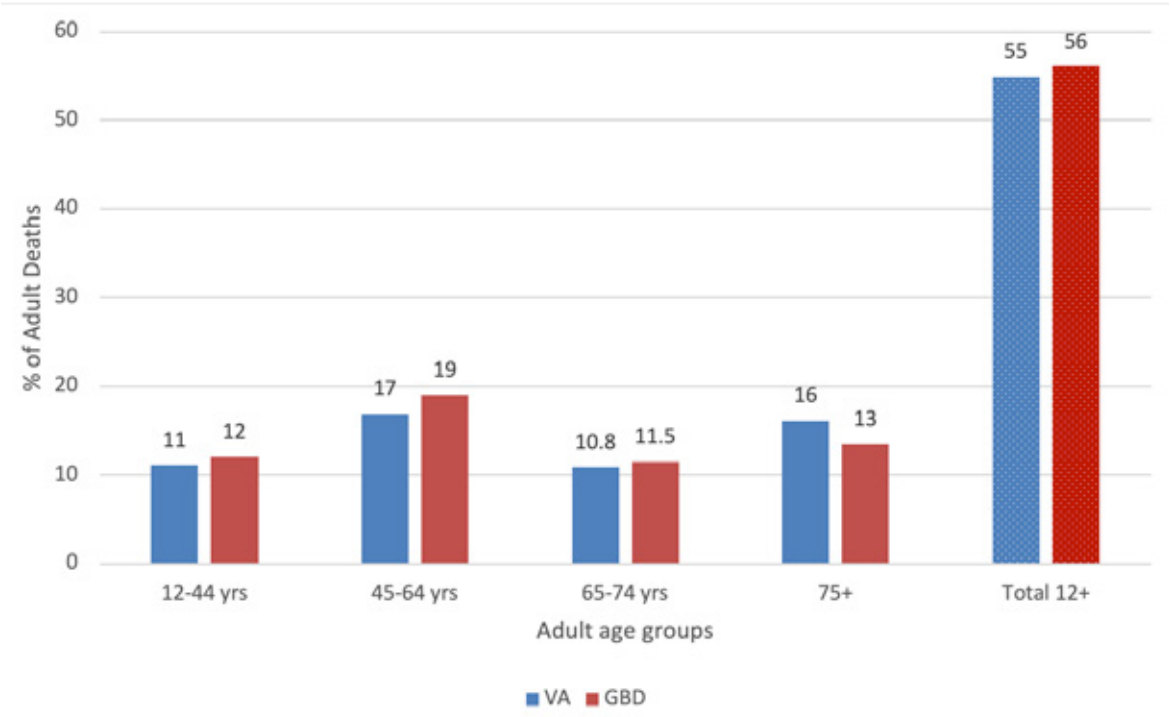
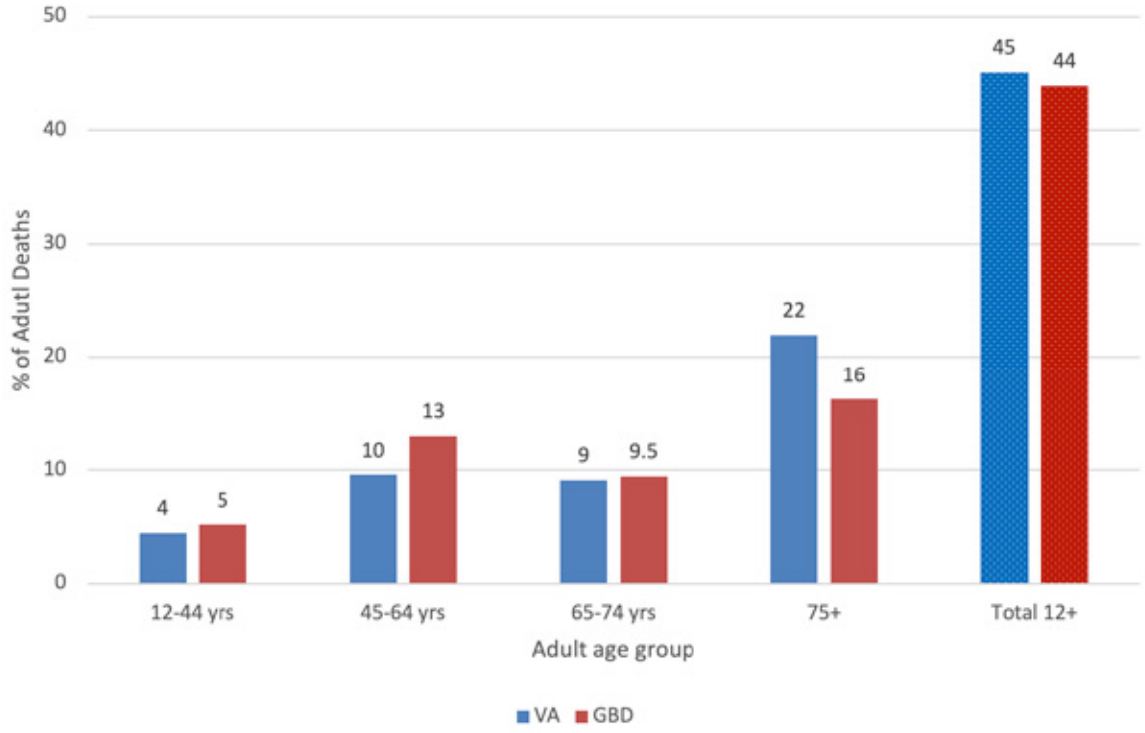


Figure 11. Comparison of death distribution of VA and GBD, female (%)



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