CO-AG NUMBER: NU2GGH001150
CO-AG NAME: SOUTH AFRICAN MEDICAL RESEARCH COUNCIL

SOUTH AFRICAN

# NATIONAL CAUSE-OF-DEATH VALIDATION PROJECT:

## REPORT 2 | UNDERLYING CAUSE OF DEATH BASED ON A SAMPLE OF MEDICAL RECORDS FROM PUBLIC SECTOR HOSPITALS AND FORENSIC PATHOLOGY SERVICE MORTUARIES

SAMRC Burden of Disease Research Unit | November 2022

CDC Centers for Disease Control and Prevention
Bloomberg Philanthropies
DATA FOR HEALTH INITIATIVE
GeoSpace measure it. manage it.
saMRC advancinglife

South African National Cause-of-Death Validation Project:
Underlying cause of death based on a sample of Medical Records from Public Sector Hospitals and Forensic Pathology Service Mortuaries

**SUGGESTED CITATION**

Groenewald P, Nannan N, Joubert JD, Maqungo M, Funani N, Glass T, Cheyip M, Zinyakatira N, Awotiwon O, Nojilana B, Kallis N, Anthony A, Akhalwaya Y, Bezuidenhout F, Martin L, Kahn K, Price J, Lombard C, Morof D, Nichols E, Rao C, Bradshaw D. South African National Cause-of-Death Validation Project: Underlying cause of death based on a sample of Medical Records from Public Sector Hospitals and Forensic Pathology Service Mortuaries. Cape Town: South African Medical Research Council, 2022.

**COLLABORATORING ORGANISATIONS**

South African Medical Research Council, Statistics South Africa, National Department of Health, Department of Home Affairs, Centers for Disease Control and Prevention, South African Funeral Practitioners Association and National Funeral Directors Association

**PRINCIPAL INVESTIGATORS**

Prof Debbie Bradshaw, Dr Pam Groenewald, Dr Jané Joubert, Dr Nadine Nannan

**CO-INVESTIGATORS**

Prof Chalapati Rao, Ms Cherie Cawood, Dr Estevão Afonso, Mr Francois Bezuidenhout, Dr Jessica Price, Prof Johan Dempers†, Dr Kassahun Ayalew, Prof Kathleen Kahn, Prof Lorna Martin, Dr Megan Prinsloo, Ms Mireille Cheyip, Dr Nadine Nannan, Mr Nesbert Zinyakatira, Prof Sam Clark, Dr Tshilidzi Muthivhi, Mr Thabo Molebatsi

**TECHNICAL ADVISORS**

Dr Beatrice Nojilana, Prof Carl Lombard, Dr Diane Morof, Dr Erin Nichols, Dr Frank Odhiambo, Dr Ian Neethling, Dr Lyn Hanmer, Ms Mmamokete Mogoswane, Ms Mosidi Nhlapo, Prof Sam Notzon, Ms Sizzy Ngobeni, Dr Oluwatoyin Awotiwon, Dr Victoria Pillay-van Wyk

**CLINICIAN REVIEW PANEL**

Dr Patricia Maud, Dr Tiana Schultz, Dr Yasmeen Akhalwaya, Dr Natasha Kallis, Dr Adele Anthony, Dr Chantelle Holmgren, Dr Anastasia Rossouw, Dr Elschke Klinkert, Dr Tania Engel, Dr Bjorn Swiegelaar, Dr Stephen Afonso, Dr Celeste Heatlie

**PROJECT COORDINATORS**

Dr Monique Maqungo and Ms Noluntu Funani

**IMPLEMENTATION PARTNERS**

Phase 1: Epicentre Health Research
Phase 2: GeoSpace International

**FUNDING**

This study has been supported in part by the President's Emergency Plan for AIDS Relief (PEPFAR) through the Centers for Disease Control and Prevention (CDC) under the terms of Cooperative Agreement SAMRC-CDC CoAG 1U2GGH01150. It has also been supported by the Bloomberg Philanthropies Data for Health Initiative through the CDC Foundation Civil Registration and Vital Statistics Project, and the South African Medical Research Council.

**DISCLAIMER**

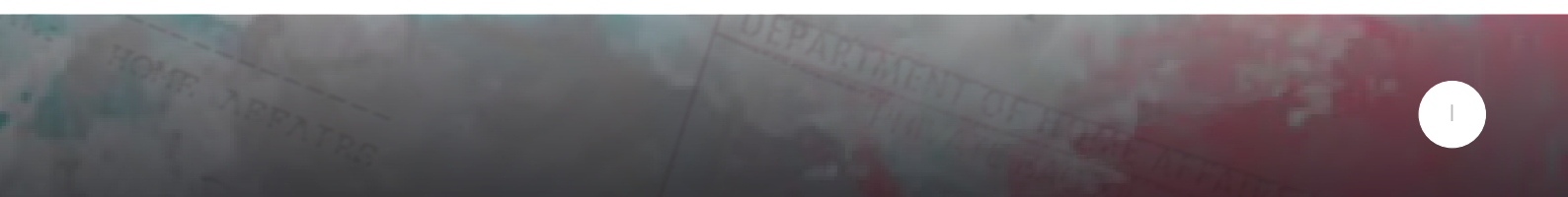
The content of the report is that of the authors and do not necessarily represent the official position of the funding agencies, the South African Medical Research Council, the Centers for Disease Control and Prevention, the CDC Foundation, or the Bloomberg Philanthropies Data for Health Initiative.

**ACKNOWLEDGEMENTS**

The fieldwork team from Geospace is thanked for their dedicated efforts to collect the data from facilities across South Africa. Ms Natashia Morris of the SAMRC Biostatistics Unit is thanked for the maps that she created for the project. Ms Patricia Woods, formerly of Statistics Canada, is thanked for her advice on the coding of maternal causes of death as well as some other challenging cases. The contribution to the study by co-investigator Professor Johan Dempers† was sadly cut short by his untimely death resulting from COVID-19.



A copy of this resource is available at: *www.mrc.ac.za/bod/reports.htm*



# CONTENTS

## List of Tables

## List of Figures

# Abbreviations and Acronyms

| | | |
|---|---|---|
| AIDS | - | Acquired immune deficiency syndrome |
| ANACONDA | - | Analysis of Causes of (National) Death for Action |
| CDC | - | Centre for Disease Control and Prevention |
| CI | - | Confidence interval |
| COD | - | Cause of death |
| COPC | - | Community oriented primary care |
| COMCATs | - | Circumstances of mortality categories |
| CRVS | - | Civil Registration and Vital Statistics |
| CSMF | - | Cause specific mortality fraction |
| DHA | - | Department of Home Affairs |
| DNF | - | Death notification form |
| FP | - | Funeral Parlor |
| FPS | - | Forensic Pathology Services |
| HDSS | - | Health and demographic surveillance site |
| HIV | - | Human immunodeficiency virus |
| HPCSA | - | Health Professions Council of South Africa |
| ICD | - | International Classification of Diseases and Related Health Problems |
| QA | - | Quality assurance |
| QAAO | - | Quality Assurance Assessment Officers |
| MCCOD | - | Medical certificate of cause of death |
| MIA | - | Minimally invasive autopsy |
| MR | - | Medical record |
| NBD | - | National burden of disease |
| NCODVP | - | National cause-of-death validation project |
| NOK | - | Next of kin |
| ODK | - | OpenDataKit |
| SA ID | - | South African Identification Number |
| SA NBD | - | South African National Burden of Disease Study |
| SA NCOD | - | South African National Cause-of-Death |
| SAMA | - | South African Medical Association |
| SAMRC | - | South African Medical Research Council |
| SDG | - | Sustainable Development Goals |
| SES | - | Socio-economic status |
| Stats SA | - | Statistics South Africa |
| TB | - | Tuberculosis |
| UCOD | - | Underlying cause of death |
| USID | - | Unique study identification |
| VA | - | Verbal autopsy |
| WBOTS | - | Ward based outreach teams |
| WHO | - | World Health Organization |

# GLOSSARY

**Aggregation of causes of death**

The analysis of the causes of death in this report makes use of the 10th revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10). This is a standardized medical classification list by the World Health Organization (WHO), updated in 2016. It classifies diseases and related health problems into 22 chapters, of which 19 are used in the reporting of information on underlying causes of death. (Available at *https://icd.who.int/browse10/2016/en*).

A basic National Burden of Disease (NBD) list, aligned to the South African National Burden of Disease list (available at *https://www.samrc.ac.za/sites/default/files/files/2016-07-04/SANBDReport.pdf*), has been developed for the analysis of the data. The basic NBD list does not make any assumptions about misclassification of causes and includes categories for ill-defined conditions (see Table 22 in Annexure 8.4).

A number of lists of aggregated causes have been developed for working with verbal autopsy data. This report uses the 2016 cause of death list for verbal autopsy comprising 64 causes mapped onto ICD-10. (Available at *https://www.who.int/healthinfo/statistics/verbalautopsystandards/en/*). The mapping is shown in Table 23 in Annexure 8.4.
Further analysis has been done by grouping the ICD-10 causes into 3 broad cause groups with an additional category for human immunodeficiency virus/acquired immune deficiency syndrome (HIV/AIDS) and Tuberculosis (TB) as has been used in the South African Burden of Disease studies.

These are: -

| Type | Broad cause group |
|---|---|
| 1 | HIV/AIDS and TB |
| | Other infections |
| 2 | Non-communicable diseases |
| 3 | Injuries. |

**Cause of death sequence**

The cause of death sequence is the chain of events leading directly from the underlying cause to the immediate cause of death.

**Community Oriented Primary Care**

Community oriented primary care (COPC) is a strategy whereby elements of primary health care and of community medicine are systematically developed and brought together in a coordinated practice.

**DHA-1663**

Also known as the death notification form, this 4-page document is printed by the Department of Home Affairs (DHA) for registration of a death. The first 3 pages include details about the decedent, the informant, the certifying doctor and the funeral undertaker. The last page, labeled Pg 1 of 1 is completed by the certifying doctor and includes the medical certificate of cause of death. In the case of a peri-natal death, the format of the medical certificate of cause of death is different to ensure information about the mother's condition is captured.

### Death

The permanent disappearance of all evidence of life at any time after a live birth has taken place, or postnatal cessation of vital functions without capability of resuscitation. This definition excludes fetal deaths i.e. stillbirths (see definition below). This study inadvertently included some stillbirths which have been described separately in the report.

### Decedent/deceased

Persons who died in South Africa and whose body has been taken to a designated funeral parlor registered with the DHA, or whose body has been prepared for burial or cremation by a funeral undertaker, or whose death has been registered directly at a local DHA office by a next of kin/ caregiver/friend of the decedent. Foreigners who died in the country were included in the study when an adult (18 years+) next of kin/caregiver/friend, could be contacted within the study timeframe and could speak English or any of the nine most common South African official languages into which verbal autopsy questions were translated.

### ICD-10

The International Statistical Classification of Diseases and Related Health Problems (ICD) is a classification and coding system developed by the WHO and defines the universe of diseases, disorders, injuries and other related health conditions, listed in a comprehensive, hierarchical fashion. The 10th revision, updated in 2016, is currently used as the international standard for reporting diseases and health conditions and can be found online. The next revision of ICD has been completed and it is anticipated that over the next few years, ICD-11 will be adopted.

### Injury death

Deaths due to injuries (external causes) are required by law in South Africa to undergo a post-mortem investigation at Forensic Pathology Services to determine culpability and cause of death.

### International Form of Medical Certificate of Cause of Death

The ICD has outlined principles for certifying the medical cause of death and the rules for coding which are essential for standardizing cause of death statistics. This starts with the form that has a specific layout and needs to be completed in a specific way to ensure that the underlying cause of death can be identified.

The sequence of the causes of death from the underlying cause to the immediate cause should be reported in part I of the form with immediate cause shown in line a). Other conditions that contributed to the death should be reported in part II.

| | Cause of death | Approximate interval between onset and death |
|---|---|---|
| I | | |
| Disease or condition directly leading to death* | a) ..... | ..... |
| | due to (or as consequence of) | |
| **Antecedent causes** | (b) ..... | ..... |
| | due to (or as consequence of) | |
| Morbid conditions, if any, giving rise to the above causes, stating the underlying condition last | (c) ..... | ..... |
| | due to (or as consequence of) | |
| | (d) ..... | ..... |
| II | | |
| Other significant conditions contributing to the death, but not related to the disease or condition causing it | ..... | ..... |
| | ..... | ..... |
| ** This does not mean the mode of dying, e.g., heart failure, respiratory failure. It means the disease, injury, or complication that caused death.* | | |

**Iris**

Iris is an automated system for coding multiple causes of death and for the selection of the underlying cause of death based on the ICD-10 coding rules. It can be used in batch or interactively.

**InterVA**

InterVA is a suite of computer models to facilitate interpreting verbal autopsies towards generating a probable cause of death, using a Bayesian approach. The latest version InterVA-5 has been used in this project.

**Manner of death**

According to ICD-10, the manner of injury deaths captures the intent, namely, homicide, suicide, accident, natural, or undetermined. In this study, we divide the accidental category into transport and other unintentional.

**Medical doctor/physician**

A medical doctor is a trained health professional who practices medicine, which is concerned with promoting, maintaining, or restoring health through the study, diagnosis, prognosis and treatment of disease, injury, and other physical and mental impairments. The term medical doctor is used interchangeably with physician in this report.

**Multiple causes of death**

When coding and classifying causes of death, you must first assign ICD codes to all the conditions reported on the death certificate. Many coding instructions are based on specific ICD codes and, to determine whether any of the instructions apply, you need to know the ICD codes for all conditions on the certificate. This is called multiple-cause coding.

**Next of Kin (NOK)**

The deceased's close living relatives are known as the next of kin and in this report, the informant is the person who reported the death to the DHA.

**Ninety-five percent confidence interval (95% CI)**

The 95% confidence interval represents the sampling variability around an estimate. A 95% confidence interval (CI) of a statistic is a range with an upper and lower number calculated from a sample that describes possible values that the true statistic could be. If multiple samples were drawn from the same population and a 95% CI calculated for each sample, we would expect the population statistic to be found within 95% of these CIs.

**Stillbirths**

The definition recommended by WHO for international comparison is a baby born with no signs of life at or after 28 weeks' gestation. A **fresh stillbirth** is defined as the intrauterine death of a fetus during labor or delivery, and a **macerated stillbirth** is defined as the intrauterine death of a fetus sometime before the onset of labor, where the fetus showed degenerative changes.

**Sustainable Development Goals (SDG)**

The Sustainable Development Goals, also known as the Global Goals, were adopted by all United Nations Member States in 2015 as a universal roadmap to end poverty, protect the planet and ensure that all people enjoy peace and prosperity by 2030. Cause of death data are a prerequisite to measure several indicators.

**Underlying cause of death (UCOD)**

The underlying cause of death, from a public-health point of view, is considered the most informative cause-of-death-data element, and therefore was designated the cause of death for primary tabulation and comparisons. From the perspective of prevention of death, "it is necessary to break the chain of events or to effect a cure at some point. The most effective public health objective is to prevent the precipitating cause from operating. For this purpose, the underlying cause has been defined as "(a) the disease or injury which initiated the train of morbid events leading directly to death, or (b) the circumstances of the accident or violence which produced the fatal injury".[1] To properly select the underlying cause of death, coders are taught to apply the ICD rules and instructions to the sequence of causes as indicated on the *International Form of Medical Certificate of Cause of Death*. Automated software developed by the Iris Institute is available to facilitate coding of multiple causes of death and selection of the correct underlying cause.

**Unusable code**

Unusable codes (also referred to as 'garbage codes') are any ICD codes that cannot or should not be considered an underlying cause of death, such as septicemia, senility or headache. They may also be the code for a cause that belongs in some other part of the morbid sequence of events leading to death such as the immediate or intermediate cause; or a cause of death that is insufficiently specified. Essentially, an unusable code is one that has no use in informing public health policy, as the related UCOD is too vague, or simply impossible. Mikkelsen et al (2017) have defined five categories of unusable codes in the Analysis of Causes of (National) Death for Action tool (ANACONDA) tool:

- Category 1 – Symptoms, signs and ill-defined conditions
- Category 2 – Impossible as underlying causes of death
- Category 3 – Intermediate causes of death
- Category 4 – Immediate causes of death
- Category 5 – Insufficiently specified causes within ICD chapters.

**Verbal autopsy (VA)**

A method of determining an individual's probable cause/s of death using a trained interviewer to administer a questionnaire during a face-to-face or telephonic interview to collect information about the signs, symptoms, treatment, and demographic characteristics of a recently-deceased person from another individual – ideally a close caregiver or family-member – with knowledge about the deceased during his/her terminal illness/event.

**Ward Based Outreach Teams (WBOTS)**

A team of community health workers (10-20) with a team leader (professional or enrolled nurse) who are responsible for primary health care service delivery in a defined municipal ward comprised of about 200 households.

# Executive summary

## South Africa National Cause-of-Death Validation Project (NCODVP)

South Africa has a well-established Civil Registration and Vital Statistics (CRVS) system with a high proportion of deaths being registered. The quality of the cause of death statistics, however, is considered sub-optimal with a high proportion of ill-defined causes. In addition, there is extensive underreporting of HIV as an underlying cause of death.

The South African National Cause of Death Validation Project (NCODVP) was implemented by the South African Medical Research Council (SAMRC) and partners to validate CRVS cause-of-death information by linking CRVS data to data obtained from medical records (MRs), forensic pathology service (FPS) records, and verbal autopsy (VA) interviews for a national sample of deaths. The main purpose of the study was to compare the underlying cause of death from the CRVS with the highest level of information collected in the study (FPS record followed by MR and VA) so that correction factors could be estimated to derive cause-of-death profiles that are adjusted for the poor-quality information. Additionally, the study aimed to compare the medical cause of death identified from the different sources to assess their performance in identifying cause of death. The study protocol was reviewed and approved by the SAMRC Ethics Committee. This project was reviewed in accordance with CDC human research protection procedures and was determined to be research, but CDC investigators did not interact with human subjects or have access to identifiable data or specimens for research purposes. Support was obtained from the National Department of Health (NDOH) and permissions were obtained from each provincial Department of Health and health facility included in the study.

## Purpose of this report

- This is the second report of three and provides a summary of the rationale, aims and objectives of the study and gives details about the methodology for the collection and processing of MRs from the public-sector hospitals and FPS mortuaries serving 27 subdistricts, randomly selected using pseudo stratification by socio-economic status within each province, to provide a national sample. The report includes the initial analysis of the medical and Forensic Pathology Services records including an evaluation of the quality of the cause of death information provided.
- This report follows the *first project report* which provided detailed information on the study rationale, aims and objectives together with the initial findings from the national sample of verbal autopsies. A third report is planned once the data collected in the study have been linked to the CRVS data and fully analyzed.

## Study design and method

A sample size of >13,000 deaths from 27 randomly selected sub-districts across the country was assessed to provide sufficient precision for the correction factors for deaths caused by four selected conditions including HIV, cerebrovascular disease, diabetes mellitus, and interpersonal violence (homicide). Originally planned as a fixed 3-month census of deaths registered in sub-districts during the period 1 September 2017 to 30 November 2017, the study period needed to be extended to nearly 8 months (1st September 2017 to 13th April 2018) due to low recruitment of next of kin for verbal autopsy interviews in the first phase of the study.

Fieldwork started in August 2018 following a 3-week national training and was completed in March 2019. Once permission was obtained to collect data in a facility, the team leaders requested a list of all decedents (all ages) who had passed away during the study census period and access to their patient records. The fieldworkers allocated a unique study identity (ID) number to each decedent and captured basic details into a customized KoBoTool questionnaire. They then anonymized and scanned the records and uploaded them against the unique study ID. Quality assurance (QA) involved daily review of the hospital and FPS records, ensuring that records were correctly de-identified and numbered, and weekly review by the project team to monitor the ongoing quality.

Clinician reviewers who had experience in reviewing verbal autopsy interviews were re-orientated to review MRs and to complete a medical certificate of cause of death. Additional doctors with training in forensic pathology were recruited and trained to review FPS records and certify the cause of death. Records were batched and shared with clinician reviewers on a private access Microsoft TEAMS platform. On completion, QA reviewers selected a 10% sample of the records. If there were any concerns about the underlying cause, the whole batch was reviewed by a QA reviewer and feedback was provided to the clinician reviewer. In addition, all the forensic records were checked to ensure that the certification of cause of death included the circumstances of the death as well as the manner of death. Any record with unknown underlying cause of death was reviewed against the forensic record to ensure that no information had been missed.

The medical certificates were coded to ICD-10 using Iris automated software to provide multiple cause and underlying cause of death codes (4-digit). Certificates that were rejected by the automated software were manually coded by members of the research team. Data cleaning was done with a focus on ensuring the ID numbers were correct and duplicate records removed. Anomalies in age, sex and cause of death were reviewed and a decision made based on a relook at the record and data submitted by the reviewer.

### Response rate

Data obtained from the DHA indicated that 36,970 deaths were registered with place of occurrence in the 27 sampled sub-districts during the study census period 1 September 2017 – 13 April 2018. A total of 5,375 verbal autopsies were successfully conducted, and 17,625 MRs and 5,752 FPS records collected. In total, information was collected for 26,514 decedents yielding a ratio of 72% relative to the target population of registered deaths and well over the number of deaths identified in the sample size determination.

A total of 10,132 MRs were reviewed, accounting for 57.5% of the records collected, focusing on deaths that occurred in 2017 or had a verbal autopsy interview conducted in 2017 or 2018. Forty stillbirths were identified and reported separately. A total of 5,460 FPS records were reviewed accounting for 94.9% of the 5,752 records collected which included some duplicate records and some MRs. There were 145 FPS cases excluded from further analysis as they either had no information or for specific reason such as non-viable fetus or stillbirth, skeletal remains etc. leaving a total of 5,315 deaths. The balance of the MRs and FPS records will be archived securely and made available for further analysis or under a new study with appropriate ethics approval.

### Medical and FPS record results

The quality of information was subjectively rated good to excellent in 77.5% of the MRs reviewed and only 22.4% of the records were rated to have poor or very poor information. The level of certainty of the UCOD, assessed based on how the diagnosis of multiple causes was made (clinical suspicion, medical history, clinical findings and or confirmatory diagnostics tests), was rated adequate to excellent in 84.5% of cases and 15.0% were considered poor or very poor. A high proportion of the causes (74.4%) were coded to usable codes, indicating good quality certification. However, 18.3% of the causes are considered to have insufficient specification within an ICD chapter, indicating that there are gaps in the information available in a MR.

The quality of information was rated good to excellent in 78.3% of the FPS records reviewed based on the consistency of the information and the reviewer's assessment. Only 14.2% of the records were rated to have poor or very poor information. A very high proportion of the causes (80.6%) were coded to usable codes and 13.9% of the causes are considered to have insufficient specification within an ICD chapter, indicating that there are gaps in the information available in an FPS record. The age sex profile of the MRs was similar to that of the Statistics South Africa (Stats SA) hospital deaths for 2017. However, the cause of death profile based on the sample of MRs had a much higher proportion of HIV/AIDS and stroke deaths than the Stats SA hospital deaths and a much lower proportion of ill-defined cardiovascular causes. In addition, compared with

the Stats SA hospital deaths, there were higher proportions of specified external causes of deaths among the injuries and a much lower proportion of injuries with undetermined intent in the MRs sample.

The age sex profile of the FPS unnatural deaths followed the same pattern as that of the Stats SA 2017 unnatural deaths, although the mode for male deaths was slightly older in the FPS sample. The manner of injury death profile was very different (Table ES1). Other unintentional injuries accounted for a very high proportion of the Stats SA injury (about 70%) compared with only 11.1% in the FPS deaths from unnatural causes. In contrast, the FPS sample has much higher proportions of deaths due to homicide, suicide and transport related injuries.

*Table ES1: Manner of injury death based on Forensic Pathology Services records (N=4,352) from the South African National Cause-of-Death Validation Project 2017/18 and Statistics South Africa injury deaths (N=51,023), 2017.*

| Manner of death | NCODVP FPS unnatural deaths | Stats SA 2017 injury deaths |
|---|---|---|
| Homicide | 34.7% | 15.0% |
| Suicide | 14.7% | 0.7% |
| Transport | 32.6% | 11.6% |
| Other unintentional | 11.6% | 69.3% |
| Undetermined intent | 6.3% | 3.3% |
| **Total** | **100.0%** | **100.0%** |

NCODVP – National Cause-of-Death Validation Project; FPS – Forensic pathology service; Stats SA – Statistics South Africa

## Key findings and recommendations

- This component of the project has demonstrated the feasibility of a national collection of copies of medical and FPS records from public health facilities to provide clear images for review by clinician reviewers to identify the cause of death.
- High proportions of the records resulted in usable codes for the identified underlying cause of death, 74.4% of MRs and 87.5% of FPS records, indicating that good quality cause of death could be derived from the records.
- The study has demonstrated that HIV/AIDS was measurable as the underlying cause based on MRs. The proportion identified in the sample of MRs was much higher than that reported in the hospital deaths in 2017 Stats SA data (32.9% vs 8.8%). In addition, a lower proportion of ill-defined natural causes was obtained from the sample of MRs than the full 2017 Stats SA data (3.3% vs 13.3%).
- The sample of FPS records provided extremely high-quality information about causes of injury deaths. While the underlying cause of death of 87.5% of the unnatural deaths were considered usable, the remainder, a relatively small proportion (12.5%), were considered insufficiently specified within the ICD chapter. The lack of complete information might be related to lack of feedback of the outcome of an inquest to determine the cause of death and the outcome of an inquest is generally not added to the FPS record.
- During the clinical review of records, the reviewers flagged treatment and management concerns in about 15% of the MRs. The most common issue was around record keeping (51%), an important standard of care required to ensure continuity of care. About 35% of the concerns resulted from indications that patients were not fully investigated in the work-up to make a diagnosis and decide on appropriate treatment. Some records had very limited clinical history or evidence of investigations.

## Recommendations

- Given the concerns related to COD that have been noted in the Stats SA cause of death profiles, it is important to complete the data linkage with CRVS, develop analysis weights and estimate correction factors, so that corrected cause of death profiles can be obtained, the main objective of the study.
- In addition, we have identified several improvements that can be implemented in the meanwhile:-
    - The resources that were developed to train doctors in medical certification have been developed into a free *online training platform* that provides continuing professional development credits following an assessment. The resource needs to be disseminated in a national effort to improve the quality of medical certification involving NDOH, Stats SA, SAMRC, South African Medical Association (SAMA), the Health Professionals Council for South Africa (HPCSA) and the Health Sciences Faculties.
    - Stats SA could consider providing the 4-digit ICD-10 code for underlying cause of death in public domain data set to enable more detailed analysis of the data.
    - In order to improve the quality of information about the external cause of injuries in the Stats SA data, it is essential to amend the DHA-1663 to include a field for information about the manner of death.
    - The study has highlighted some concerns about standards in record keeping. Although the HPCSA guideline includes some basic standards for MRs, it would be useful to promote the use of some more detailed guidelines.
    - Large numbers of deaths occur in health facilities and FPS. It would be helpful if there were a system to routinely capture this information in the facility and provide information to NDOH. It would provide a measure of health outcomes which is currently missing.

# 1. Introduction

## 1.1 Cause-of-death data in South Africa

As outlined in the first report of the National Cause-of-Death Validation Project,[2] the ideal source of a country's mortality data is a well-functioning, national, full-coverage civil registration and vital statistics (CRVS) system with high levels of completeness of death registration, thorough ascertainment of the cause/s of death by medical doctors well-trained in the medical certification of the cause of death, and timely-published vital statistics reports.[3-5]

The 2030 Agenda for Sustainable Development[6,7] clearly illustrates the importance and advantage of countries having a national CRVS system in that 67 of 230 proposed indicators to monitor progress in 12 of the 17 total Sustainable Development Goals (SDG) can be measured from data derived from well-functioning CRVS systems. The prominence of mortality reduction among the health-related SDGs has intensified countries' need for robust national mortality measurements to monitor levels and causes of mortality.[8]

Currently, South Africa houses a well-functioning, inter-operable civil registration, vital statistics and identity management system, settled within a legal framework provided by the Births and Deaths Registration Act (Act no 51 of 1992).[9] Despite improvements in death registration, major challenges remain with the way that doctors complete the medical certificate of the cause/s of death and the consequent quality of cause-of-death information. These include a high proportion of deaths with ill-defined causes (13%), and an additional 13% having a cause of death not valid as an underlying cause in 2016,[10] under-reporting and misclassification of HIV deaths and an inaccurate profile of injury deaths[11] (for example accidental gun deaths are too high and homicides are too low).

Over the past 15 years, between 41% and 48% of annual deaths in South Africa occurred in health facilities[12] where there is an expectation that MRs would be available for the decedent. With more than half of annual deaths occurring outside health facilities, reference sources other than hospital record reviews are required for validation purposes. For injury deaths in South Africa, forensic autopsy records have been shown to provide a suitable reference source for attributing or validating causes of death.[13] For deaths that occur outside health facilities, study results from the Agincourt HDSS have illustrated that verbal autopsies can result in reliable cause-of-death results, despite acknowledged limitations, and that there is potential for verbal autopsy diagnoses to be used as a reference diagnosis for CVRS data.[14,15,85,86]

## 1.2 Rationale for a national cause-of-death validation project

Substantial misclassification of CRVS cause-of-death data have been documented,[11] particularly for HIV, tuberculosis (TB), injuries, and cardiovascular causes, as well as a large proportion of deaths certified with ill-defined/non-specific causes. Moreover, valid cause-of-death data are critical to inform health planning and evaluation of interventions aiming to improve population health and reduce health inequalities. Despite this knowledge, the validity of national CRVS cause-of-death data has not been studied in a nationally representative sample of deaths in South Africa.

A national validation study of cause-of-death statistics is critically important so that deaths due to HIV/AIDS and TB can be accurately quantified, as these have become endemic[16,17] and were major contributors to the rapidly reduced life expectancy seen until 2006,[18-21] and there are alternative mortality data sources that can be used to assess causes of death. These include hospital and forensic pathology records for facility and injury deaths, respectively, and the standardized WHO instruments for conducting verbal autopsies for deaths occurring outside health facilities.

# 2. Aims and Objectives

## 2.1 Aim

The overall aim of the NCODVP is to derive estimates of cause-specific mortality patterns in South Africa in 2017 at national, provincial, and district levels, using civil registration data validated and corrected against cause-of-death data from hospital, forensic, and verbal autopsy records.

## 2.2 Objectives

The study has three interrelated objectives with detailed sub-objectives described in Annexure 8.1.

The broad objectives of the project are:

1. To verify causes of death reported on CRVS death notification forms in a nationally representative sample of deaths occurring within and outside health facilities.
2. To derive correction factors to adjust cause-specific mortality data from CRVS according to reference diagnoses at national, provincial, and district levels.
3. To design and test a standardized methodology for household verbal autopsy for deaths occurring outside health facilities, with a view towards broader implementation within the routine CRVS system.

## 2.3 Purpose of report

Data collection has been completed and data processing and analysis are underway. The first project report outlined the study methodology and described the sample realization. It also presented and discussed initial results from the national sample of verbal autopsies.[2] This second report provides additional methodological details concerning the collection of MRs from a national sample of public sector hospitals and FPS mortuaries, the process of identifying the underlying cause of death by a panel of doctors trained in medical certification of cause of death and data analysis. The report includes basic comparisons of the cause profile with Stats SA hospital deaths and injury deaths respectively. The third report will provide the results from the data linkage with CRVS data.

# 3. Methods

## 3.1 Study design and sample

Full details of the study design, target population, sampling, sample size determination and revised sample are provided in the previous report.[2] Briefly, this was a cross-sectional study using data collected for a fixed-period census of deaths of any age that occurred in a nationally representative sample of health sub-districts in South Africa during part of 2017 and 2018. Families of decedents were recruited through undertakers and later contacted to arrange for a face-to-face verbal autopsy interview with the next of kin/caregiver/friend of the decedent. At the same time, but completely independently, MRs and forensic pathology service (FPS) records were collected from facilities serving the selected areas. Data were reviewed by trained doctors to identify the underlying cause of death. The underlying cause of death reported in the CRVS will be validated against the underlying cause identified through the highest level of evidence collected in the study for each decedent. The forensic pathology information will be considered the highest level of evidence, followed by the MRs, and then the verbal autopsy.

A nationally representative random sample of 27 sub-districts (Figure 1) was selected using pseudo stratification according to socio-economic status (SES) based on the poverty headcount within each province. It was considered that a sample size of 13,000 deaths would provide an adequate estimate of the correction factors being estimated which were anticipated to result in 5,980 hospital deaths in hospital and just over 1,000 forensic pathology deaths (Figure 2).

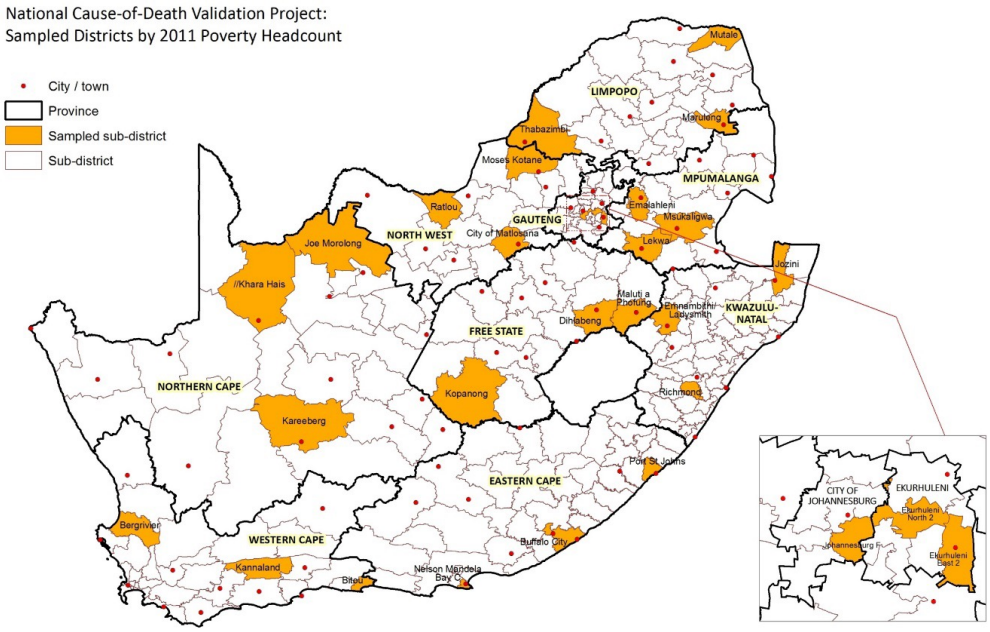



*Figure 1: Map of selected health sub-districts and provincial boundaries, SA NCOD Validation Project 2017/18.*

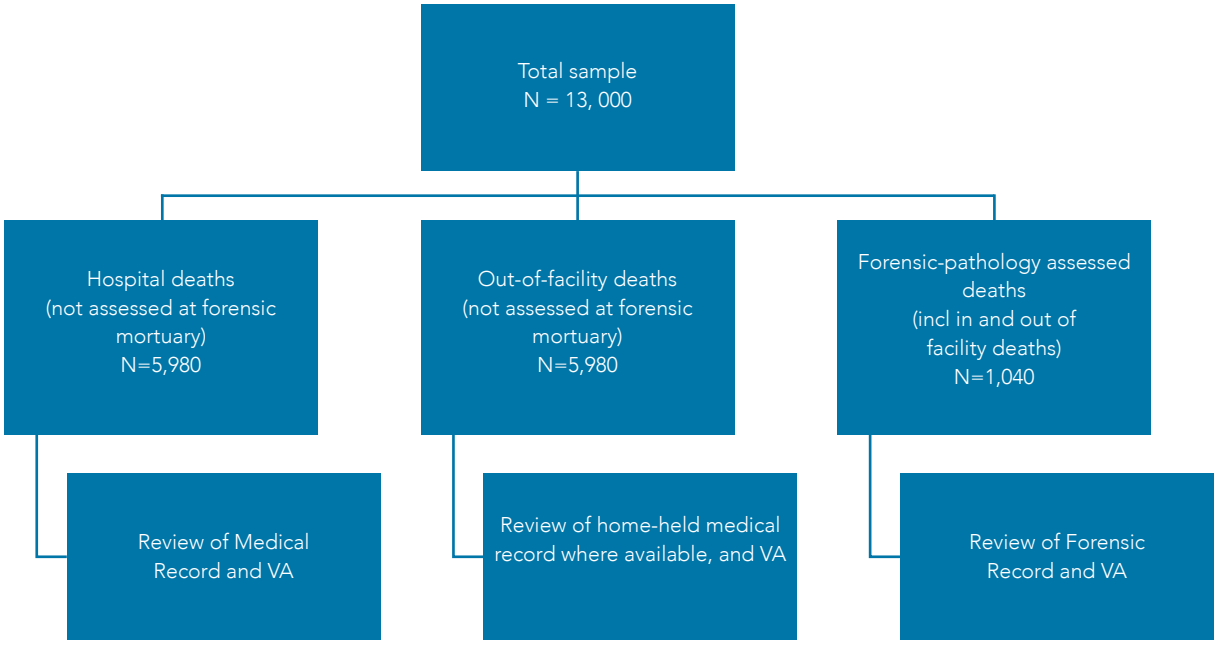



*Figure 2: Graphical presentation of the sampling plan, SA NCOD Validation Project 2017/18.*

The sample plan as per protocol was to collect medical and forensic pathology records for the decedents for whom next of kin had consented. However, given the challenges of the recruitment of next of kin, the protocol was amended to increase the sample size of the decedents who died in a health facility or were referred to forensic pathology services. The protocol was amended to obtain permission from health facilities to collect data from the records of all the deaths that occurred in the identified health facilities and forensic pathology laboratories during the period September – December 2017. It was anticipated that records for 16,000-17,000 deaths would be collected.

In the amended protocol it was noted that although the study will provide invaluable information about the implementation of verbal autopsies, there is a possibility of bias in the data collected for the second validation sub-objective (Annexure 8.1 Objective 1b). It was proposed that, in the analysis of the linked data, it would be necessary to investigate the pattern of non-response during the recruitment for VAs and explore the possibility of doing a post-survey weighting, based on the basic characteristics of the registered deaths that occurred in the sampled areas when calculating the correction factors.

Data obtained from the Department of Home Affairs (DHA) indicated that 36,970 deaths were registered with place of occurrence in the 27 sampled sub-districts during the study census period 1 September 2017 – 13 April 2018 but it is unknown how many of these deaths occurred in health facilities or would have been processed by forensic pathology services.

## 3.2 Data collection for medical records

Digital data collection tools were developed using KoBoToolbox,[22] an open-source secure online/tablet platform set up by the Harvard Humanitarian Initiative for field-data collection in challenging environments. A medical record checklist[i] was set up to capture identification details (name, surname, national identity number, date of birth, and date of death) against a unique study identity number (USID) for deceased hospital patients identified to be eligible for inclusion in the study. Inclusion criteria included a date of death between 1 September 2017 and 30 April 2018, and the hospital being in the selected health sub-districts. Similarly, a forensic pathology checklist[ii] was set up in KoBoToolbox for the deaths in the selected facilities.

Eighty-four fieldworkers were trained from 24 July 2018 – 7 August 2018 in Pretoria. Fieldworker applicants were scored based upon a matrix of education and experience. Graduates were preferred, but matriculants with adequate fieldwork experience were accepted. Experience in fieldwork with digital instruments was ranked as important as education qualifications. Good spoken and written English was a requirement as was multilingualism in any of the South African official languages. Team leaders required a driver's license and older persons with maturity were preferred for this role. A minimum of 50% females was also a requirement for selection.

Each fieldworker was given a tablet that was set up with the data collection tools and fieldworker manuals.[iii] All fieldworkers were trained to capture identifiers from medical and forensic records, de-identify medical and forensic records and scan all records from the last admission before death for MRs and all forensic records relating to the scene of the injury, postmortem results and any laboratory test results. They were also trained in how to use Clearscanner in the classroom prior to the practice on real records later in the training. Following the fieldworker training, the team leaders were taken in groups to a forensic pathology mortuary and a hospital to practice reviewing medical and forensic record folders, and anonymizing and scanning the relevant sections using the ClearScanner application.[23] Since space and time were limited, only team

i *https://www.samrc.ac.za/sites/default/files/attachments/2020-02-17/NCODVP%20Medical%20record%20checklist.pdf*

ii *https://www.samrc.ac.za/sites/default/files/attachments/2020-02-17/Forensic%20record%20checklist.pdf*

iii *https://www.samrc.ac.za/sites/default/files/files/2022-12-07/SAValidationProjectTrainingManual.pdf*

leaders took part in the scanning exercise. A total of 52 MRs and 38 forensic records were anonymized and scanned for practice purposes. These cases were not included in the final dataset. Debriefings were undertaken, and the captured data reviewed to provide feedback to the fieldworkers.

Fieldwork began on the 16th of August 2018 in the Gauteng area so that the field team headquarters (Geospace International) could monitor and provide support. Teams were deployed to the various provinces at the end of August 2018 and a google sheet that could be accessed by the team leads was used for online field scheduling and monitoring progress (Figure 3). Generally, a team comprising four fieldworkers would conduct the verbal autopsies and scan the medical and forensic records for a specific sub-district before moving on to another sub-district. Hospital and Forensic Pathology Mortuary communication was done daily to gain approval and access to the selected facilities to collect data. In some cases where permission to access hospitals or forensic mortuaries was delayed, a different team might have returned to do the record scanning.

Each decedent was allocated a USID. The first digit represented the province, the second and third represented the sub-district and the last four digits were a sequential numbering generated within each sub-district. The fieldworkers captured the USID with the study decedent identifiers from the medical and forensic records including name, surname, date of birth, date of death and South African identity number (SA ID) in the medical and forensic checklists previously described (Figure 3). At the sampled hospitals and forensic pathology mortuaries, fieldworkers captured personal identifiers from relevant medical and forensic records using KoBoToolbox data collection forms for a MR checklist and a forensic record checklist and issued a USID if the decedent did not already have one. To ensure confidentiality, pages from medical and forensic records were anonymized by covering any patient identifiers with sticky notes and labelled with the assigned USID. Imaging was done by fieldworkers using a high-definition camera software application, ClearScanner,[23] using the android tablets. The collected images were stored on the access-controlled device and uploaded daily to the secure access-controlled Dropbox for Business[24] folder.

QA was set up at GeoSpace headquarters with daily review of the hospital and forensic pathology records, ensuring that records were correctly de-identified and numbered. The project team reviewed the data collected on KoBoToolbox on a weekly basis and any issues were discussed with the field team manager.

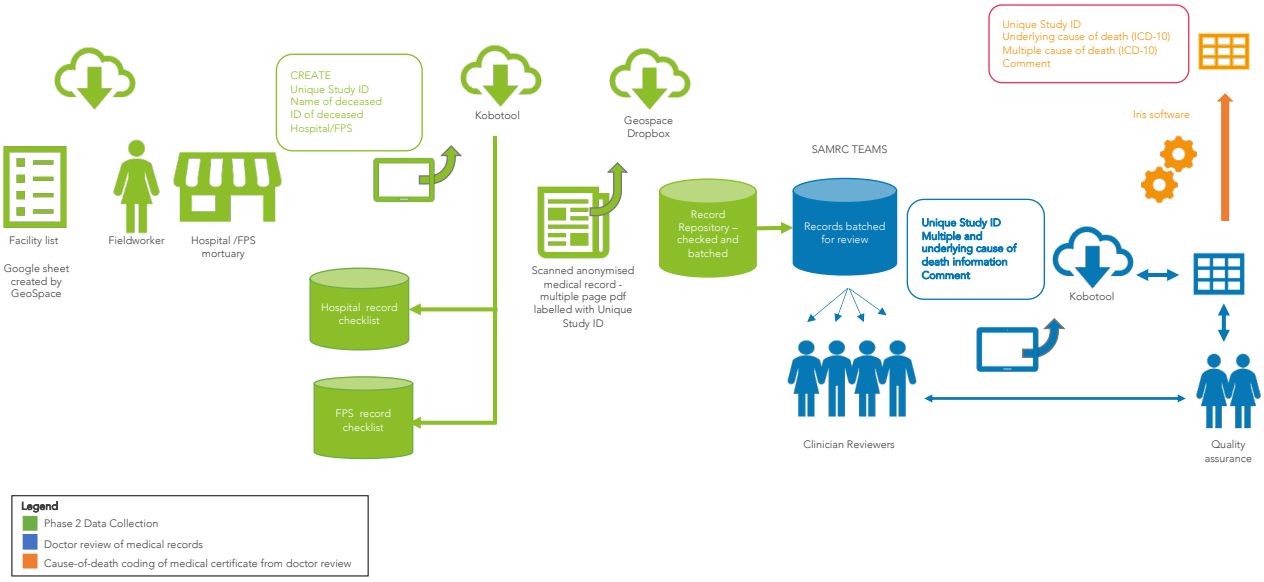



*Figure 3: Medical and forensic pathology record information workflow, SA NCOD Validation Project 2017/18.*

## 3.3 Data Processing

### *3.3.1 Doctor review of medical records*

Data processing was focused on the MRs for deaths that occurred in 2017 as well as the 2018 cases for which there was a VA interview.

We recruited medical doctors to participate in the study through an advertisement posted on the SAMRC website and shared with colleagues. The doctors were required to review VA interviews and MRs to identify the underlying COD. They were invited to attend a face-to-face training for 1 day and were required to successfully complete 3 home assignments and pass a competency test before they were offered a contract. In terms of the medical and FPS records, the main aim of the training was to ensure that the doctors were competent in certifying deaths according to ICD-10 guidelines and were able to use the data capture tool, including a brief medical history, feedback regarding the source of COD information and any concerns about the quality of record. A training manual,[iv] a series of PowerPoint presentations[v],[vi] and class assignments to certify medical COD[vii] were used during face-to-face training. Participants were required to complete a home assignment on medical certification of COD[viii] and a competency test.[ix] Standard operating procedures (SOPs)[x] were developed and shared with the reviewers via the Microsoft Teams application.[25] This included technical SOPs for using KoBotools and KoBoCollect.[xi, xii, xiii, xiv] The project training materials in medical certification of COD[xv] have subsequently been used to develop an online course on medical certification of COD (*http://www.deathcertification.org/*).

A total of 105 medical doctors attended the training of whom 75 successfully completed the assignments and were appointed to review verbal autopsy interviews on services rendered contracts. Seventeen doctors resigned between March 2019 and November 2019 leaving 58 still conducting reviews at end November 2019. At the time of the completion of the VA reviews, there were 49 medical doctors employed by the project. The majority of the medical doctors were doing the reviews after routine work hours.

---

iv *http://www.samrc.ac.za/sites/default/files/attachments/2020-02-17/Training%20Manual%20for%20doctor%20reviewers.pdf*

v *http://www.samrc.ac.za/sites/default/files/attachments/2020-02-17/Medical%20certification%20of%20cause%20of%20death%20training.pdf*

vi *http://www.samrc.ac.za/sites/default/files/attachments/2020-02-17/Verbal%20autopsy_physician%20assessment%20training.pdf*

vii *http://www.samrc.ac.za/sites/default/files/attachments/2020-02-17/MCCOD%20class%20assignment.pdf*

viii *http://www.samrc.ac.za/sites/default/files/attachments/2020-02-17/MCCOD%20home%20assignment.pdf*

ix *http://www.samrc.ac.za/sites/default/files/attachments/2020-02-17/NCODVP%20reviewer%20competency%20test.pdf*

x *http://www.samrc.ac.za/sites/default/files/attachments/2020-02-17/Guidelines%20for%20NCODVP%20Reviewers_MCCOD%20Record%20Reviews.pdf*

xi *http://www.samrc.ac.za/sites/default/files/attachments/2020-02-17/NCODVP_Reviewer%20Technical%20SOP%201.pdf*

xii *http://www.samrc.ac.za/sites/default/files/attachments/2020-02-17/NCODVP%20Reviewer%20SOP%202%20_Consensus%20case.pdf*

xiii *http://www.samrc.ac.za/sites/default/files/attachments/2020-02-17/NCODVP%20Reviewer%20Technical%20SOP%203%20_VA%20home%20assignment%20support.pdf*

xiv *http://www.samrc.ac.za/sites/default/files/attachments/2020-02-17/NCODVP%20Reviewer%20Technical%20SOP%204_%20Access%20VA%20review%20form.pdf*

xv *https://www.samrc.ac.za/sites/default/files/files/2022-12-07/NCODVPGuidelineMedicalReview.pdf*

Additional training materials[xvi] and five test MRs[xvii] were provided to orientate the existing reviewers to the MR reviews and the MR review data capture form.[xviii] Feedback was provided on the reviews for the test MRs. Only reviewers who provided reviews of acceptable standard were asked to continue with MR reviews (30/49). Additional recruitment was undertaken to assist with the MR reviews and an additional 16 reviewers were recruited following face-to-face training on ICD-10 guidelines on medical certification of COD[iv] and the KoBoToolbox MR review data capture form.[xviii] The new reviewers were required to successfully complete the medical certification home assignment[viii] and competency test[ix] as well as five test MRs[xvii] before they were offered a contract.

As shown in Figure 3, the de-identified pdf scanned documents of the MRs were batched and allocated to reviewers using Microsoft Teams. Reviewers viewed the records on their laptops and then captured the information extracted using a MR form in KoboCollect on an android tablet.

The MRs were reviewed by a single reviewer who captured a short summary of the decedent's medical history, information on TB and HIV status, manner of death and the sequence of conditions leading to death according to the format of the certificate of cause of death along with an indication of the quality of the COD information and the level of certainty for the causes that they listed in Part 1. The reviewers were asked to specify how the diagnosis of each cause reported in Part 1 was made (medical history, clinical findings, special investigations, surgery, autopsy and other) and to specify the most important results used to confirm the diagnosis. Based on this information they provided a level of certainty of the diagnosis for each cause which was used to rate the level of certainty for the UCOD. The quality of the cause of death information in the medical records was assessed subjectively.

### *3.3.2 Forensic pathologist review of FPS records*

A total of 11 doctors were trained to perform forensic record reviews, including three doctors who participated in the VA reviews and an additional eight doctors who were recruited solely for the forensic record review. Once the three doctors who participated in the VA reviews completed their VA reviews, they were oriented to the Forensic record review and conducted 2-5 forensic record reviews prior to being allocated batches of 40 FPS records for review in a similar manner to the MRs. The additional 7 reviewers who were recruited for forensic record reviews received face-to-face training on ICD-10 guidelines on medical certification of COD and the KoBoToolbox forensic record review data capture form . They were also required to conduct 2-5 forensic record reviews prior to being allocated batches to review. Whilst all those trained were eligible to review records, only 4 went on to perform reviews, mainly due to work commitments.

The forensic record review form[xix] in KoBoToolbox completed by the reviewer captured a short summary of the decedent's case history, information on HIV and TB status, manner of death and the sequence of conditions leading to death according to the format of the certificate of COD along with an indication of the quality of the forensic records and level of certainty for the underlying COD. The quality of the forensic records was assessed by reporting whether the case history and autopsy findings were consistent, as well as assessing the completeness of the autopsy report (all reviewers were forensic pathologist specialists). Reviewers were asked to report on how the diagnosis of each cause reported in Part 1 was confirmed (case / medical history, post mortem examination without autopsy, post mortem examination with autopsy and/or special investigations). They were then asked to report the level of certainty of the cause of death based on this information.

xvi Available upon request from *pamela.groenewald@mrc.ac.za*

xvii Available upon request from *pamela.groenewald@mrc.ac.za*

xviii *http://www.samrc.ac.za/sites/default/files/attachments/2019-12-12/Medical%20record%20review%20data%20capture%20form.pdf*

xix *http://www.samrc.ac.za/sites/default/files/attachments/2019-12-12/Forensic%20record%20review%20data%20capture%20form.pdf*

A small team of QA reviewers reviewed all the forensic records to ensure that the certification of COD included the circumstances of the death as well as the manner of death. All records with unknown underlying COD were reviewed against the forensic records to ensure that no information had been missed. Where necessary, these cases were discussed with the reviewer to reach consensus on manner and circumstances of the death. Where consensus could not be reached between the original reviewer and the QA reviewer, the case was referred to the panel of QA reviewers for discussion and a decision on the underlying cause.

### *3.3.3 Quality assurance procedures*

A QA Panel comprising eight QAAOs who were all medical doctors, who had participated in the study as reviewers and had demonstrated a high standard of clinical acumen as well as accurate death certification was formed to assist with standardization of the review process, through developing SOPs for the reviewers and doing ongoing QA. A QA process was established ensuring each case was briefly assessed by one of the QA team to confirm the validity of the underlying COD and the causal sequence was correct, without evaluation of the MR (see Annexure 8.2.1). This process also allowed for the identification of any cases requiring in-depth review of the MR (e.g., those with an unknown UCOD, or difficult diagnoses which were then processed by the QA reviewer/panel.) The Panel met weekly to discuss and reach consensus on complicated cases referred either directly by reviewers or brought by the QAAOs. Overall, QAAOs agreed with the reviewers UCOD in approximately 90% of reviews and only 922/10,353 (8.9%) of causal sequence and/or UCODs required changing. In addition to the brief review of each case, four records from each batch were randomly sampled (10%) for QA to check whether the QA reviewer agreed with the underlying cause selected by the medical reviewer. If the QA reviewer's opinion on COD differed with the medical reviewer for two or more records, then the whole batch was assessed, and feedback was given to the medical reviewer (Annexure 8.2.2) and the cases were resubmitted. In 892/1,116 cases (80%) the QAAO agreed with the original reviewer. In 12 of the 279 batches the QAAO disagreed with 2 or more of the sample cases (so complete case records were reviewed for each of these completed batches).

The QA reviewers and the co-principal investigator met regularly to discuss difficult cases, as a QA review panel. Where additional information was found by the QA reviewers, the final underlying cause was decided by consensus among the panel. The FPS cases were reviewed by 8 reviewers, all of whom were specialist forensic pathologists, except one medical officer, who had years of experience in forensic pathology and is responsible for undergraduate teaching in forensic pathology. From these reviewers, 3 QAAOs were chosen, based on the good quality of reviews they had submitted. Each QAAO was assigned batches of submitted cases to review on KoBoToolbox. These batches were allocated to a QAAO at random, based on the time available to the assessment officer – with the one caveat that no QA personnel reviewed their own submitted batches.

The QA process for the FPS records differed slightly from the medical and verbal autopsies as most underlying causes of death were clear. As the FPS reviews proceeded a list of challenges identified by the reviewers was developed together with an agreed response (Annexure 8.3.1). Each review was considered by a member of the panel and either accepted or referred to the panel for consideration (Annexure 8.3.2). Detailed steps in the quality assessment are outlined in Annexure 8.3.3.

### *3.3.4 Coding cause of death*

All COD coding was performed by the researchers using Iris automated software[26] which codes the multiple causes of death to 4-digit ICD-10 codes and selects the underlying COD by applying the ICD coding rules. After cleaning the data set with the doctors' medical certificates of COD based on their review of MRs, the initial batch processing in Iris yielded about 39% rejects. These rejects were mainly due to spelling errors, additional words (e.g., poorly controlled hypertension, HIV defaulted etc.; cancer, carcinoma, ca, Ca etc.), conditions not in the dictionary, etc. In order to resolve these issues, the rejects were divided into 3 lots and manually coded to identify the underlying COD using an updated dictionary with additional medical terms.

Prior to coding the FPS records the data were cleaned as for the MRs. The external causes were checked manually in Excel to identify the most common terms reported for external causes and nature of injury. The Iris dictionary was updated to include these terms. Initial batch processing of these records yielded about 38% rejects. These rejects were divided into 3 lots and manually coded using an updated dictionary where required. The final codes were checked against the manner of death selected in the FPS record review.

## 3.4 Data management, cleaning and analysis

### *3.4.1 Data management*

In compliance with SAMRC Information Technology policy, images of anonymized medical and forensic records were stored on Microsoft Teams for access by the medical reviewers. The batching of records was done in the Teams folder and allowed for restricted access and provided a secure platform for data storage.

The medical doctor reviewers accessed relevant records on Microsoft Teams on their laptops and captured the record review data in KoBoToolbox data collection forms that had been installed on their password protected android tablets. The data submitted into KoBoToolbox form, without personal identifiers other than the USID, was automatically uploaded to a secure server based at Harvard University from which the data could be downloaded by the research team at SAMRC. Data access was restricted to authorized users only, with a full audit trail maintained to guarantee data integrity. User access was limited to the information pertinent to that user. CDC staff were not involved in data collection and did not have access to participants' identifying information. Once the study was completed, a backup of the patient records data, excluding the identifying information, was archived, and the identifying information deleted from the server of the service provider. Electronic records will be retained for five years on the SAMRC secure server.

Analytical data sets, identified by the USID, have been created in Excel for coding and into Stata for further analysis. The anonymized data set will be made available coincident with the publication of papers reporting the findings of this study. The final anonymized dataset will be archived and stored with metadata for 20 years in a data repository at the SAMRC.

### *3.4.2 Data cleaning*

The identifiers (including names, SA ID, date of birth, date of death and sex) from the three datasets (verbal autopsies, the MR checklist, and the forensic pathology checklist) were merged on the USID to create a consolidated Master List of the decedents in the study. We checked that the SA ID were valid. Invalid SA IDs were identified through an algorithm and the last digit (13th), corrected according to the sequence of the first 12 digits.[27] In the cases where the first 6 digits of the invalid SA ID did not reflect the date of birth, these were corrected accordingly and again verified using the algorithm. The corrected SA ID were then linked to the Rapid Mortality Surveillance database[28] to verify that the death had been registered. The linking was done on date of birth, date of death, sex and province for records that did not have SA ID. When a definite match was found, the SA ID was included in the consolidated Master List.

The identification of duplicate records of the same decedent was conducted on SA ID as well as on the combination of date of birth and date of death. In cases where duplicates were identified across any of the 3 data sources, exact cases were identified and dropped from the Master List and cases with the same USID (but that were not the same decedent) which arose from the algorithm that we applied during data collection to cater for simultaneous data capture from multiple facilities, were identified and a new unique USID was allocated.

The ICD-10 codes for the underlying COD identified through Iris based on the medical certification by the doctors were run through the ANACONDA tool,[29] to ensure that no biologically implausible causes had been assigned. Fourteen cases were identified as having biologically implausible causes, based on sex or age of the decedent. On review of the records, the incorrect sexes and ages of these records were corrected and none of the implausible cases were retained. For babies, who had been recorded against their mother's SA ID, care needed to be taken to ensure the correct age was recorded for the baby.

### 3.4.3 Data analysis

The quality of the medical certification of COD was evaluated using the updated classification of "garbage" codes. Naghavi et al (2010)[30] had published a typology for garbage codes, categorizing them into four groups. The list was extended for the 2017 Global Burden of Disease Study [31] and evaluated by an expert group convened by the Bloomberg Philanthropies Data for Health Initiative and the Civil Registration and Vital Statistics Improvement project of the University of Melbourne in 2017[32] for incorporation in ANACONDA. Five categories of "unusable" codes were identified including immediate causes of death (e.g., Disseminated intravascular coagulation [defibriation syndrome]), impossible as underlying COD (e.g., Viral warts), insufficiently specified causes within ICD chapter (e.g., Cancer with unknown primary site), intermediate causes of death (e.g., Other cardiac arrhythmias) and symptoms, signs and ill-defined conditions (e.g., Headache, other abnormal findings of blood chemistry).

For the analysis of the COD information on the MRs, the underlying COD were aggregated to the following groups: ICD-10 Chapters; the WHO 2016 cause of death list for verbal autopsy (64 causes), and the burden of disease 3 broad cause groups with an additional category for HIV/AIDS and TB as used in the Second South African National Burden of Disease Study (SA NBD).[33] For a more detailed comparison, we made use of an aggregation aligned with the SA NBD list but which does make any assumptions about misclassification of causes and has categories for ill-defined causes. We call this a basic NBD list (Annexure 8.4).

For this report, the analysis does not take into account the complex sampling. Descriptive statistics of the basic characteristics of the deaths including median age, and proportions, and 95% confidence intervals (CI) were calculated for sex and province using Stata IC/14.2 (StataCorp, USA) and Excel for Microsoft Office 365 ProPlus Version 1902 (Build 11328.20480 Click-to-run).

### 3.4.4 Comparison with Stats SA death data

Public domain unit record COD data released by Stats South Africa for 2017[12] has been analyzed for comparison. Stats SA codes the COD information provided on the death notification forms by medical doctors or forensic pathologists following the international medical certificate of COD. An unknown proportion of the deaths from natural causes are registered based on an affidavit by a local headman. These either have an unknown underlying COD or one based on information provided by the next of kin.

The underlying COD data, coded to 3-digit ICD-10 codes, has been aggregated in the same way as the NCODVP data and divided into deaths that occurred in health facilities for comparison with the MRs and injures for the comparison with the FPS records. Although the NCODVP sample partially represents 2017 and 2018, they will be compared with Stats SA data for the whole of 2017.

## 3.5 Ethical consideration and permissions

The major ethical considerations in the project referred to permission to review health records of deceased patients and maintaining confidentiality of information from medical and forensic records. Strict confidentiality measures were adhered to with regards to the protection of information obtained from medical and forensic records. As far as possible, anonymized decedent data were used as input to the project.

### 3.5.1 Permission

The protocol was presented to the NDOH and the Forensic Pathology Services Committee to obtain their support.

Since access to individuals' MRs is required only for the purpose of retrospective record review after death, in order to assess the cause-of-death, a waiver of the need for individual consent for this access by family members was requested on

the basis of the public health benefit. Permission to access information of decedents from medical and forensic records at public hospitals and forensic autopsy facilities was obtained from the national, provincial and district health departments as well as individual facilities. Although permission was granted by the Department of Health in KwaZulu-Natal Province, permission to access FPS records in that province could not be secured.

### *3.5.2 Confidentiality*

Researchers and field workers had access to individual patient records in multiple formats, including individual paper-based or electronic in-patient records, and paper-based or electronic registers which include entries for individual patients and verbal autopsy interviews. The importance of confidentiality was explained to all fieldworkers during training and all other project staff including field supervisors, researchers, quality assurance staff, data managers, and research/administrative, IT support staff and the medical doctors undertaking the reviews. All project staff were required to sign a confidentiality agreement to handle all project data ethically and confidentially.

Individual decedent data were de-identified, as described in the Data Collection section, once a USID was allocated. Personal identifiers were masked before the record was scanned for the study. Records provided to the medical doctors for review were thus anonymized and identified through a USID.

Results produced from the project are presented in aggregate form and cannot be traced back to individual decedents.

### *3.5.3 Potential risks and benefits*

Benefits include improved quality of cause of death data for health policy makers, as well the strengthening of research and analytic capacity through the methods and staff development for the project, but also via consultation with and technical inputs by expert co-investigators and technical advisors working with the research team.

### *3.5.4 Ethics review*

The project protocol was reviewed by the SAMRC Ethics committee and approved on 27 June 2017 (EC004-2/2017). Amendments were subsequently approved on 28 August 2017, 26-27 February 2018. The protocol was also reviewed by the CDC Centre for Global Health Office of the Associate Director for Science (ADS) (CGH-HSR 2017-231) in accordance with CDC human research protection procedure. CDC investigators did not interact with human subjects or have access to identifiable data or specimens and approval was received on 8/4/2017. Clearance for amendments was obtained 2/7/2020.

# 4. Results

## 4.1 Medical Records

### *4.1.1 Response*

A total of 10,132 deaths were reviewed by clinician reviewers from the 17,619 MRs collected for the NCODVP. The balance of the records will be stored securely for possible future use. Most of the MRs of deaths that occurred in 2017 were reviewed (87.7%), while only the records of decedents for whom a VA interview was done were selected for 2018 (19.0%) (Table 1). The 1,468 MRs from 2018 records were selected on the basis that a verbal autopsy had been conducted, or in a very few instances, a FPS record had been collected.

*Table 1: Number of medical records reviewed compared with number collected by year of death, SA NCOD Validation Project 2017/18.*

| Year of death | Number MRs reviewed | Total MRs collected | % reviewed |
|---|---|---|---|
| 2017 | 8,664 | 9,878 | 87.7% |
| 2018 | 1,468 | 7,741 | 19.0% |
| **Total** | **10,132** | **17,619** | **57.5%** |

MRs – medical records

The numbers and percentages of deaths in each province from the sample is shown in Table 2, alongside the provincial number and percentage of health facility deaths reported by Stats SA for 2017. There are noticeable differences in the geographic distribution of the sample and the national data. It is important to note that, the sample of sub-districts was drawn based on the population size, and not the numbers of deaths. They were selected to ensure provincial representation of all socio-economic strata. Furthermore, the sample does not include private sector facilities. Relative to the numbers reported by Stats SA, the numbers in Eastern Cape, Free State, Mpumalanga, and North West provinces are over-represented while the other provinces are under-represented. The detailed breakdown by health sub-district is reported in Table 24 in Annexure 8.5.

*Table 2: Provincial distribution of medical records reviewed (N=10,132) compared with Stats SA 2017 data, SA NCOD Validation Project 2017/2018.*

| Province | NCOD Validate, 2017/18 | | Stats SA 2017 | | | |
|---|---|---|---|---|---|---|
| | | | Hospital deaths | | All deaths | |
| | Number | % | Number* | % | Number# | % |
| Eastern Cape | 2,357 | 23.3% | 26,411 | 14.5% | 65,162 | 15.2% |
| Free State | 917 | 9.1% | 13,985 | 7.7% | 31,209 | 7.3% |
| Gauteng | 1,718 | 17.0% | 41,005 | 22.5% | 92,524 | 21.6% |
| KwaZulu-Natal | 1,073 | 10.6% | 35,025 | 19.2% | 76,605 | 17.8% |
| Limpopo | 660 | 6.5% | 17,929 | 9.8% | 43,707 | 10.2% |
| Mpumalanga | 789 | 7.8% | 12,337 | 6.8% | 29,300 | 6.8% |
| Northern Cape | 543 | 5.4% | 13,324 | 7.3% | 32,473 | 7.6% |
| North West | 1,164 | 11.5% | 4,941 | 2.7% | 12,638 | 2.9% |
| Western Cape | 911 | 9.0% | 17,267 | 9.5% | 45,715 | 10.6% |
| **Total** | **10,132** | **100.0%** | **182,224** | **100.0%** | **429,333** | **100.0%** |

* 8,011 hospital deaths had no province information; # 17,213 deaths had no province information; NCOD – National Cause-of-Death

### *4.1.2 Socio-demographic characteristics*

Of the 10,132 MRs reviewed, 40 were stillbirths. These have been excluded from further analysis, leaving a total of 10,092 deaths. One early-neonatal death had missing information about sex. The sex distribution of the MR sample is shown in Table 3 and is nearly identical to that for the Stats SA 2017 deaths in hospital. The age distribution of the sample of MRs and the Stats SA 2017 hospital deaths are shown in Figure 4. They follow very similar age and sex patterns.

*Table 3: Sex distribution of deceased from medical records by year (N=10,091), SA NCOD Validation Project 2017/18, compared with Stats SA 2017 data (N=190,200).*

| | Medical records | | | Stats SA hospital deaths 2017 | | |
|---|---|---|---|---|---|---|
| | **Number** | **%** | **95% CI** | **Number** | **%** | **95% CI** |
| Male | 5,131 | 50.9% | 50% – 52% | 96,265 | 50.6% | 50% - 51% |
| Female | 4,960 | 49.2% | 48% – 50% | 93,935 | 49.4% | 49% - 50% |
| **Total** | **10,091** | **100.0%** | **-** | **190,200** | **100.0%** | **-** |

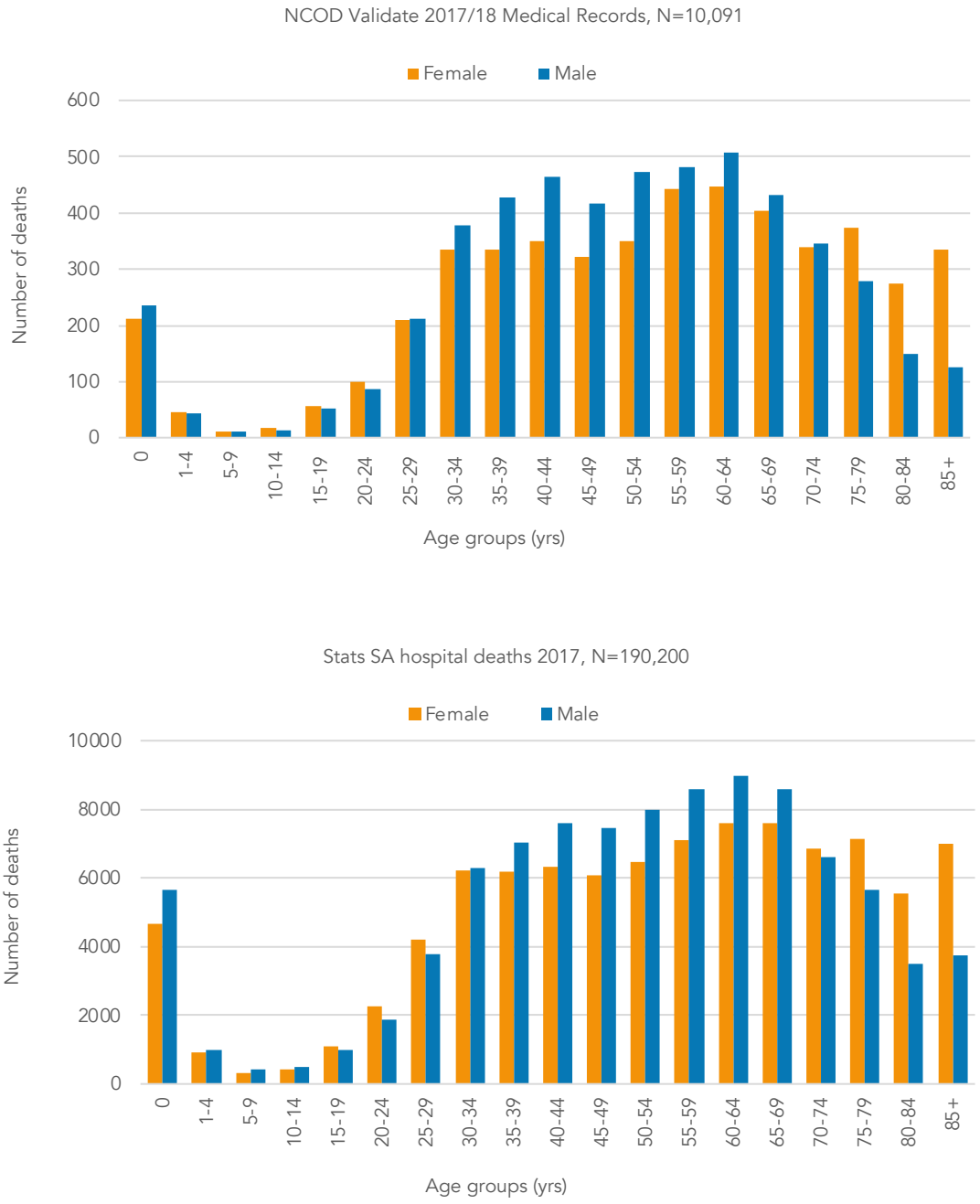



*Figure 4: Age distribution of medical record sample by sex (N=10,038), SA NCOD Validation Project 2017/18, compared with the age distribution of Stats SA hospital deaths by sex (N=190,200), 2017.*
*NCOD – National Cause-of-Death*

Table 4 shows the age group break-down of the sample of MRs by sex (N=10,132), for the study period. This includes the 39 stillbirths. There were high proportions of adults with 34.0% in the 45-64 years age group and 30.2% in the 65+ years age group.

*Table 4: Age group distribution of sample with medical records including stillbirths by sex (N=10,132), SA NCOD Validation Project 2017/18.*

| Age group | Male | % | Female | % | Total | % |
|---|---|---|---|---|---|---|
| Stillbirths * | 21 | 0.4% | 18 | 0.4% | 40 | 0.4% |
| Early neonatal (0-6 days)* | 117 | 2.3% | 105 | 2.1% | 223 | 2.2% |
| Late neonatal (7-27 days) | 41 | 0.8% | 45 | 0.9% | 86 | 0.9% |
| Post neonatal (28 days -11 months) | 77 | 1.5% | 63 | 1.3% | 140 | 1.4% |
| Child (1-4 years) | 43 | 0.8% | 45 | 0.9% | 88 | 0.9% |
| Older child (5-14 years) | 25 | 0.5% | 29 | 0.6% | 54 | 0.5% |
| Adolescent and youth (15-24 years) | 140 | 2.7% | 156 | 3.1% | 296 | 2.9% |
| Adult (25-44 years) | 1,481 | 28.8% | 1,229 | 24.7% | 2,710 | 26.8% |
| Adult (45-64 years) | 1,878 | 36.5% | 1,562 | 31.4% | 3,440 | 34.0% |
| Older adult (65+ years) | 1,329 | 25.8% | 1,726 | 34.7% | 3,055 | 30.2% |
| **Total** | **5,152** | **100.0%** | **4,978** | **100.0%** | **10,132** | **100.0%** |

* 1 stillbirth and 1 early neonatal death had unknown sex

### *4.1.3 Quality of cause of death information as assessed by medical doctor reviewers*

The clinician reviewer assessed the quality of the cause of death information in the MRs and the level of certainty of the UCOD as described in the methods section using a rating score ranging from 1 (very poor) - 5 (excellent). Some records were mistakenly allocated twice for clinical review resulting in a total of 10,353 reviews. The duplicates were reviewed and the data from both consolidated into one record before removing the other, leaving a total of 10,132 records for analysis.

The reviewers considered that the information about cause of death in the records were of reasonable quality. It can be seen in Table 5 that the quality of the information was assessed as adequate to excellent in 78% of records by the clinician reviewers, and only 22% of the records were rated to have poor or very poor information. The level of certainty of the UCOD was assessed as adequate to excellent in 85% of cases and 15% were considered poor or very poor.

*Table 5: Reviewer's assessment of quality of medical records and the level of certainty of the UCOD based on medical record information (N=10,132), SA NCOD Validation Project 2017/18.*

| Rating 1 (very poor) - 5 (excellent) | Quality of COD information | | Level of certainty of UCOD | |
|---|---|---|---|---|
| | Number of records | % of records | Number of records | % of records |
| 1 (very poor) | 706 | 7.0% | 596 | 5.9% |
| 2 (poor) | 1,561 | 15.4% | 925 | 9.1% |
| 3 (adequate) | 4,516 | 44.6% | 3,215 | 31.7% |
| 4 (good) | 2,664 | 26.3% | 3,860 | 38.1% |
| 5 (excellent) | 670 | 6.6% | 1,513 | 14.9% |
| Not reported | 12 | 0.1% | 22 | 0.2% |
| **Total** | **10,132** | **100.0%** | **10,132** | **100.0%** |

COD – cause of death; UCOD – underlying cause of death

### 4.1.4 Concerns about treatment and care of patients identified by clinician reviewers

At the end of each review, the clinician reviewer flagged cases for which they had experienced any concerns about the treatment or care of the patient. Concerns were identified for 1,905 of the records reviewed (18.8%), ranging from poor record keeping to concerns about the treatment and/or management of the patient. Based on the view of the clinical panel, the recorded management of one patient was considered to verge on medical negligence.

The proportion of records flagged with a concern varied by province from 33% of the cases from hospitals in Mpumalanga and 20% in hospitals in Limpopo, Eastern Cape, and North West provinces down to 13% in hospitals in KwaZulu-Natal (Table 6). One sub-district reached 40% while several had less than 10% (data not reported).

*Table 6: Number of records for which concern was expressed by clinical reviewer by province (N=10,132), SA NCOD Validation Project 2017/18.*

| Province* | Number of records with management concern/s | Total records | % records with management concern/s |
|---|---|---|---|
| Mpumalanga | 261 | 789 | 33.1% |
| Limpopo | 138 | 660 | 20.9% |
| Eastern Cape | 490 | 2,357 | 20.8% |
| North West | 226 | 1,164 | 19.4% |
| Free State | 168 | 917 | 18.3% |
| Northern Cape | 95 | 543 | 17.5% |
| Western Cape | 140 | 911 | 15.4% |
| Gauteng | 246 | 1,718 | 14.3% |
| KwaZulu-Natal | 141 | 1,073 | 13.1% |
| **South Africa** | **1,905** | **10,132** | **18.8%** |

*Provinces ordered from highest to lowest proportion of records with concern/s

In order to describe the nature of the concerns that had been flagged during the review, a 10% systematic sample (191 cases) of the cases flagged with a concern (1905 cases) was audited to confirm a concern and identify the nature of the concern. The concerns were then coded into eight categories: missing medical notes, poor record keeping, indications of poor work-up, indications of poor management, indications of poor treatment, delay in starting treatment, missed opportunities, e.g., for HIV testing and possible negligence. Examples of concern are provided in Annexure 8.6 grouped into those associated with poor records keeping and those associated with poor management.

In 33 of the 191 audited cases, no concerns were identified. In addition, it was noted that seven of the audited cases were found to have either died at home or were dead on arrival at the hospital. These were flagged as a concern because they did not have relevant clinical information for the reviewer to identify the underlying cause of death, rather than a concern about the treatment or care of the patient. These 40 records were removed from further analysis, leaving 151 records with confirmed concerns. Based on the sample of cases that were audited, the overall proportion of cases having concerns is estimated to be 15%.

A total of 236 concerns were confirmed among the 151 cases, yielding an average of 1.6 concerns per case for the records identified to have concerns. In 83 of the 151 records audited (55%) only one concern was identified. In 53 of the 151 (35%) two concerns were identified and in the remaining 14 records three or four concerns were identified. The nature of concerns identified is shown in Figure 5. Poor record keeping was the most frequent concern and was reported for 51% of the cases. This was followed by an inadequate clinical work up for the diagnosis (35%) and missing medical notes (20%). There were sizable proportions of the concerns related to less sub-optimal care. A total of 17% of the cases reviewed had a concern about poor management as well as 15% with incorrect treatment.

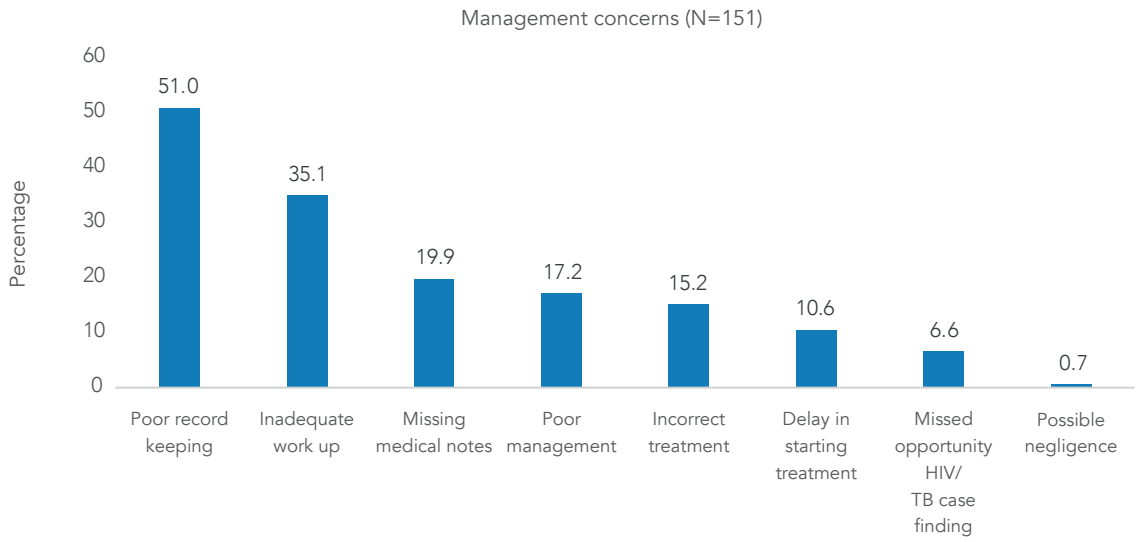



*Figure 5: Nature of management concerns identified by clinician reviewers (N=151), SA NCOD Validation Project 2017/18.*

It was noted that the presentation of the records as well as the quality of the information within the records differed from province to province, and also from rural to metro-based hospitals. However, the data are too sparse to present by subgroup.

### *4.1.5 Quality of coded data based on medical records*

#### Garbage codes

The quality of the underlying cause information of the 10,091 deaths with specified sex was assessed using the criteria developed by an expert group convened by the Bloomberg Philanthropies Data for Health Initiative and the Civil Registration

and Vital Statistics Improvement project of the University of Melbourne in 2017.[32] A high proportion of the causes (74.4%) in NCODV sample of MRs were coded to usable codes (Figure 6), indicating good quality certification. There were very low proportions of ill-defined causes (3.3%) or impossible or intermediate causes (3.7%). However, 18.3% of the causes are considered to have insufficient specification within an ICD chapter, indicating that there are gaps in the information available in a MR. Compared with the hospital deaths reported by Stats SA (Figure 6), the proportion of usable codes in the sample is higher (74.7% vs 61.3%).

The breakdown of garbage type is similar for males and females in both the MR sample and Stats SA hospital deaths, with slightly higher proportions of usable codes for males (Figure 7).

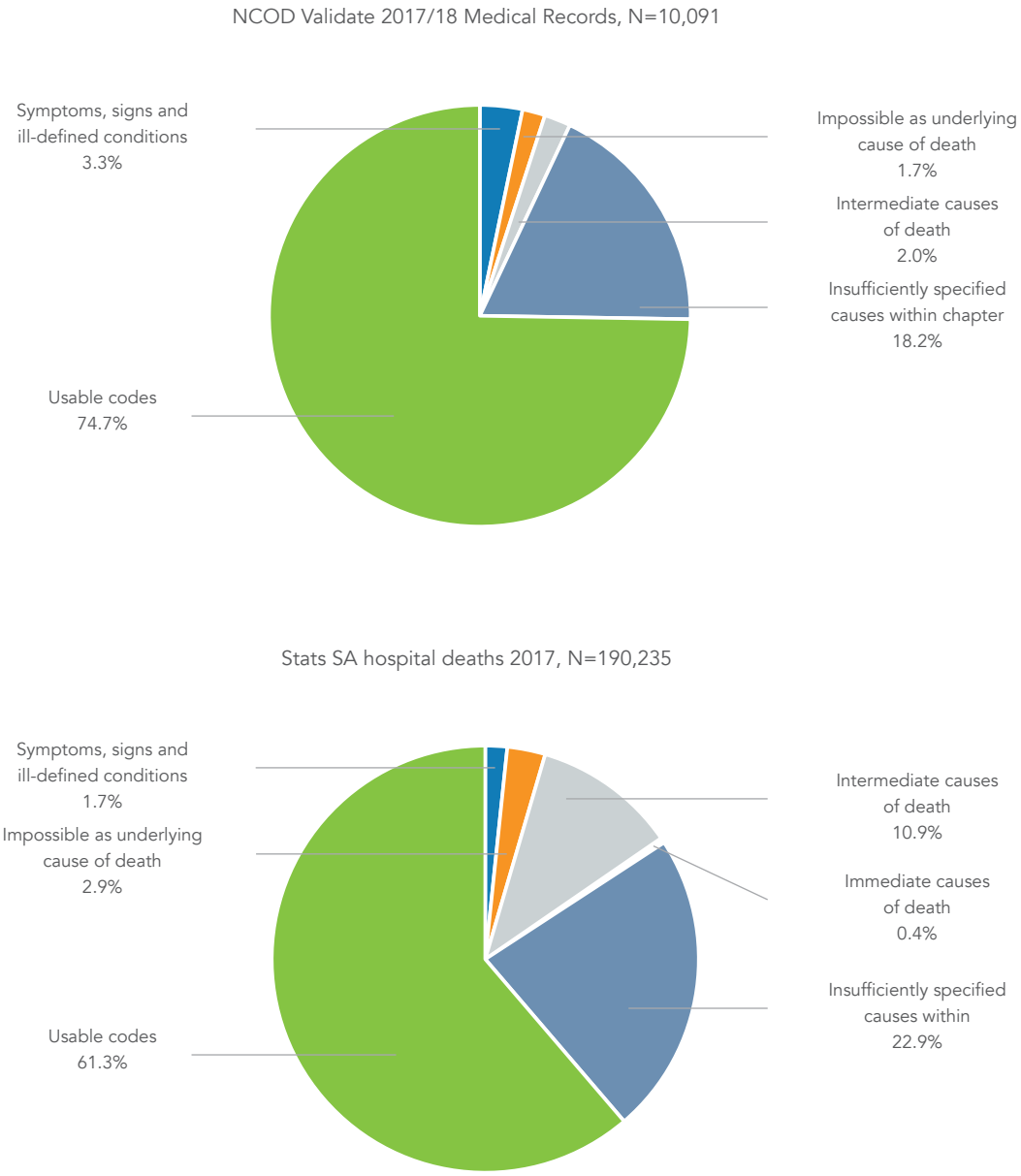



*Figure 6: Quality of the underlying cause of death codes from doctor reviewed medical records (N=10,091), SA NCOD Validation Project 2017/18 compared with codes from Stats SA hospital deaths (N=190,235), 2017.*

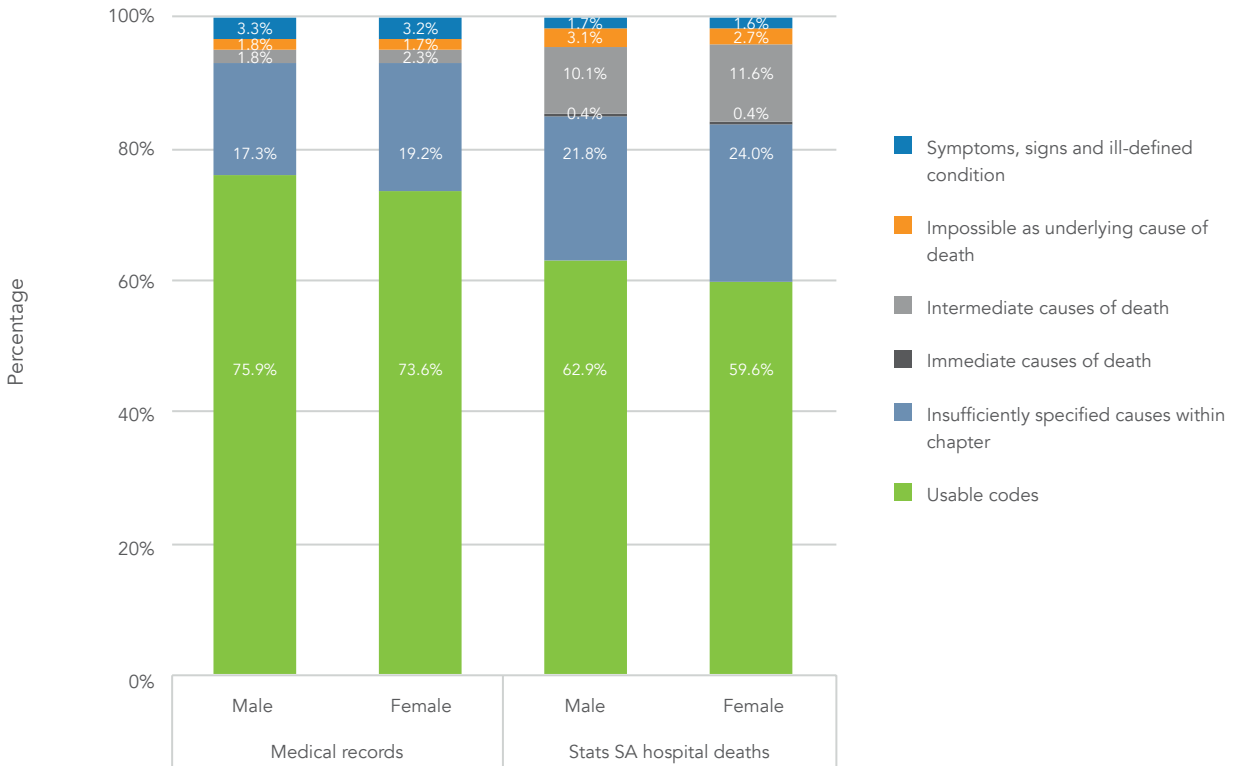



*Figure 7: Quality of underlying cause of death codes from doctor reviewed medical records by sex (N=10,091), SA NCOD Validation Project 2017/18 compared with underlying cause of death codes from Stats SA hospital deaths by sex (N=190,235), 2017.*

### Number of causes specified on the Medical Certificate of Cause of Deaths (MCCOD)

Part 1 of the MCCOD is for the causal sequence between the underlying cause of death and the immediate cause. The number of causes reported in Part 1 of the MCCOD is demonstrated in Table 7. Most records (50.7%) had two causes of death reported in the causal sequence in Part 1, followed by 33.1% with a single cause and 12.6% with three causes. Part 2 of the MCCOD is for contributory causes which were not in the direct causal sequence but considered to have played a role. In 56.5% of records at least one cause was reported in Part 2 while 43.5% had nothing specified in Part 2.

*Table 7. The number of cases by number of causes of death reported in Part 1 and Part 2 of the medical certificate of cause of death from medical records (N=10,132), SA NCOD Validation Project 2017/18.*

| Number of causes specified | N | % total records |
|---|---|---|
| **Part 1** | | |
| 1 cause | 3,355 | 33.1 |
| 2 causes | 5,136 | 50.7 |
| 3 causes | 1,279 | 12.6 |
| 4 causes | 306 | 3 |
| 5 causes | 46 | 0.5 |
| 6 causes | 10 | 0.1 |

| Number of causes specified | N | % total records% |
|---|---|---|
| **Part 2** | | |
| No causes | 4,411 | 43.5 |
| At least 1 | 5,721 | 56.5 |
| 1 cause | 3,199 | 31.6 |
| 2 causes | 1,635 | 16.1 |
| 3 causes | 887 | 8.8 |
| **Total** | **10,132** | **100** |

### Certainty of diagnosis

The medical doctor reviewer indicated the level of certainty (confirmed, highly probable, possible or unknown) of the diagnosis specified in each line of the MCCOD (based upon whether the diagnosis was confirmed with specific diagnostic tests, clinical findings or medical history) as shown in Table 8. While only 45.2% of the records had a confirmed diagnosis in Part 1a, about 70% of the diagnoses on other lines in Part 1 and 65.2% of diagnoses in Part 2 were confirmed. This pattern is a result of the necessity of reporting an immediate cause diagnosis in line 1a (even if it is less certain) and only choosing to report a diagnosis in subsequent lines when there is strong evidence. Data has been collected on the source of the information (Medical history, clinical findings, hematology or biochemistry, microbiology, serology or viral tests, imaging [X-rays, ultrasound, scopes etc.,] cardiovascular function tests, lung function tests, histology, surgical, autopsy or other). These data have not yet been analyzed. Of the 269 perinatal deaths, 63% were confirmed.

*Table 8. Number and proportion of diagnoses by level of certainty in each line of Part 1, Part 2 and Perinatal main cause from medical records (N=10,132), SA NCOD Validation Project 2017/18.*

| Level of certainty of cause of death | Part 1a | | Part 1b | | Part 1c | | Part 1d | | Part 2 | | Perinatal main cause | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | N | % | N | % | N | % |
| Confirmed | 4,456 | 45.2% | 4,605 | 70.5% | 934 | 67.4% | 147 | 73.9% | 3,644 | 65.2% | 170 | 63.2% |
| Highly probable | 4,420 | 44.8% | 1,675 | 25.6% | 403 | 29.1% | 49 | 24.6% | 1,535 | 27.5% | 86 | 32.0% |
| Possible | 753 | 7.6% | 246 | 3.8% | 49 | 3.5% | 3 | 1.5% | 405 | 7.2% | 12 | 4.5% |
| Unknown | 234 | 2.4% | 10 | 0.2% | 0 | 0.0% | 0 | 0.0% | 3 | 0.1% | 1 | 0.4% |
| **Total** | **9,863** | **100%** | **6,536** | **100%** | **1,386** | **100%** | **199** | **100%** | **5,587** | **100%** | **269** | **100%** |

## *4.1.6 Cause of death profile based on medical records*

### Cause profile according to broad cause groups compared with Stats SA hospital deaths

The cause of death profile based on the NCODVP medical records has a higher proportion of HIV/AIDS and TB deaths than the hospital deaths from Stats SA for 2017 (38.1% vs 18.4%). It can be seen from Figure 8 that the proportion of unknown causes and injury deaths are fairly similar, while Stats SA hospital deaths have higher proportions of Other type 1 conditions (other infections, maternal, perinatal and nutritional conditions) and non-communicable diseases. The same differences are seen in the cause of death profiles for males and females (Figure 9), but HIV/AIDS and TB and injuries have lower proportions for females compared to males while the Other type 1 and non-communicable disease groups had slightly higher proportions for females than males.

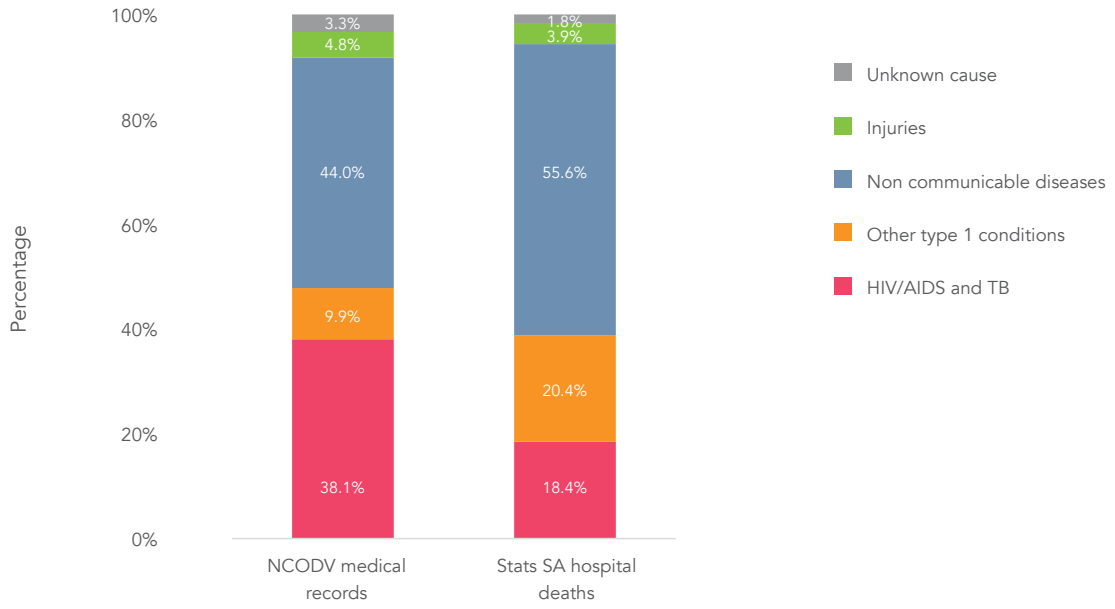



*Figure 8: Broad cause group based on doctor reviewed medical records by sex (N=10,091), SA NCOD Validation Project 2017/18 compared with underlying cause of death codes from Stats SA hospital deaths for persons (N=190,235), 2017.*

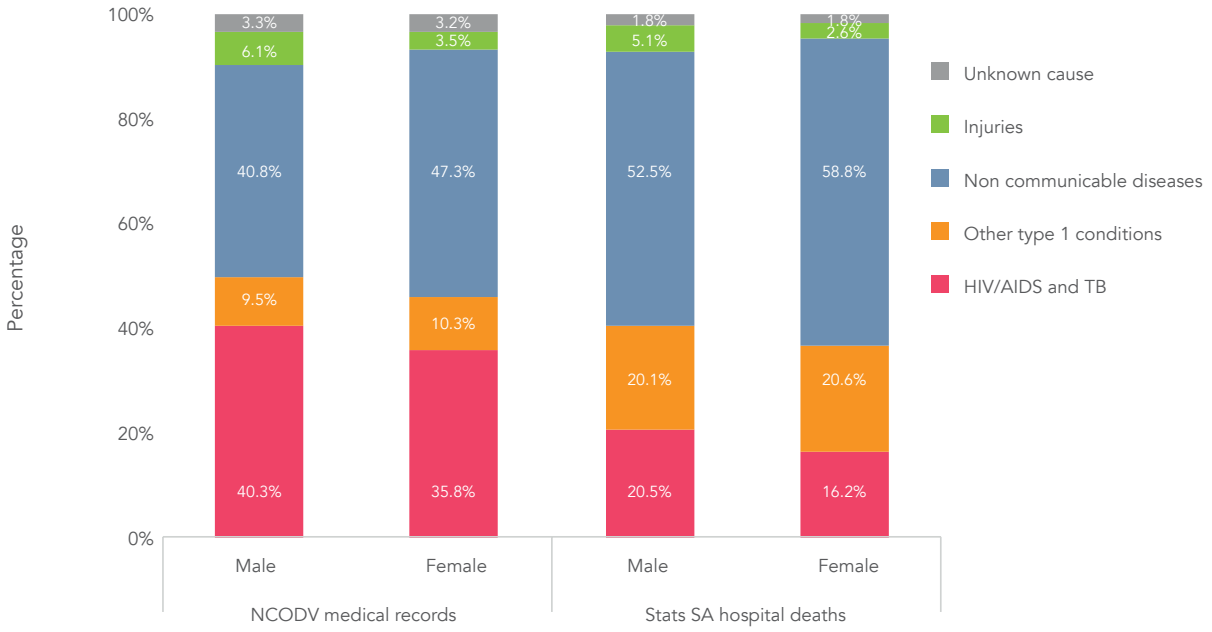



*Figure 9: Broad cause group by sex based on doctor reviewed medical records by sex (N=10,091), SA NCOD Validation Project 2017/18 compared with underlying cause of death codes from Stats SA hospital deaths by sex (N=190,235), 2017.*

### Cause profile according to ICD chapter compared with Stats SA 2017 data

The cause of death profile by ICD chapter for the MR sample is shown in Figure 10 together with the Stats SA hospital deaths. The chapter for infectious and parasitic diseases accounted for 40.9% of all the deaths followed by the circulatory (16.7%) and neoplasms chapters (10.9%). External causes accounted for 4.8% and ill-defined causes and symptoms for 3.4%. The Stats SA hospital deaths had a lower proportion in the infectious and parasitic disease chapter (27.9%) which was balanced by higher proportions across several other chapters.

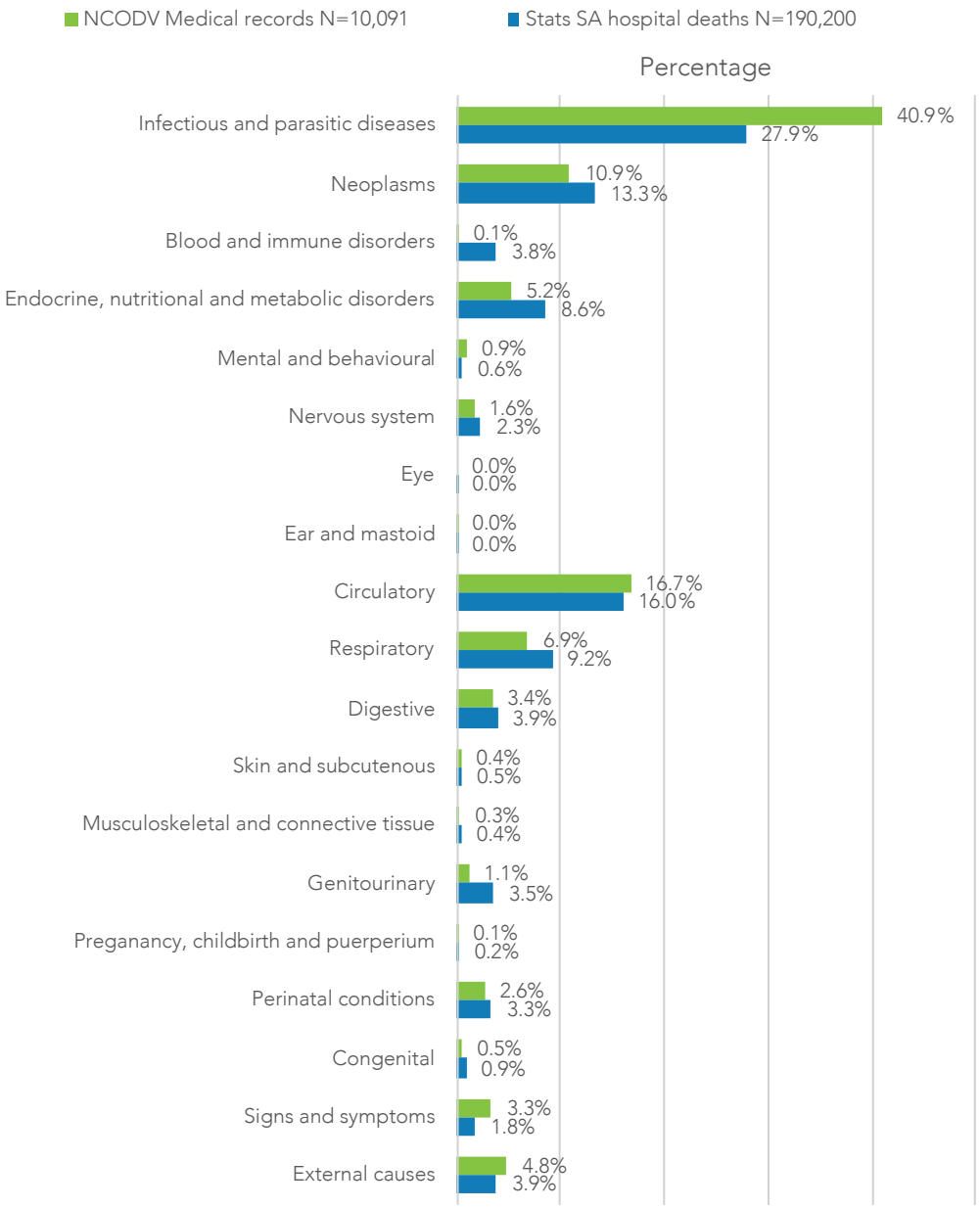
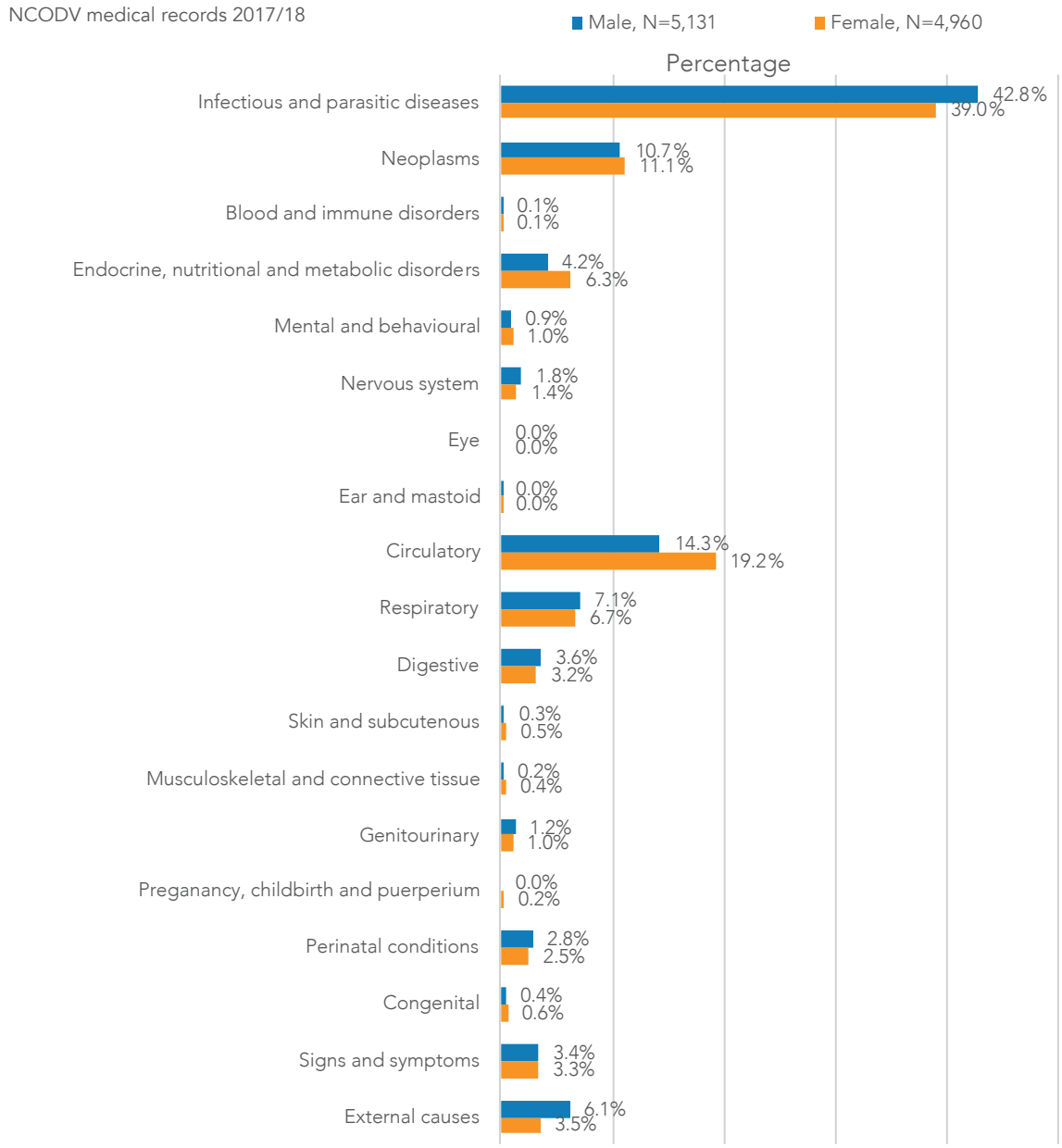



*Figure 10: Cause of death by ICD chapter based on doctor review of medical records sample (N=10,091), SA NCOD Validation Project 2017/18 and Stats SA hospital deaths (N=190,200), 2017.*

### Cause profile according to the SA National Burden of Disease list compared with Stats SA 2017

The profile for males and females differed slightly (Figure 11). Compared with males, females had higher proportions of deaths due to circulatory conditions (19.2% vs 14.3%) and endocrine, nutritional and metabolic conditions (6.3% vs 4.2%) while males had higher proportions due to infectious and parasitic conditions (43.2% vs 39.0%) and external conditions (6.1% vs 3.5%). Ill-defined signs and symptoms accounted for similar proportions of male and female deaths (3.4% vs 3.3%).



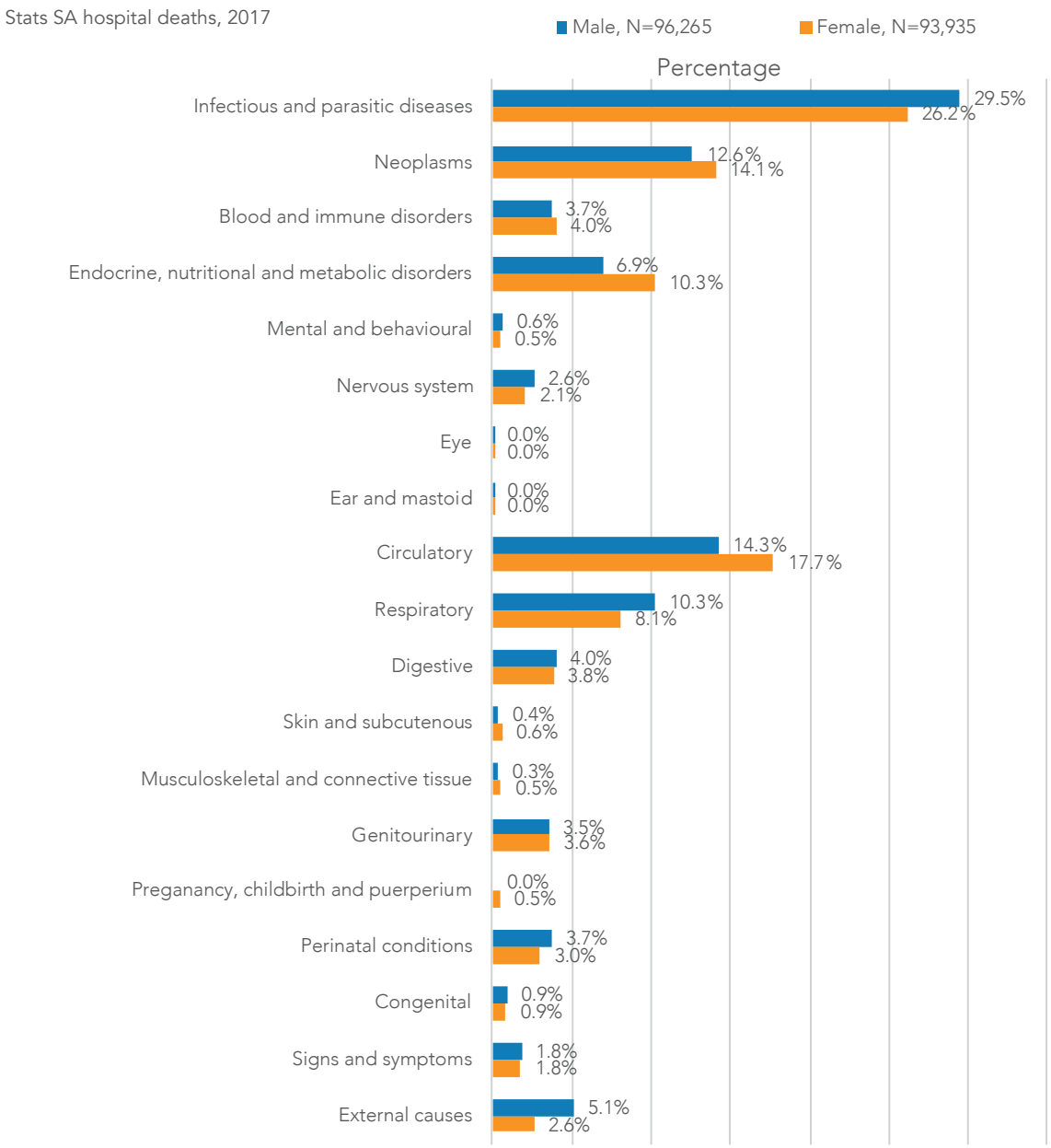



*Figure 11: Male and female cause of death by ICD chapter based on doctor review of medical records (N=10,091), SA NCOD Validation Project 2017/18 and Stats SA hospital deaths (N=190,200), 2017.*

## HIV/AIDS and TB

HIV was the most commonly identified underlying cause of death in the sample of MRs, accounting for 33.1%. Together with TB, HIV and TB resulted in 3,842 deaths accounting for 38.0% of all deaths from the sample of MRs. Whereas Stats SA death data are coded to 3-digit ICD codes, the underlying cause of death has been coded for 4-digit ICD codes for NCODVP, making it is possible to distinguish the deaths that are HIV related that resulted in TB (B20.0) which cannot be achieved when coded to 3-digits as they would combined with all infections (B20). Figure 12 provides the breakdown of HIV and TB deaths. HIV resulting in TB occurred in 1,509 deaths, accounting for 39.3% of the HIV and TB deaths. Of the 2,027 TB deaths in hospitals, 74.4% were related to HIV. The breakdown of the causes of HIV and TB is shown in Figure 13 and the breakdown of the HIV deaths is shown in Figure 14. Nearly half of the deaths identified with HIV as the underlying cause had resulted TB (45.4%) in the immediate cause of death and a further 30.6% of the HIV deaths resulted in another infection as the immediate cause.

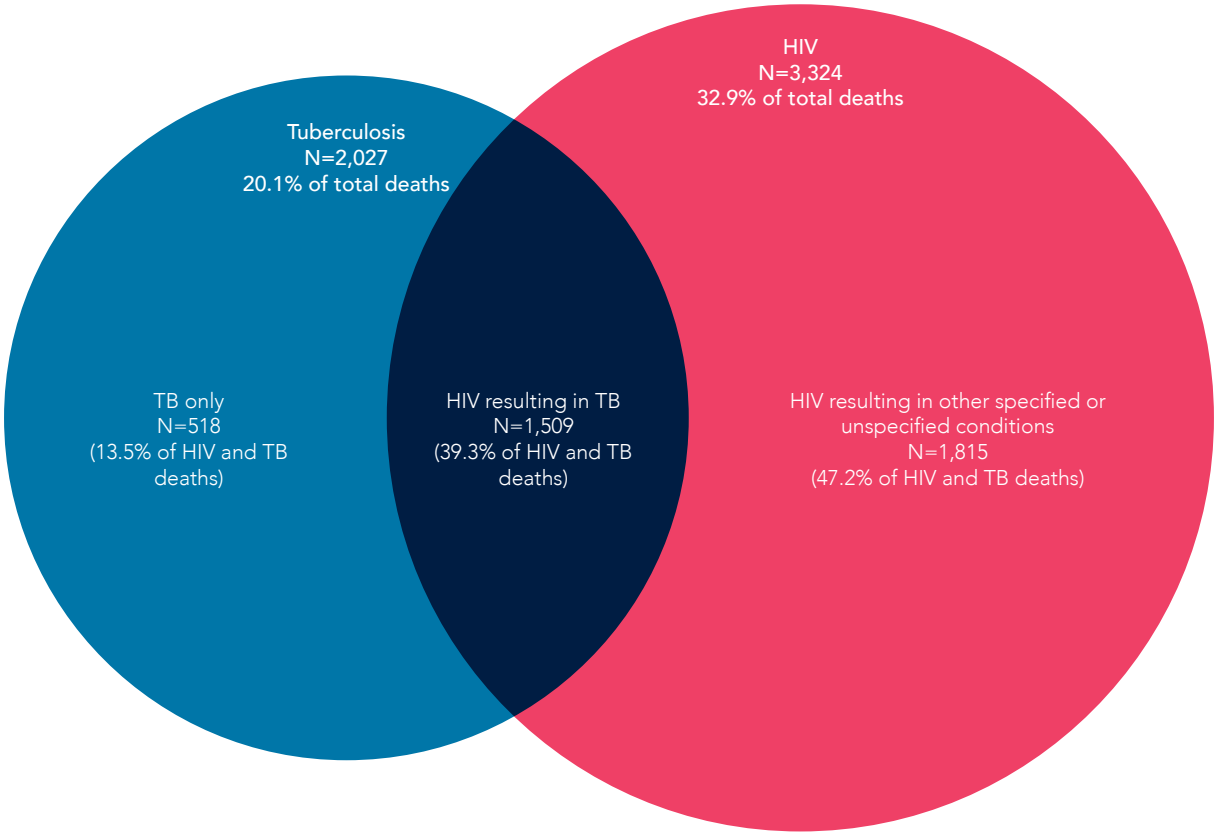



*Figure 12: Distribution of HIV and TB related deaths based on doctor review of medical records (N=3,842), SA NCOD Validation Project 2017/18.*

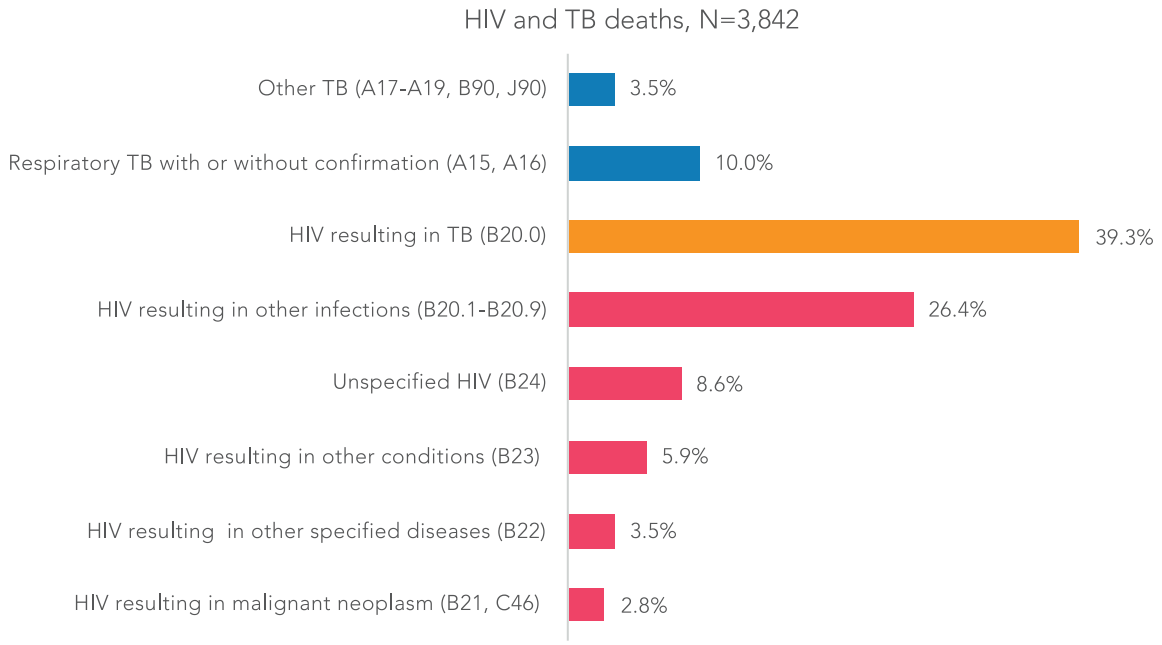



*Figure 13: Distribution of HIV and TB deaths by ICD codes based on doctor review of medical records (N=3,842), SA NCOD Validation Project 2017/18.*

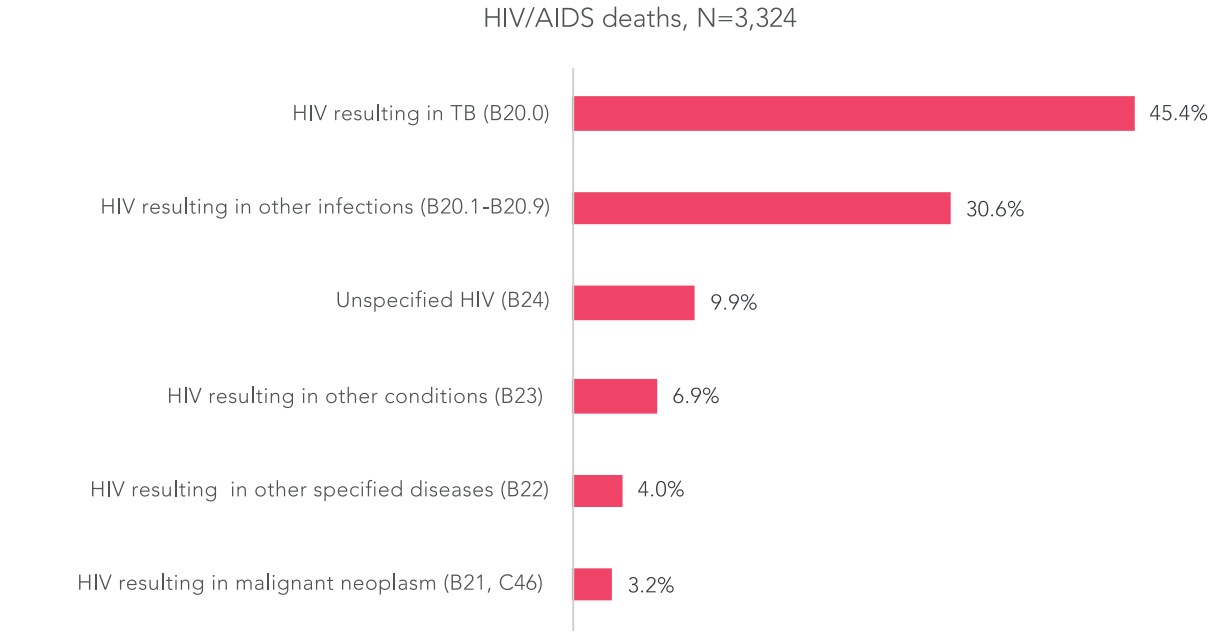



*Figure 14: HIV/AIDS deaths by ICD codes based on doctor review of medical records (N=3,324), SA NCOD Validation Project 2017/18.*

### HIV status data

The clinician reviewers captured information regarding the characteristics of the data on HIV and TB from the MRs that they reviewed. These included recorded HIV status, CD4 count, viral load and report of any AIDS related conditions, recorded TB status, results of investigations for TB etc. Overall, out of the 10,112 records (20 were missing this information), 3,176 (31.4%) were reported as HIV positive, 613 (6.1%) had a history of antiretroviral treatment (ART) and 132 (1.3%) infants were reported as HIV-exposed (Table 9).

*Table 9: HIV status information from medical records (N=10,112), SA NCOD Validation Project 2017/18.*

| HIV status | Number | Percentage |
|---|---|---|
| Negative | 1,687 | 16.7% |
| Positive | 3,176 | 31.4% |
| History of ART or clinical suspicion | 613 | 6.1% |
| HIV-exposed (infants only) | 132 | 1.3% |
| No information | 4,504 | 44.5% |
| **Total** | **10,112** | **100.0%** |

HIV - Human immunodeficiency virus; ART – anti-retroviral therapy

Table 10 shows the distribution of the underlying causes of death (mutually exclusive) according to the recorded HIV status. There was close correspondence between the reported HIV status from MRs and HIV/AIDS as an underlying cause of death, with 2,807 (88.4%) cases reported HIV positive and 409 (86.7%) the cases with a history of ART dying from HIV/AIDS. A relatively small number of HIV positive cases (367 accounting for 13.6% of the total) and those with a history of ART (63 accounting for 13.5% of the total) died due to other natural causes or injuries. Most of infant deaths (117/132 accounting for 88.6%) in the HIV-exposed category were from other natural causes. However, 11 (8.3%) of the HIV-exposed infants died from HIV/AIDS.

*Table 10: Selected underlying causes of death by HIV status from medical records (N=10,112), SA NCOD Validation Project 2017/18.*

| HIV status | Underlying cause of death | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | HIV/AIDS | | TB | | Injuries | | Other causes | | All causes | |
| Negative | 3 | 0.2% | 201 | 11.9% | 66 | 3.9% | 1,417 | 84.0% | 1,687 | 100.0% |
| Positive | 2,807 | 88.4% | 1 | 0.0% | 40 | 1.3% | 328 | 10.3% | 3,176 | 100.0% |
| History of ART | 409 | 86.7% | 0 | 0.0% | 4 | 0.8% | 59 | 12.5% | 472 | 100.0% |
| Clinical suspicion of HIV | 78 | 55.3% | 33 | 23.4% | 0 | 0.0% | 30 | 21.3% | 141 | 100.0% |
| HIV-exposed (infants only) | 11 | 8.3% | 0 | 0.0% | 4 | 3.0% | 117 | 88.6% | 132 | 100.0% |
| No information | 11 | 0.2% | 260 | 5.8% | 373 | 8.3% | 3,860 | 85.7% | 4,504 | 100.0% |
| **Total** | **3,319** | **32.8%** | **495** | **4.9%** | **487** | **4.8%** | **5,811** | **57.5%** | **10,112** | **100.0%** |

HIV - Human immunodeficiency virus; AIDS - Acquired immune deficiency syndrome; TB – Tuberculosis; ART – Anti-retroviral therapy

A total of 8,293 MRs specified HIV status as positive or indicated that there was no information. The laboratory and clinical information for these cases are shown in Table 11, by category of HIV status.

*Table 11: Laboratory and clinical information on medical records by HIV status (N=8,293), SA NCOD Validation project 2017/18.*

| HIV/AIDS indicators | HIV status from medical record | | | | |
|---|---|---|---|---|---|
| | Positive | History of ART | Clinical suspicion | No information | Total |
| Number of medical records | 3,176 | 472 | 141 | 4,504 | 8,293 |
| **CD4 count** | | | | | |
| N | 1,516 | 187 | 19 | | 1,722 |
| Median | 71 | 71 | 178 | | 71 |
| IQR | 24 - 208 | 25 - 182 | 55 - 549 | | 25 - 208 |
| **Viral load** | | | | | |
| N | 716 | 73 | 4 | | 793 |
| Median | 6,484 | 1,042 | 999 | | 5,055 |
| IQR | 43 - 196,471 | 48 - 52,212 | 500 - 1,163 | | 45 - 190,000 |
| **AIDS indicator conditions** | | | | | |
| % with AIDS conditions | 57.7% | 62.7% | 46.8% | 1.3% | 27.2% |
| % HIV wasting | 29.8% | 35.8% | 22.0% | 0.3% | 14.0% |
| % extrapulmonary TB | 19.6% | 16.1% | 14.9% | 0.6% | 9.0% |
| % candidiasis | 8.8% | 9.5% | 12.1% | 0.2% | 4.2% |
| % other infections | 9.1% | 8.9% | 7.8% | 0.1% | 4.2% |
| % cancers | 4.6% | 4.0% | 8.5% | 0.0% | 2.2% |
| % encephalopathy | 2.4% | 2.8% | 1.4% | 0.0% | 1.1% |
| % other AIDS conditions | 2.6% | 5.5% | 1.4% | 0.0% | 1.3% |

AIDS - Acquired immune deficiency syndrome; ART – Anti-retroviral therapy; CD4 - Cluster of differentiation 4; HIV - Human immunodeficiency virus; IQR – Interquartile range; N - Number; TB - Tuberculosis

### Tuberculosis status data

TB status was completed in 10,109 cases, with 1,431 indicated as a known TB case on treatment, 2,180 as No TB, 1,206 being investigated for TB and 4,613 Unknown. Table 12 shows the distribution of the underlying causes of death (mutually exclusive) according to the recorded TB status. In 81% of the known TB cases on treatment the UCOD was TB (respiratory or other) or HIV & TB, Table 12. For cases being investigated for TB, 50% had an UCOD of TB (respiratory or other) or HIV & TB.

*Table 12: Selected underlying causes of death by TB status from medical records (N=10,132, 23 with status = missing), SA NCOD Validation Project 2017/18.*

| TB Status | Underlying cause of death | | | | | | |
|---|---|---|---|---|---|---|---|
| | Respiratory TB without confirmation (A16) | Other TB (A17-A19, B90) | HIV & TB | HIV and other diseases | Unspecified HIV | Other conditions | Total |
| Missing | 0 | 0 | 1 | 2 | 4 | 16 | 23 |
| Known TB case on treatment | 212 | 56 | 898 | 165 | 2 | 98 | 1,431 |
| No mention of TB but signs and symptoms suggestive of TB | 29 | 13 | 73 | 38 | 13 | 65 | 231 |
| No TB | 1 | 1 | 3 | 227 | 47 | 1,901 | 2,180 |
| Previous history of TB | 31 | 22 | 65 | 139 | 26 | 165 | 448 |
| Under investigation for TB | 107 | 39 | 456 | 305 | 46 | 253 | 1,206 |
| Unknown | 5 | 1 | 14 | 607 | 192 | 3,794 | 4,613 |
| **Total** | **385** | **132** | **1** | **1** | **330** | **6** | **10,132** |

HIV - Human immunodeficiency virus; TB - Tuberculosis

In a total of 1,394 records confirmation of the diagnosis of TB by microscopy, culture, GeneXpert or chest X-ray was reported, Table 13. The majority of these were diagnosed on chest X-ray (65%), followed by GeneXpert (12%) and chest X-ray and GeneXpert (10.8%).

*Table 13: TB status by laboratory and radiological information confirming TB diagnosis from medical records status (N=1,394), SA NCOD Validation Project 2017/18.*

| TB Investigation | TB status | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Known TB case on treatment | | Previous history of TB | | Under investigation for TB | | Total | |
| | N | % | N | % | N | % | N | % |
| Microscopy only | 14 | 1.9% | 1 | 0.9% | 8 | 1.5% | 23 | 1.6% |
| Culture only | 11 | 1.5% | 0 | 0.0% | 3 | 0.5% | 14 | 1.0% |
| GeneXpert only | 129 | 17.5% | 5 | 4.6% | 38 | 6.9% | 172 | 12.3% |
| CXR only | 369 | 50.1% | 90 | 83.3% | 447 | 81.3% | 906 | 65.0% |
| Microscopy and Culture | 12 | 1.6% | 0 | 0.0% | 3 | 0.5% | 15 | 1.1% |
| Microscopy and GeneXpert | 15 | 2.0% | 2 | 1.9% | 0 | 0.0% | 17 | 1.2% |
| Microscopy and CXR | 8 | 1.1% | 0 | 0.0% | 0 | 0.0% | 8 | 0.6% |
| Culture and GeneXpert | 10 | 1.4% | 2 | 1.9% | 5 | 0.9% | 17 | 1.2% |
| Culture and CXR | 10 | 1.4% | 0 | 0.0% | 6 | 1.1% | 16 | 1.1% |
| GeneXpert and CXR | 119 | 16.2% | 6 | 5.6% | 26 | 4.7% | 151 | 10.8% |
| Microscopy, Culture and GeneXpert | 12 | 1.6% | 1 | 0.9% | 2 | 0.4% | 15 | 1.1% |
| Microscopy, Culture and CXR | 5 | 0.7% | 0 | 0.0% | 2 | 0.4% | 7 | 0.5% |
| Microscopy, GeneXpert and CXR | 12 | 1.6% | 0 | 0.0% | 5 | 0.9% | 17 | 1.2% |
| Culture, GeneXpert and CXR | 3 | 0.4% | 1 | 0.9% | 3 | 0.5% | 7 | 0.5% |
| Microscopy, Culture, GeneXpert and CXR | 7 | 1.0% | 0 | 0.0% | 2 | 0.4% | 9 | 0.6% |
| **Total** | **736** | **100.0%** | **108** | **100.0%** | **550** | **100.0%** | **1,394** | **100.0%** |

CXR – Chest X-ray

## Maternal deaths

Twelve deaths were attributed to maternal causes (Table 14). While there were two deaths associated with abortive outcomes, two associated with hypertensive conditions and one pregnancy-related infection, there were five deaths due to other obstetric conditions including three deaths from cardiomyopathy. There was one non-obstetric death (mental disorder) and one death due to a condition that was expected to contribute to death but not be the cause of death (premature rupture of membrane). There were very few maternal deaths, and the results should be interpreted cautiously.

*Table 14: Underlying cause of maternal deaths (N=12), NCODV 2017/18.*

| ICD-10 code | Underlying cause of death | Number |
|---|---|---|
| **Pregnancy with abortive outcome** | | |
| O06.3 | Unspecified abortion incomplete, with other and unspecified complications | 1 |
| O06.9 | Unspecified abortion, complete or unspecified, with other and unspecified | 1 |
| **Hypertensive disorders** | | |
| O14.9 | Pre-eclampsia, unspecified | 1 |
| O15.9 | Eclampsia, unspecified as to time period | 1 |
| **Pregnancy-related infection** | | |
| O86.0 | Infection of obstetric surgical wound | 1 |
| **Other obstetric complications** | | |
| O26.6 | Liver disorders in pregnancy, childbirth and the puerperium | 1 |
| O90.3 | Cardiomyopathy in the puerperium | 3 |
| O90.9 | Complication of the puerperium, unspecified | 1 |
| **Non-obstetric complications** | | |
| O99.3 | Mental disorders and diseases of the nervous system complicating pregnancy, childbirth and the puerperium | 1 |
| **Causes unlikely to cause death but may have contributed to death** | | |
| O42.9 | Premature rupture of membranes, unspecified | 1 |
| **Total** | | **12** |

ICD-10 - International Classification of Diseases and Related Health Problems (10th edition)

## Stillbirths

Stillbirths have been excluded from the analysis. For completeness, a basic description of the 40 stillbirths is presented is in this section. The majority of the MR sample identified as stillbirths did not provide adequate information about the underlying cause of death. It can be seen in Figure 15 that only 25.0% of the causes were usable and there was a very high proportion with insufficiently specified causes (70.0%). The breakdown of the stillbirth causes of death is shown in Table 15 . However, the data are very sparse, particularly those with usable codes and should be interpreted with caution.

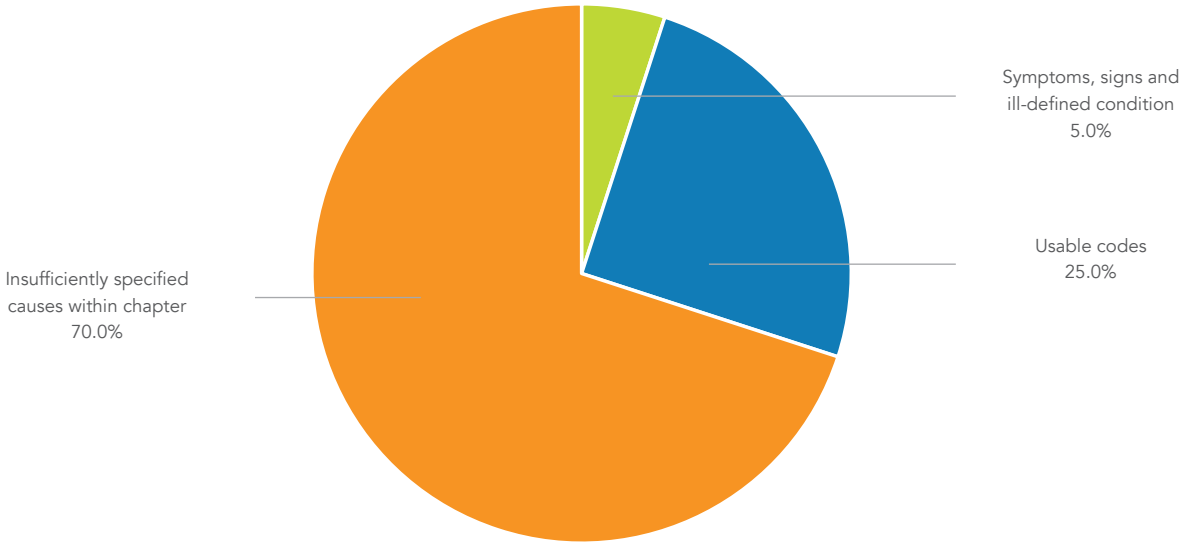



*Figure 15: Assessment of the stillbirth underlying cause of death data from medical records (N=40), SA NCOD Validation Project 2017/18.*

*Table 15: Stillbirth causes of death based on medical records (N=40), SA NCOD Validation Project 2017/18.*

| ICD-10 Code | Stillbirth cause of death | Number | % |
|---|---|---|---|
| P96 | Other conditions originating in the perinatal period | 27 | 67.5 |
| P07 | Disorders related to short gestation and low birth weight, not elsewhere classified | 4 | 10.0 |
| P02 | Fetus and newborn affected by complications of placenta, cord and membranes | 3 | 7.5 |
| P95 | Fetal death of unspecified cause | 2 | 5.0 |
| A50 | Congenital syphilis | 1 | 2.5 |
| P00 | Fetus and newborn affected by maternal conditions that may be unrelated to present pregnancy | 1 | 2.5 |
| P05 | Slow fetal growth and fetal malnutrition | 1 | 2.5 |
| Q89 | Other congenital malformations, not elsewhere classified | 1 | 2.5 |
| | **Total** | **40** | **100.0** |

ICD-10 - International Classification of Diseases and Related Health Problems (10th edition)

### Non-communicable diseases compared with Stats SA 2017 data

Non-communicable disease deaths accounted for 44.0% of the MR sample compared with 55.6% of the Stats SA hospital deaths in 2017 (Figure 8). The profile of the causes of the non-communicable disease was examined for the two data sets based on the NBD list. The leading 15 NCDs in the Stats SA data are shown in Figure 16 compared with the NCODV data. While the leading cancers accounted for similar proportions in both data sets, there were noticeable differences in the proportions of deaths due to stroke, hypertensive heart disease, nephritis/nephrosis and ill-defined cardiovascular diseases, possibly a result of poor certification in the Stats SA data with incorrect specification of conditions in Part I and II of the death notification. Stats SA data also had a much higher proportion of deaths due to other endocrine and metabolic conditions (8.2% vs 0.6%). This category includes the codes for non-specific "immune suppression", a common pseudonym used on death certificates to reflect HIV/AIDS.

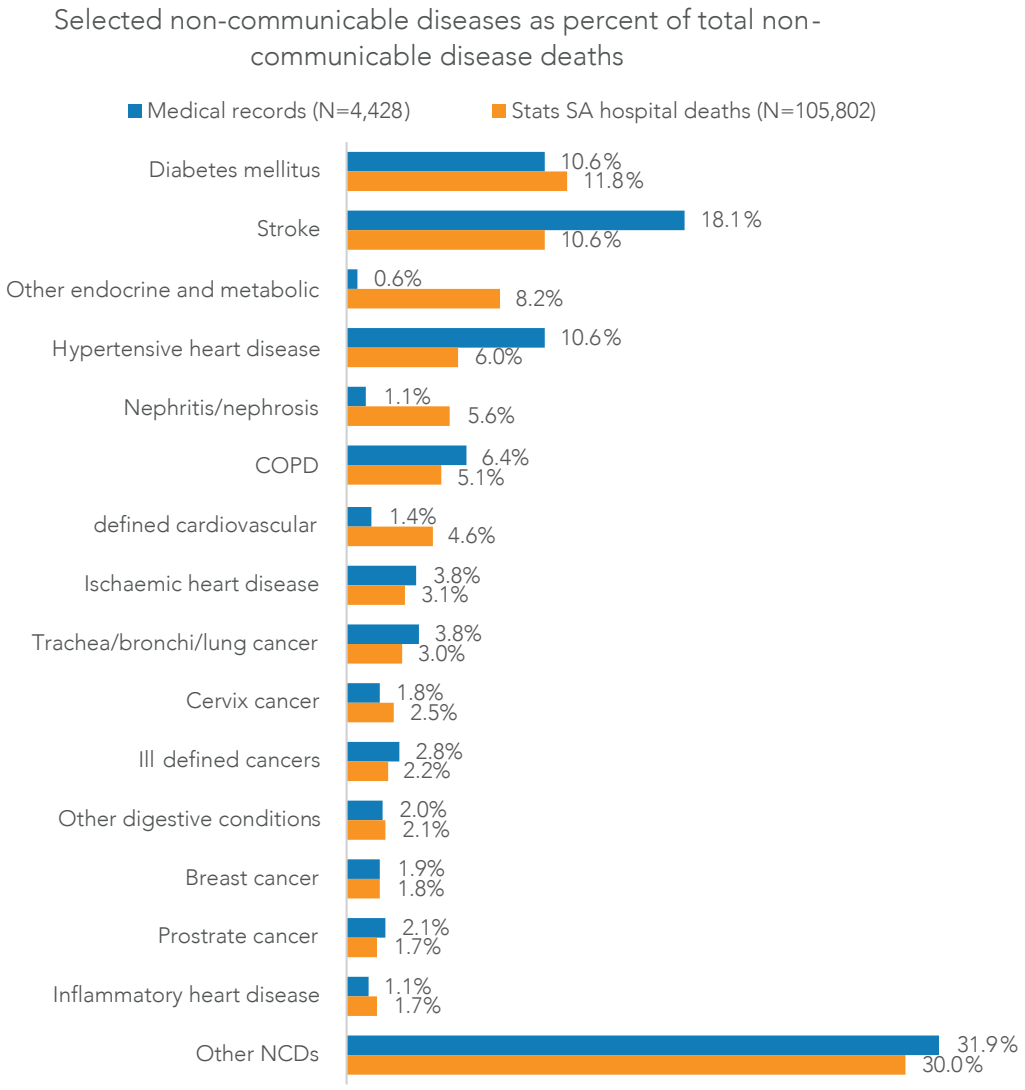



*Figure 16: Selected non-communicable disease deaths by NBD list based on doctor review of medical records (N=3,324), SA NCOD Validation Project 2017/18 compared with Stats SA hospital deaths (N=90,787).*

### Injury deaths compared with Stats SA 2017 data

There were 488 injury deaths, accounting for 4.8% of all MR deaths, with nearly double the number of male injury deaths compared with female deaths. The profile of the injuries is shown in Figure 17 for the NCODV sample of MRs and Stats SA hospital deaths for males and females separately. Unintentional injuries (including transport) accounted for 74.6% of female deaths and 53.4% of male deaths. Homicide accounted for 29.4% of the male injury deaths compared with 6.3% of female injury deaths. The profile for Stats SA hospital deaths is dominated by a high proportion of undetermined intent (42.2% for males and 40.5% for females).

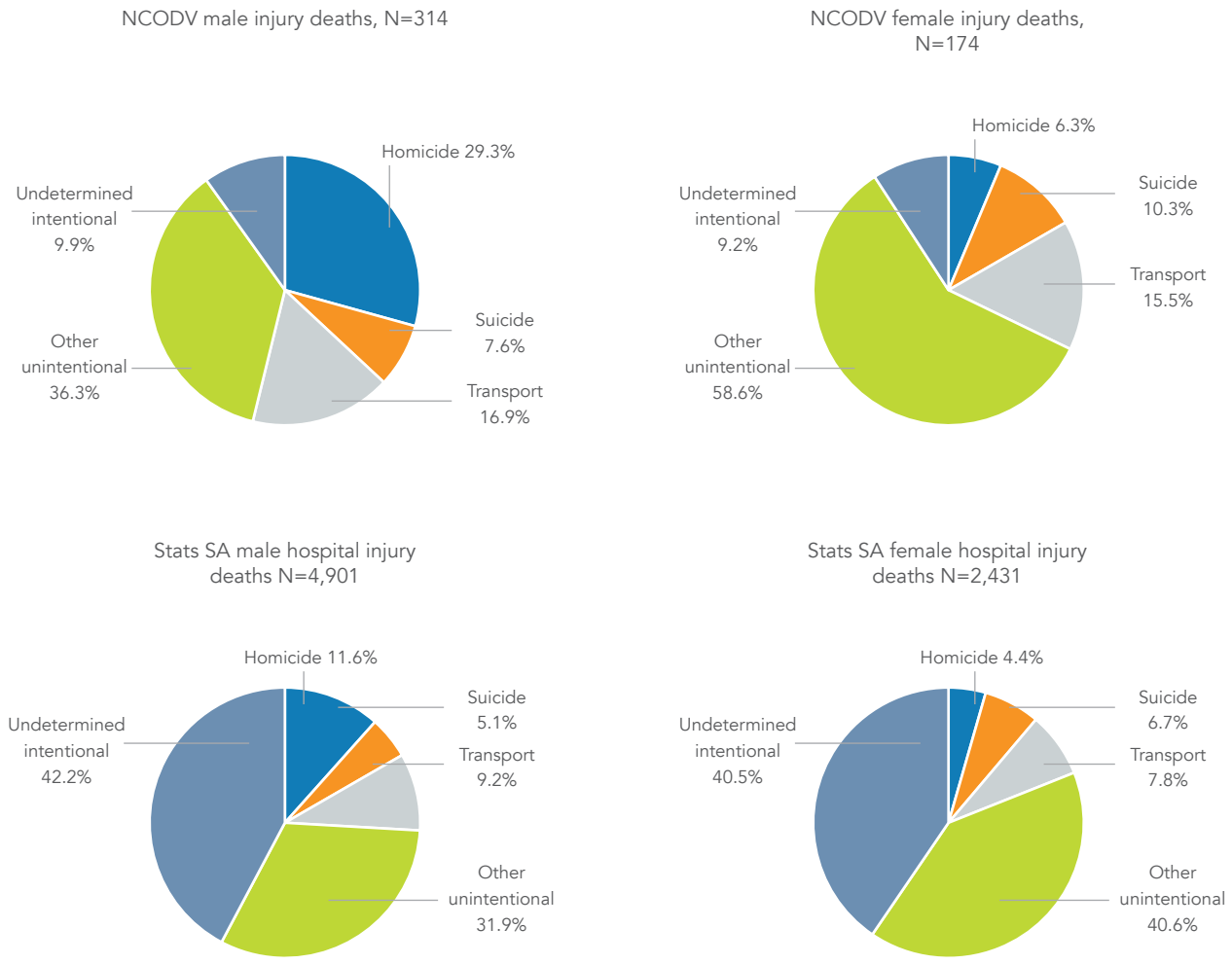



*Figure 17: Manner of injury death based on doctor review of medical records by sex (N=488), SA NCOD Validation Project 2017/18 and Stats SA hospital deaths (N=7,332), 2017.*

## 4.2 Forensic Pathology Records

### 4.2.1 Response

A total of 5,460 FPS records were reviewed by clinician reviewers from the 5,752 collected for the NCODV, Table 16. Of the 5,752 FPS case records collected during fieldwork the image of the record was lost during syncing for 148; there were 122 duplicate records and 22 only had MRs available to review.

*Table 16: Number of forensic pathology services records reviewed compared with number collected by year of death, SA NCOD Validation Project 2017/18.*

| Year of death | Number FPS records reviewed | Total FPS records collected | % |
|---|---|---|---|
| 2017 | 3,381 | 3,498 | 96.7% |
| 2018 | 2,079 | 2,254 | 92.2% |
| **Total** | **5,460** | **5,752** | **94.9%** |

FPS – Forensic pathology services

The numbers of deaths in each province from the sample is shown in Table 17, alongside the provincial number of deaths reported by Stats SA for 2017. There are noticeable differences in the geographic distribution of the sample and the national data. It is important to note that the sample of sub-districts was drawn based on the population size, and not the numbers of deaths. They were selected to ensure provincial representation of all socio-economic strata. Furthermore, the sample does not include private sector facilities.

No records were collected in KwaZulu-Natal (Table 17). Relative to the numbers reported by Stats SA, the numbers in Eastern Cape, Free State, Mpumalanga, Northern Cape and North West provinces are over-represented while the other provinces are under-represented. The detailed breakdown by health sub-district is reported in Table 22 in Annexure 8.5.

*Table 17: Provincial distribution of FPS records reviewed (N=5,460) compared with Stats SA 2017 data, SA NCOD Validation Project 2017/2018.*

| Province | NCOD Validate, 2017/18 | | Stats SA 2017 | | | |
|---|---|---|---|---|---|---|
| | | | All deaths | | Unnatural deaths | |
| | Number | % | Number* | % | Number | % |
| Eastern Cape | 1,279 | 23.4% | 65,162 | 15.2% | 7,746 | 15.8% |
| Free State | 362 | 6.6% | 31,209 | 7.3% | 3,197 | 6.5% |
| Gauteng | 777 | 14.2% | 92,524 | 21.6% | 10,894 | 22.2% |
| KwaZulu-Natal | 0 | 0.0% | 76,605 | 17.8% | 9,671 | 19.7% |
| Limpopo | 575 | 10.5% | 43,707 | 10.2% | 4,065 | 8.3% |
| Mpumalanga | 683 | 12.5% | 29,300 | 6.8% | 3,386 | 6.9% |
| Northern Cape | 534 | 9.8% | 32,473 | 7.6% | 2,859 | 5.8% |
| North West | 801 | 14.7% | 12,638 | 2.9% | 1,339 | 2.7% |
| Western Cape | 449 | 8.2% | 45,715 | 10.6% | 5,890 | 12.0% |
| **Total** | **5,460** | **100.0%** | **429,333** | **100.0%** | **49,047** | **100.0%** |

* 17,213 deaths had no province information; # 2,117 injury deaths had no province information; NCOD – National Cause-of-Death

### 4.2.2 Exclusions

A total of 145 FPS cases are excluded from further analysis as they either had no information or for specific reason such as non-viable fetus or stillbirth (Table 18), leaving a total of 5,315 deaths.

*Table 18: Reason for exclusion from analysis (N=145), SA NCOD Validation Project 2017/2018.*

| Category | Number | % |
|---|---|---|
| No information | 67 | 46.2% |
| Non-viable birth | 46 | 31.7% |
| Stillbirth | 11 | 7.6% |
| Skeletal remains | 11 | 7.6% |
| Concealment of birth* | 10 | 6.9% |
| **Total** | **145** | **100.0%** |

* legal term used for birth remains, regardless of fetal age

### 4.2.3 Socio-demographic characteristics

The sex distribution of the reviewed FPS records is shown in Table 19 for all causes and for natural and unnatural causes. The FPS sample has a much higher proportion of male deaths than the Stats SA data overall. However, when stratified by natural and unnatural, they were similar. Natural causes account for 18.1% of the total FPS sample, 15.4% of the male sample and 27.3% of the female sample. The age sex distribution of the FPS sample is compared with that of Stats SA 2017 data by natural and unnatural causes in Figure 19. The unnatural deaths have similar age sex characteristics. However, the most frequent age group in the FPS male sample was in an older age group (25-29 years) compared with the most frequent age group of 20-24 years in the Stats SA deaths from unnatural causes for males. The age sex characteristics of natural deaths in the FPS sample are different from the Stats SA natural deaths with higher proportions of male deaths and considerably lower proportions of older age groups.

*Table 19: Sex distribution of deceased from forensic pathology records (N=5,315), SA NCOD Validation Project 2017/18, compared with Stats SA 2017 data by natural and unnatural causes.*

| Sex | Forensic pathology records | | | Stats SA death data 2017 | | |
|---|---|---|---|---|---|---|
| | Number | % | 95% CI | Number | % | 95% CI |
| **All causes** | | | | | | |
| Male | 4,123 | 77.6% | 76.0% - 79.0% | 235,699 | 5 | 52 |
| Female | 1,186 | 22.3% | 21.0% - 23.0% | 210,507 | 47.2% | 47.0% |
| Ambiguous/intersex | 6 | 0.1% | 0.0% - 0.2% | | | |
| **Total** | **5,315** | **100.0%** | - | **446,206** | **100.0** | - |
| **Natural causes** | | | | | | |
| Male | 633 | 65.9% | 63.0% - 69.0% | 196, | 49. | 48.2 |
| Female | 324 | 33.8% | 31.0% - 37.0% | 199, | 50.4 | 49.5 |
| Ambiguous/intersex | 3 | 0.3% | 0.0% - 0.9% | | | |
| **Total** | **960** | **100.0%** | - | **395,** | **100.0** | |
| **Unnatural causes** | | | | | | |
| Male | 3,490 | 80.1% | 79.0% - 81.0% | 39,593 | 77.4% | 75.4% - 79.5% |
| Female | 862 | 19.8% | 19% - 21% | 11,430 | 22.3% | 20.7% - 24.1% |
| Ambiguous/intersex | 3 | 0.1% | 0.0% - 0.2% | - | | |
| **Total** | **4,355** | **100.0%** | - | **51,023** | **100.0%** | |

* 340 deaths have unknown or unspecified sex


*Figure 18: Age sex distribution of FPS sample (N=5,309), SA NCOD Validation Project 2017/18 and Stats SA 2017 deaths (N= 446,206) by unnatural and natural causes.*

Table 20 shows the age group break-down of the sample of FPS records by sex (N=5,326), for the study period. This includes the 11 stillbirths. There were high proportions of adults with 45.2% in the adult 25-44 years age group and 21.5% in the adult 45-64 years age group.

*Table 20: Age group distribution FPS records excluding stillbirths by sex (N=5,309), SA NCOD Validation Project 2017/18.*

| Age group | Male | % | Female | % | Total* | % |
|---|---|---|---|---|---|---|
| Early neonatal (0-6 days) | 8 | 0.2% | 6 | 0.5% | 14 | 0.3% |
| Late neonatal (7-27 days) | 6 | 0.1% | 8 | 0.7% | 14 | 0.3% |
| Post neonatal (1-11 months | 91 | 2.2% | 54 | 4.6% | 145 | 2.7% |
| Child (1-4 years) | 81 | 2.0% | 58 | 4.9% | 139 | 2.6% |
| Older child (5-14 years) | 159 | 3.9% | 44 | 3.7% | 203 | 3.8% |
| Adolescent and youth (15-24 years) | 650 | 15.8% | 187 | 15.8% | 837 | 15.8% |
| Adult (25-44 years) | 1,999 | 48.5% | 407 | 34.3% | 2,406 | 45.3% |
| Adult (45-64 years) | 864 | 21.0% | 283 | 23.9% | 1,147 | 21.6% |
| Older adult (65+ years) | 212 | 5.1% | 130 | 11.0% | 342 | 6.4% |
| **Missing ages** | 53 | 1.3% | 9 | 0.8% | 62 | 1.2% |
| **Total** | **4,123** | **100.0%** | **1,186** | **100.0%** | **5,309** | **100.0%** |

*6 had unknown sex; 11 stillbirths have been excluded

### 4.2.4 Quality of cause of death information as assessed by medical doctor reviewers

While reviewing the forensic records to ascertain the case history of the patient and identify the cause of death identified during autopsy, the forensic pathologist reviewer assessed whether the admission/case history and autopsy records were consistent and allocated these to one of the following 3 categories: not consistent, unclear, consistent. They then scored the quality and coherence of the case / admission history and the autopsy findings using a rating score ranging from 1 (very poor) - 5 (excellent). The reviewers assessed the admission and case history and autopsy findings as consistent in 81.0% of records (Table 21). They rated the quality and coherence of these as adequate to excellent in 85.8% of cases (Table 21). Overall, 78.3% (4,159/5,315) scored adequate - excellent for both consistency and quality.

A major concern regarding the FPS records with low scores was poor documentation of the details of the autopsies. This raised questions about whether the autopsies were performed by appropriately qualified medical professionals. In addition, toxicology results were rarely available at the time of reviewing; however, best medical judgement was used based on available circumstantial evidence (e.g., If a container of organophosphates was found near the body and the autopsy suggested poisoning the reviewer would assume that the UCOD was organophosphate poisoning. In cases involving a fetus and/or an abandoned baby with minimal background history, it proved difficult to identify the manner of death and thus the causal sequence and UCOD. Such cases have been excluded from further analysis. A diagram showing categories of fetuses and infants and the possible causes of death in infants was developed by the senior forensics and epidemiology team with a view to reviewing these cases in detail at a later stage (Figure 24 in Annexure 8.3.1).

*Table 21: Reviewers assessment of the quality of FPS records and the level of certainty of the UCOD based on medical record information (N=5,315), SA NCOD Validation Project 2017/18.*

| Coherence and quality of records score | Consistency of records | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|
| | No | | Not clear | | Yes | | | |
| | N | % | N | % | N | % | N | % |
| **1 (very poor)** | 75 | 1.4 | 153 | 2.9 | 12 | 0.2 | **240** | 4.5 |
| **2 (poor)** | 68 | 1.3 | 313 | 5.9 | 132 | 2.5 | **513** | 9.7 |
| **3 (adequate)** | 52 | 1.0 | 305 | 5.7 | 690 | 13.0 | **1,047** | 19.7 |
| **4 (good)** | 20 | 0.4 | 25 | 0.5 | 1,343 | 25.3 | **1,388** | 26.1 |
| **5 (excellent)** | | | 1 | 0.0 | 2,126 | 40.0 | **2,127** | 40.0 |
| **Total** | **215** | **4.0** | **797** | **15.0** | **4,303** | **81.0** | **5,315** | **100.0** |

### 4.2.5 Quality of coded data based on FPS records

Using the criteria developed by an expert group convened by the Bloomberg Philanthropies Data for Health Initiative and the Civil Registration and Vital Statistics Improvement project of the University of Melbourne in 2017,[32] the quality of the underlying cause information of the 5,309 deaths with specified sex was found to be of good quality. A high proportion of the causes (80.6%) were coded to usable codes (Figure 19), and there were very low proportions of ill-defined causes (3.3%) or impossible (0.5%) or intermediate causes (1.1%). However, 13.9% of the causes are considered to have insufficient specification within an ICD chapter, indicating that there are gaps in the information available in an FPS record. The breakdown of garbage type is shown for the natural and unnatural causes compared with 2017 data from Stats SA in Figure 20. The underlying cause of death information for the unnatural deaths in the FPS sample is extremely high quality with 87.5% usable codes and only 12.5% with insufficient information. In contrast, the natural deaths from the FPS sample of deaths only have 49% usable codes with a range of unusable codes including 21.3% due to ill-defined signs and symptoms. Compared with the FPS sample, Stats SA data has a similar proportion of usable codes among the natural causes (48.9%), however, a much lower proportion of usable codes among the unnatural causes (43.3%). The high proportion of unnatural deaths that are insufficiently specified in the Stats SA unnatural deaths arises from the lack of a field to capture the manner of death on the DHA-1663, resulting in not being able to determine the intent of the external cause.

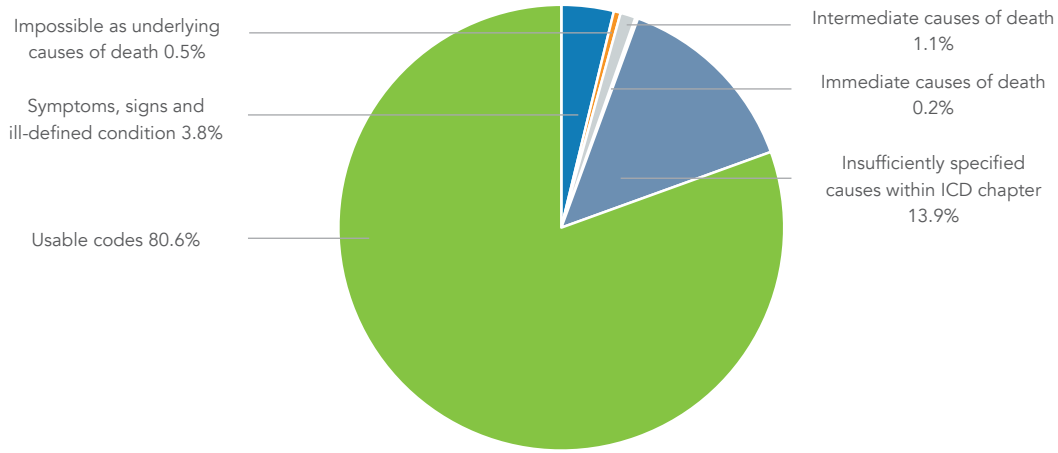



*Figure 19: Assessment of the underlying cause of death data from doctor reviewed FPS records (N=5,309), NCOD Validation Project 2017/18.*

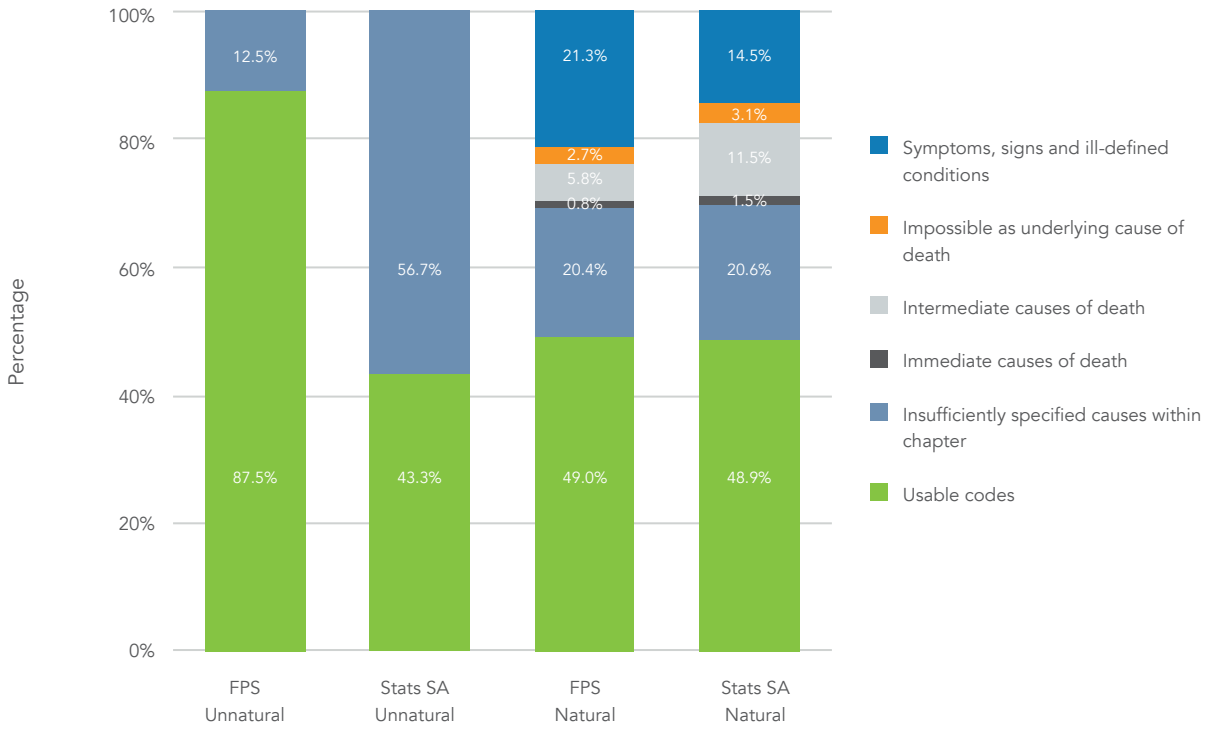



*Figure 20: Assessment of the underlying cause of death data from doctor reviewed FPS records (N=5,309), NCOD Validation Project 2017/18 and 2017 Stats SA data (N=446,546) by unnatural and natural causes.*

Females have a lower proportion of usable codes than males (Figure 21). This is associated with the higher proportion of female deaths due to natural causes in the FPS sample.

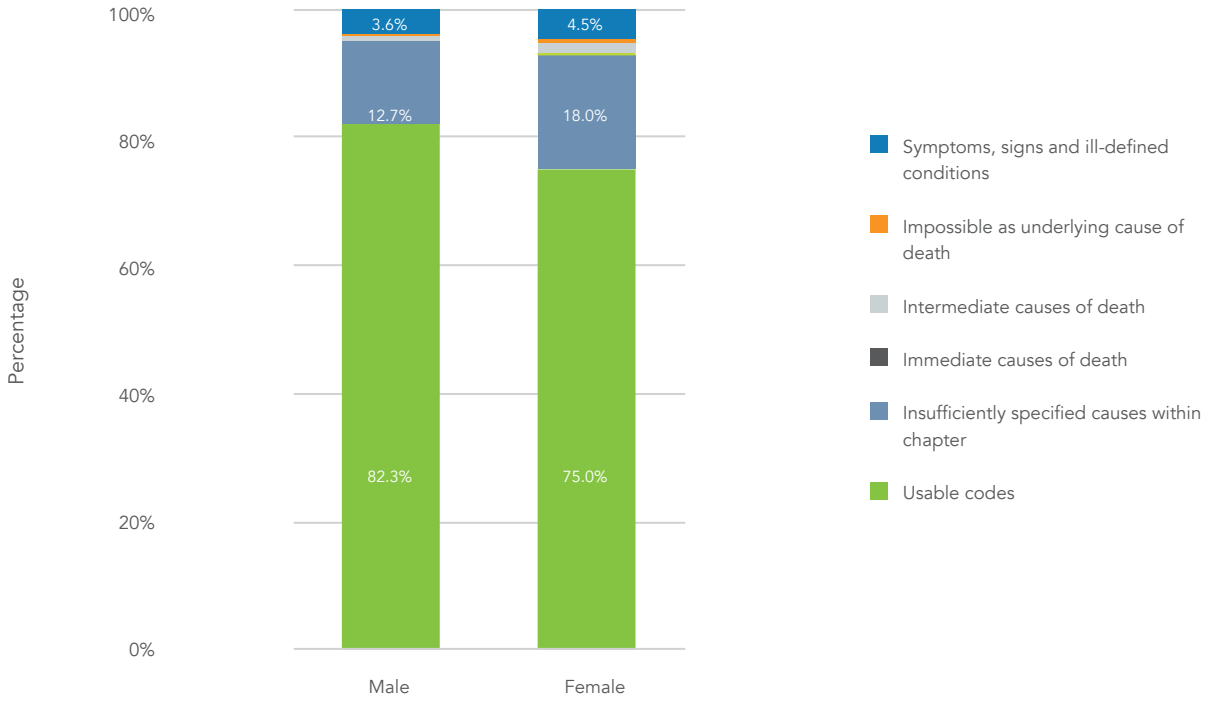



*Figure 21: Assessment of underlying cause of death from FPS records by sex (N=5,309), SA NCOD Validation Project 2017/18.*

### 4.2.6 Cause of death profile based on FPS records compared with Stats SA injury deaths

The manner of injury death profile is very different for the FPS sample and Stats SA death data for 2017. From Figure 22, it can be seen that a very high proportion of the Stats SA injury (about 70%) are reported as other unintentional injuries. In contrast, the FPS sample only had 11.6% other unintentional causes and much higher proportions of deaths due to homicide, suicide, and transport, regardless of sex. The substantively different pattern arises from the lack of information about the manner of injury on the DHA-1663. The lower proportions of injury deaths due to undetermined intent in the Stats SA data (2.7% vs 5.7% for males and 5.7% vs 8.8% for females) is likely as a result of the ICD-10 coding practice of coding "gunshot wounds" without additional details to "W34 Discharge from other and unspecified firearms" which is considered accidental rather than to "Y24 Other and unspecified firearm discharge" which is considered undetermined intent.

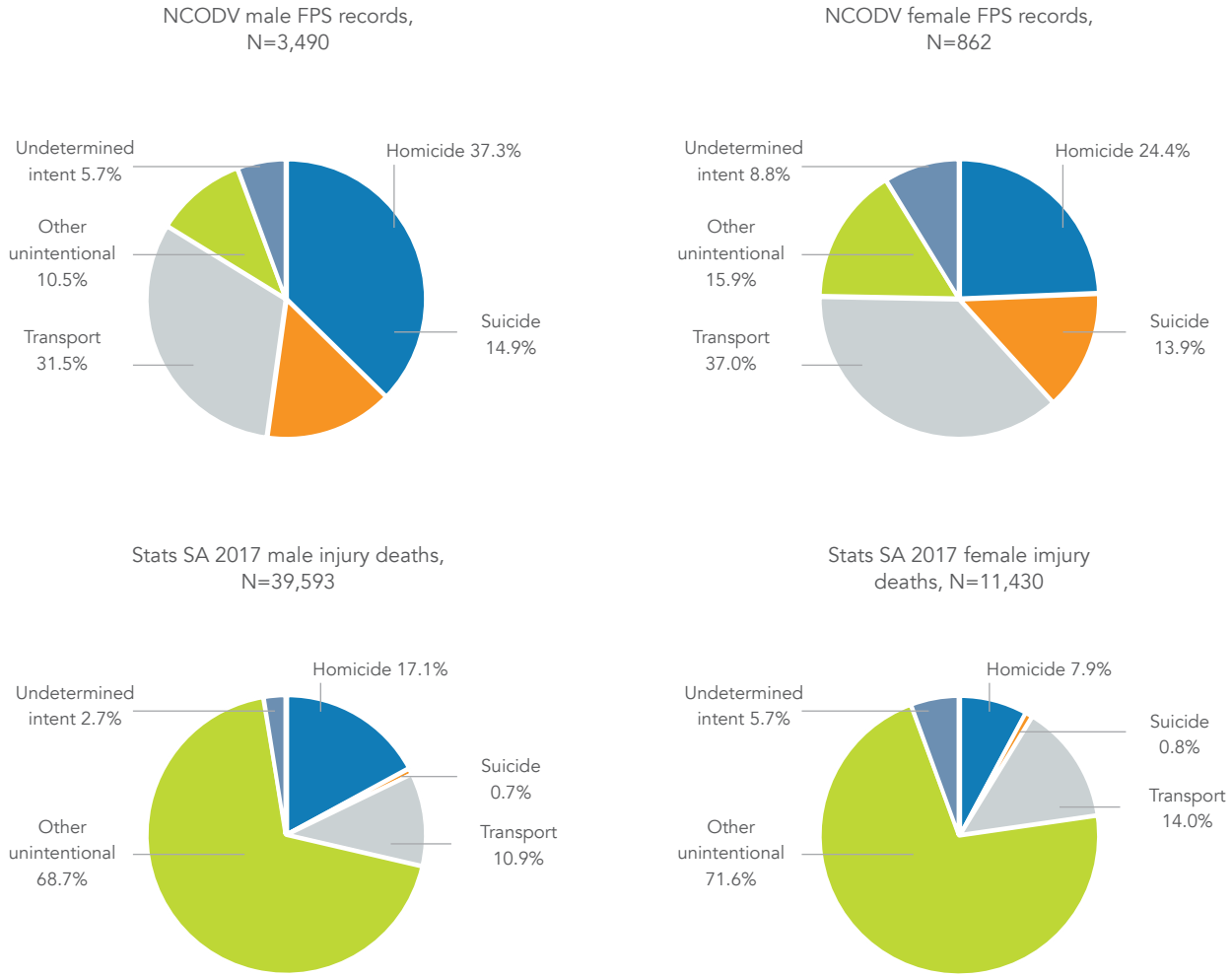



*Figure 22: Manner of injury death based on FPS records by sex (N=4,352), SA NCOD Validation Project 2017/18 and Stats SA injury deaths (N=51,023), 2017.*

Figure 23 shows the leading causes of injury deaths (based on the NBD list, Table 22 in Annexure 8) according to the FPS sample and the Stats SA data. There are substantial variations between the two sources of data. The FPS data shows that overall injury deaths are 4x higher in males than in females and homicide/femicide is 6x higher in males. Out of the 210 records for femicides, 51 (24%) reported that the perpetrator was an intimate partner. This is lower than observed in other South African femicide studies,[34] which had supplemented their review of FPS records with additional data collected from the police.

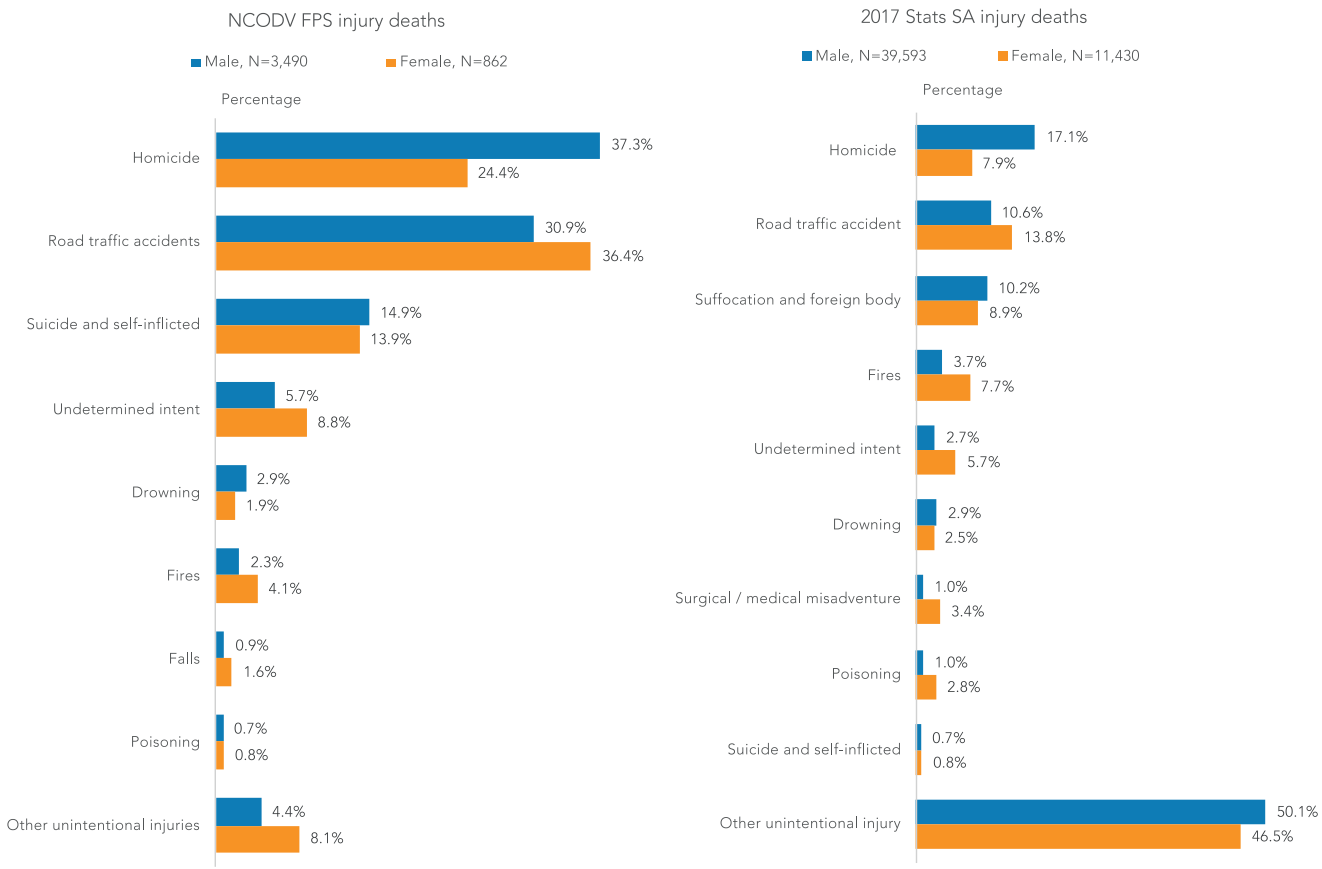



*Figure 23: Leading causes of injury death by sex based on FPS records (N=4,352), SA NCOD Validation Project 2017/18 and Stats SA injury deaths (N=51,023), 2017.*

## 4.3 Comparison of medical and forensic pathology records cause of death profile with 2017 Stats SA data

An overall summary of the causes of death from the NCODV medical and FPS records against the cause of death profile for the 2017 Stats SA deaths and the subset of Stats SA hospital deaths is shown in Table  in Annexure 8.6.

- The high proportion of HIV/AIDS deaths (32.9%) and the relatively high proportion of stroke deaths (8.0%) among the MRs are highlighted when compared with the Stats SA hospital deaths (8.8% and 5.9% respectively).
- The high proportions of specified injury deaths among the sample of FPS records due to external causes (homicide (34.7%), transport injuries (32.6%), and suicide (14,7%)) are highlighted when compared with the injury deaths in the Stats SA injury data ((homicide (15.0%), transport injuries (11.6%), and suicide (0.7%)).
- The high proportion of ill-defined natural deaths among the total Stats SA data (13.4%) is highlighted when compared with Stats SA hospital deaths (1.8%), the MR sample (3.3%) and the FPS records (3.8%).

# 5. Discussion

## 5.1 Key findings

- This study has demonstrated that it was possible to scan medical and forensic records from a national sample of facilities to provide clear images for review by medical professionals at a centralized site. The MRs and FPS records were deidentified in the collection process and managed in the project using a USID number. These records provided good quality information on which cause of death could be assigned by doctors trained in medical certification of cause of death. The quality of information collected was considered to be good.
- Although, not a specific objective of the study, a number of concerns were identified about quality of care through the review of the records and it was decided to audit a systematic sample of records that had been flagged as having a concern. Following the audit, it was determined that 15% of the medical records had a concern. These related to poor record keeping as well as concerns about patient management.
    - Most common were issues around record keeping, which accounted for 51% of the identified concerns. Good record keeping, itself, is important for quality patient care, firstly to ensure effective communication between all the personnel in a multi-disciplinary team and continuity of care over time for a chronic condition. Staff members work different shifts and as such, the patient record is the document of communication between everyone regarding the patient's ongoing condition and plans for management. Secondly, regular reviews and auditing of MRs can be taken to monitor the standard of care of patients and competence of staff members. There are occasions, such as in mortality meetings or legal hearings where a review of the MR is required to determine the events called into question. A poor record in these instances would render a case indefensible. Budget constraints always exist and limit the ability to perform investigations, hence a thorough clinical history and examination is the mainstay of directing the doctor's investigation and management plan.
    - Other concerns potentially indicating poor patient management were identified. In 35% of the sample of records identified as having an issue, reviewers reported that the clinical work-up was inadequate. Staff shortages may be a reason for this but cannot be an excuse. Inadequate clinical work up included:
        - An incomplete clinical history and examination, and/or
        - Incomplete or no diagnostic investigations (laboratory or other).

    In a further 17%, reviewers reported management concerns such as inadequate monitoring, failure to respond to abnormal laboratory investigations, discharging case without a complete investigation for presenting symptoms, and failure to perform investigations indicated by clinical condition.

- The study has demonstrated that HIV/AIDS and TB mortality was measurable in a high HIV burden country, and the proportion of deaths with HIV/AIDS as the underlying cause based on MRs, was considerably higher than the proportion identified in the hospital deaths in Stats SA data. Given that in a large proportion of cases (~ 45%) the HIV and TB status was not documented in the medical records, it is possible that the proportion of deaths due to HIV/AIDS and or TB could be even higher. In addition, HIV and TB comorbidity is not generally reported by Stats SA (because it requires 4-digit ICD coding) but could be identified through the physician reviewed records.
- The sample of FPS records provided extremely high-quality information about causes of injury deaths. The underlying cause of death of 87.5% of the unnatural deaths were considered usable. A relatively small proportion (12.5%) were considered insufficiently specified within the ICD chapter. This might be related to lack of information from an inquest to determine the cause of death and the outcome of an inquest is generally not added to the FPS record.

## 5.2 Study limitations

- This study collected data from public sector hospitals only. It is unknown what proportion of deaths occur in private health facilities.
- Having reviewed a large sample of cases and assessing the UCOD identified by the clinician reviewers, the quality assurance panel identified two factors related to the data collection process that could have contributed to the overall quality of the data. Since the review of the MRs occurred after the field work was complete, it was not possible to provide feedback to the field work team on any adjustments for quality for this study but can be noted when conducting other studies. However, such incidents were relatively infrequent and are unlikely to affect the overall findings of the study.
  - **Quality of medical records imaging and preparation**
    - During de-identification of the records field workers occasionally blanked out the basic demographic information of the patient such as age and sex.
    - There were occasions where more than one patient's notes were in the case file. This is possibly linked to the neatness of filing at the various institutions. We were able to identify the correct notes by referring to the master list of MRs which contained identifiers, date of birth (DOB) and date of death (DOD).
    - Although the study aimed to obtain records of deaths within a specified period, occasionally the MRs available were prior to the date of demise of the case. This was usually where the patient had demised at home.
    - In the case of maternal / perinatal records, it was not always clear whether the decedent was the stillborn child or mother since the details are recorded as that of the mother by the fieldworker. This could be checked by checking whether the mothers ID was in the database of deaths on the National Population Register that the SAMRC obtains from DHA. If not, the decedent was presumed to be the infant/fetus.
    - In a few cases the date of death had been recorded incorrectly as 2017 when it was 2018.
  - **Clinical experience of the reviewers**
    - The clinical experience of the reviewer could have influenced the causal sequence and UCOD chosen. Despite training some reviewers still recorded non-specific signs and symptoms instead of valid conditions or incorrect causal sequences. Where possible, feedback was given to specific reviewers to pre-empt this happening again. Reviewers identified as persistently conducting poor quality reviews were not allocated any further batches to review.
- This project was a very large national study using methodology that had never been used in South Africa before and made the planning and budgeting difficult. Additional time and resources were and still are required to complete all objectives.

## 5.3 Study strengths

- Good quality cause of death data were collected. The fieldwork to collect facility records was very well prepared, conducted, and monitored. There was a low refusal rate by facilities to participate – only the 3 FPS facilities in KwaZulu-Natal did not provide permission for data collection.
- Digital data collection tools using KoBoToolbox enabled ongoing monitoring and immediate identification of data quality issues. This quality assurance has ensured good quality data.
- Thorough training of medical doctors to conduct the reviews of the MRs and FPS records and identify the underlying cause of death has resulted in good quality data. Materials from previous trainings for doctors in medical certification provided the basis for the training of study doctors, together with input that was provided by experienced collaborators during pre-testing phases.
- The project has built capacity for cause of death determination which will remain beyond the study.
- The project will enable cause of death validation at a national level.

# 6. Recommendations

## 6.1 Link the data with Stats SA data to verify the cause of death and estimate correction factors

It is essential to complete the final step of this project by linking the data collected in the NCODV project with the 2017 and 2018 Stats SA cause of death data. The high proportion of HIV/AIDS deaths found in the sample of MRs and the detailed information about causes of injury deaths in the FPS sample highlights the importance of estimating correction factors that can assist with providing informative cause of death profiles.

Given that the sample realization was somewhat different from the original protocol, careful analysis of the data will be required once the linkage has been achieved and any potential bias understood to determine analysis weights that can be applied in calculating correction factors.

## 6.2 Improve cause of death data

### 6.2.1 Train doctors in medical certification

The high quality of the cause of death information provided by the study doctors emphasizes the importance of training doctors in the ICD principles of underlying cause of death and how to complete the medical certificate. The training resources used for this study are currently being adapted into an online training platform that will enable self-learning and assessment linked to Continuing Education Units. Offering Ethics Continuing Education Units would provide an incentive for both public and private doctors to complete the course. The platform can be tested and evaluated for use in academic settings during medical training (under-graduate and internships), in the public sector during compulsory community service year and when physicians are newly appointed, and in the private sector. This is one opportunity to enhance the quality of cause of death statistics in South Africa. A national effort involving NDOH, Stats SA, SAMRC, SAMA, HPSCA and the Health Sciences Faculties is suggested.

### 6.2.2 Provide 4-digit codes for underlying cause of death data

Although the Stats SA cause of death data has limitations resulting from insufficient information provided on the death notifications and/or misclassification of the underlying cause, it could be helpful to make the data available with 4-digit codes for the underlying cause of death for further analysis. This would make it possible to report the number of deaths registered with HIV with TB, for example.

### 6.2.3 Amend the DHA-1663 to include manner of death

The extremely different COD profile for injury related deaths that was identified from the FPS records collected in this study from that reported by Stats SA, highlights the importance of amending the DHA-1663 to include a field for information about the manner of death, in line with the International Medical Certificate of Death recommended by the International Statistical Classification of Diseases and Related Health Problems (ICD-10) [1].

### 6.2.4 Record keeping standards in hospitals

The most common concern flagged by clinical reviewers was around poor quality of record keeping. While the HPCSA has issued Guidelines on the keeping of patient records (Booklet 9 of the Guidelines for good practice in the health care professions) outlines the elements of clinical records,[35] the guideline is not very detailed. The Medical Protection Society Guide on Medical Records in South Africa[36] emphasizes the purpose of MRs in supporting continuity of care and highlights medico-legal aspects of keeping records. Facilities can have procedures in place to monitor record-keeping standards.

### 6.2.5 Monitoring quality of care

In the exercise of reviewing the records, the clinician reviewers identified a number of instances of possible concern about poor patient management which warrants further investigation through a more carefully designed assessment.

### 6.2.6 Routine collection of facility-based death data

Since large numbers of death occur in health facilities and FPS, it can be a matter of course that there is a system to routinely capture information about such deaths. Data on the numbers and causes of deaths in facilities would provide important outcome measures which can be monitored in all facilities.

# 7. References


1. World Health Organisation. International statistical classification of diseases and related health problems. Tenth revision. Geneva: WHO; 2011.
2. Bradshaw D, Joubert J, Maqungo M, et al. South African National Cause-of-Death Validation Project: Methodology and Description of National Sample of Verbal Autopsies: South African Medical Research Council, 2020.
3. Phillips D, Lozano R, Naghavi M, et al. A composite metric for assessing data on mortality and causes of death: the vital statistics performance index. *Population Health Metrics* 2014; 12(1): 14.
4. United Nations Statistics Division. Principles and recommendations for a vital statistics system. Statistical Papers, Series M, No. 19, Revision 3. New York: United Nations; 2014.
5. United Nations Statistics Division. Handbook on Civil Registration and Vital Statistics Systems: Management, Operation and Maintenance: Revision 1. New York, USA: United Nations, 2018.
6. United Nations. Transforming Our World: The 2030 Agenda for Sustainable Development. Resolution A/RES/70/1. New York: United Nations General Assembly: United Nations, 2015, Sep 25.
7. United Nations Statsitics Division. SDG Indicators: Global indicator framework for the Sustainable Development Goals and targets of the 2030 Agenda for Sustainable Development. 2019. https://unstats.un.org/sdgs/indicators/indicators-list/ (accessed 08 Oct 2019 2019).
8. Roth GA, Abate D, Abate KH, et al. Global, regional, and national age-sex-specific mortality for 282 causes of death in 195 countries and territories, 1980–2017: a systematic analysis for the Global Burden of Disease Study 2017. *The Lancet* 2018; 392(10159): 1736-88.
9. Republic of South Africa. Births and Deaths Registration (Act 51 of 1992). Government Gazette No. 13953, Vol. 323. Cape Town, South Africa: Government Printer; 1992.
10. Statistics South Africa. Mortality and causes of death in South Africa, 2016: findings from death notification. Statistical release P0309.3. Pretoria, South Africa: Statistics South Africa, 2018.
11. Pillay-van Wyk V, Bradshaw D, Groenewald P, Laubscher R. Improving the quality of medical certification of cause of death: the time is now! *S Afr Med J* 2011; 101(9): 626.
12. Statistics South Africa. Mortality and causes of death in South Africa, 1997 - 2013. Dataset produced and provided by Statistics South Africa, Pretoria, South Africa, based on information extracted from official civil registration Death Notification Forms submitted for death registration to the Department of Home Affairs, for deaths occurring in the years 1997 - 2013;; 2014.
13. Matzopoulos R, Prinsloo M, Pillay-van Wyk V, et al. Injury-related mortality in South Africa: a retrospective descriptive study of postmortem investigations. *Bull World Health Organ* 2015; 93(5): 303-13.
14. Joubert J, Bradshaw D, Kabudula C, et al. Record-linkage comparison of verbal autopsy and routine civil registration death certification in rural north-east South Africa: 2006-09. *International journal of epidemiology* 2014; 43(6): 1945-58.
15. Kahn K, Tollman SM, Garenne M, Gear JSS. Validation and application of verbal autopsies in a rural area of South Africa. *Tropical Medicine & International Health* 2000; 5(11): 824-31.
16. Bradshaw D, Msemburi W, Dorrington R, et al. HIV/AIDS in South Africa: how many people died from the disease between 1997 and 2010? *Aids* 2015.
17. Bradshaw D, Groenewald P, Laubscher R, et al. Initial burden of disease estimates for South Africa, 2000. *S Afr Med J* 2003; 93(9): 682-8.
18. Birnbaum JK, Murray CJL, Lozano R. Exposing misclassified HIV/AIDS deaths in South Africa. *Bull World Health Organ* 2011; 89(4): 278-85.
19. Wang H, Dwyer-Lindgren L, Lofgren KT, et al. Age-specific and sex-specific mortality in 187 countries, 1970-2010: a systematic analysis for the Global Burden of Disease Study 2010. *The Lancet* 2012; 380(9859): 2071-94.

20. Naghavi M, Wang H, Lozano R, et al. Global, regional, and national age–sex specific all-cause and cause-specific mortality for 240 causes of death, 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. *The Lancet* 2014; 385(9963): 117-71.
21. Dorrington RE, Bourne D, Bradshaw D, Laubscher R, Timaeus IM. The impact of HIV/AIDS on adult mortality in South Africa. Cape Town: South African Medical Research Council, 2001.
22. Harvard Humanitarian Initiative. KoBoToolbox: Data Collection Tools for Challenging Environments. Available at: http://www.kobotoolbox.org/; .
23. Clear Scanner. Available: https://clear-scanner-free-pdf-scans.en.softonic.com/android Accessed: 11 Dec 2019.
24. Dropbox Business. Available: https://www.dropbox.com/business Accessed: 11 Dec 2019. .
25. Microsoft Teams. (Version release Android 1416/1.0.0.2019101801) [Desktop application software] Available: http://products.office.com/en-us/microsoft-teams/group-chat-software Accessed: 05 Dec 2019.
26. Iris Institute. Iris - Automated coding system for causes of death. Heidelberg, Germany: German Institute of Medical Documentation and Information (DIMDI), 2018.
27. Chapman WB. Validate South African ID Number with Excel Formula. 2019. https://wa.rwick.com/author/admin/ (accessed Accessed: 09 Dec 2019.
28. Dorrington RE, Bradshaw D, Laubscher R, Nannan N. Rapid mortality surveillance report 2018. Cape Town: South African Medical Research Council, 2020.
29. Mikkelsen L, Lopez AD. Guidance for assessing and interpreting the quality of mortatlity data using ANACONDA. Melbourne, Australia: Bloomberg Philanthropies Data for Health Initiative, and the Civil Registration and Vital Statistics Improvement Group of the Melbourne University, 2017.
30. Naghavi M, Makela S, Foreman K, O'Brien J, Pourmalek F, Lozano R. Algorithms for enhancing public health utility of national causes-of-death data. *Popul Health Metr* 2010; 8: 9.
31. GBD 2017 Causes of Death Collaborators. Global, regional, and national age-sex-specific mortality for 282 causes of death in 195 countries and territories, 1980-2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet* 2018; 392(10159): 1736-88.
32. University M. Reducing barriers to the accurate medical certification of cause of death. CRVS technical outcome series. Melbourne, Australia: Bloomberg Philanthropies Data for Health Initiative, and the Civil Registration and Vital Statistics Improvement project of the University of Melbourne, 2018.
33. Pillay-van Wyk V, Msemburi W, Laubscher R, et al. Mortality trends and differentials in South Africa from 1997 to 2012: second National Burden of Disease Study. *The Lancet Global health* 2016; 4(9): e642-53.
34. Abrahams N, Mathews S, Martin L, Lombard C, Jewkes R. Intimate Partner Femicide in South Africa in 1999 and 2009. *PLoS Med* 2013; 10(4): e1001412.
35. Health Professions Council of South Africa. Guidelines on keeping of patient records (Booklet 9). In Health Professions Council of South Africa: *Guidelines for good practice in the health care professions*. Pretoria: HPCSA; September 2016.
36. Medical Protection Society. Medical Records in South Africa: An MPS guide. London: MPS; 2014.

# 8. Annexure

## 8.1 Objectives of SA NCOD Validation Project 2017/18

The study has three interrelated objectives which each have their own more detailed sub-objectives:

1. To verify causes of death reported on death notification forms in a nationally-representative sample of deaths occurring within and outside health facilities.
    a. For deaths occurring in health facilities, agreement between the underlying cause of death reported on the DHA-1663 and the underlying cause of death based on MRs will be measured.
    b. For deaths occurring outside health facilities, the agreement between the underlying cause of death reported on the DHA-1663 and the underlying cause of death obtained from an interviewer-administered household VA will be measured.
    c. For deaths requiring a forensic investigation, the agreement between the underlying cause of death (external or natural) reported on the DHA-1663 and the underlying cause of death (external or natural) reported in forensic records will be measured.
    d. To check whether decedents were recorded in appropriate death registers (e.g., cancer register, Tier.net (ie HIV register) or the TB register).

2. To derive correction factors to adjust cause-specific mortality data from vital registration according to reference diagnoses at national, provincial, and district level.
    a. Correction factors for reference diagnoses will be derived from national sample data.
    b. The nationally derived correction factors for reference diagnoses will be applied to cause of death profiles from vital registration data at national, provincial, and district level.

3. To design and test a standardized methodology for household VA for deaths occurring outside health facilities, with a view towards broader implementation within the routine CVRS system.
    a. The agreement between physician coded VA underlying cause of death and the underlying cause of death obtained from medical and forensic records, will be measured for deaths occurring in health facilities and those requiring a forensic investigation.
    b. The agreement between the cause-specific mortality fraction (CSMF) produced through automated coding of VA and CSMF from medical and forensic records, will be measured for deaths occurring in health facilities and those requiring a forensic investigation.
    c. The feasibility and community acceptability of implementing VA as a routine part of the CVRS system will be assessed based upon interviewer experience in the field.

## 8.2 Quality assurance of hospital medical record reviews

### 8.2.1 Initial QA assessment

Each completed batch of MRs was assigned to one of the eight QAAOs for quality assurance review. The QAAO had access to the medical record reviews on the Kobotools database. The initial QA assessment of the 10,353 records from 279 batches occurred by reviewing the case summary and causal sequence only. The quality assurance process involved the following steps:-

1. Assessing the validity of the causal sequence reported in Part 1
2. Assessing the validity of the underlying cause of death (UCOD)
3. Checking that no mechanisms of death were reported as an UCOD
4. Checking and correcting spelling of reported causes of death.

5. Review of the summary of the case to ensure that
    a. It provided a clear description of the case
    b. The clinical reasoning was good
    c. It was consistent with the reported causal sequence
    d. The diagnosis was correct
6. Identification of all cases where the UCOD was reported as unknown. This included records where MRs were of poor quality (e.g., only a DOA form, or a single prescription chart available) and the reviewer felt that too little information was available to make a diagnosis. The USID for all cases with unknown UCOD in each batch were recorded.

If the review met the requirements in points 1-5 the QAAO would approve the case in Kobotools. If not, or if the UCOD was unknown, the QAAO would indicate that the case was on hold. This process was continued until the batch was complete. All cases that were put on hold, underwent complete review of the record.

1. If after reading the medical record the QAAO agreed with the reviewer's medical certificate of cause of death, they approved the case.
2. If minor edits were required these were edited in Kobotools, reasons for the edits indicated in the summary and then the case was approved.
3. If the QAAO disagreed with the reviewer's diagnosis, they could make changes to the submitted case giving an explanation in the summary. The USID of all cases where the UCOD was changed were recorded.
4. Ambiguous cases with a number of possible diagnoses or particularly complicated cases were referred to the QA panel for further discussion.

A total of 482 MRs had the complete case reviewed as the UCOD was reported as unknown. They were assessed to decide if the UCOD was truly unknown or whether a reasonable diagnosis could be made. If, after reading, the UCOD was determined to be unknown the case was approved. Where a diagnosis could be made the record was edited as in point 3 above.

#### 8.2.2 Assessment of a 10% sample

Four cases from each batch were sampled (usually every 10th case listed) for a full review by the QAAO, to confirm that the QAAO agreed with the reported causal sequence. The USIDs for the four cases reviewed in each batch were recorded. A total of 1,116 cases were reviewed in this 10% sample. In batches where the QAAO disagreed with two (or more) of these cases, the QAAO would review the MRs for the whole batch and edit or refer cases as described above.
Once all cases in the batch were approved, the QAAO completed a summary table available as a shared Excel document. This table documented the Batch number, Number of cases reviewed, the USID of the cases that were sampled and whether the AO agreed with the diagnosis or not, the number of Unknowns and which cases had the UCOD changed by the AO. Regular updates to this table enabled a quick visual assessment of which Batches were completed, which were being worked on and which Batches were yet to be assigned to a QA officer.

### 8.3 Quality assurance of forensic record reviews

#### 8.3.1 Issues / challenges identified during review of FPS records and how these were handled

1. **Pending toxicology/histology results** not available for the duration of the study - best medical judgment based on the information available was used i.e., if organophosphate poisoning was suspected pending toxicology results, and a bottle of organophosphate containing liquid was found near the body, it was assumed that this was indeed the UCOD.
2. **Quality of the case records were insufficient or sub-standard** - again, best medical judgment based on the available information was used, and a debriefing session took place to allow reviewers to air their frustrations and report any specific cases to senior forensics staff. Each review included ratings of various aspects of the record quality.

3. **Emotional toll due to the nature of the cases** - mostly, the forensics team managed well in this regard due to the nature of their everyday work, but a debriefing meeting was held, and confidential employee wellness facilities were made available to both reviewers and the QAAO team.
4. **In fetus /abandoned baby cases with minimal background history** - it proved difficult to identify the manner of death and thus the causal sequence and UCOD. Such cases have been excluded from further analysis. However, a decision tree was developed by the senior forensics and epidemiology team diagram to assist with the identification of the possible causes of death in infants, with a view to reviewing these cases in detail at a later stage, Figure 24.
5. **Committing to a causal sequence or a manner of death without sufficient irrefutable evidence** - the forensics QAAO team underwent training to clarify situations whereby best-medical-judgment could be used to suggest an underlying cause of death or manner of death.

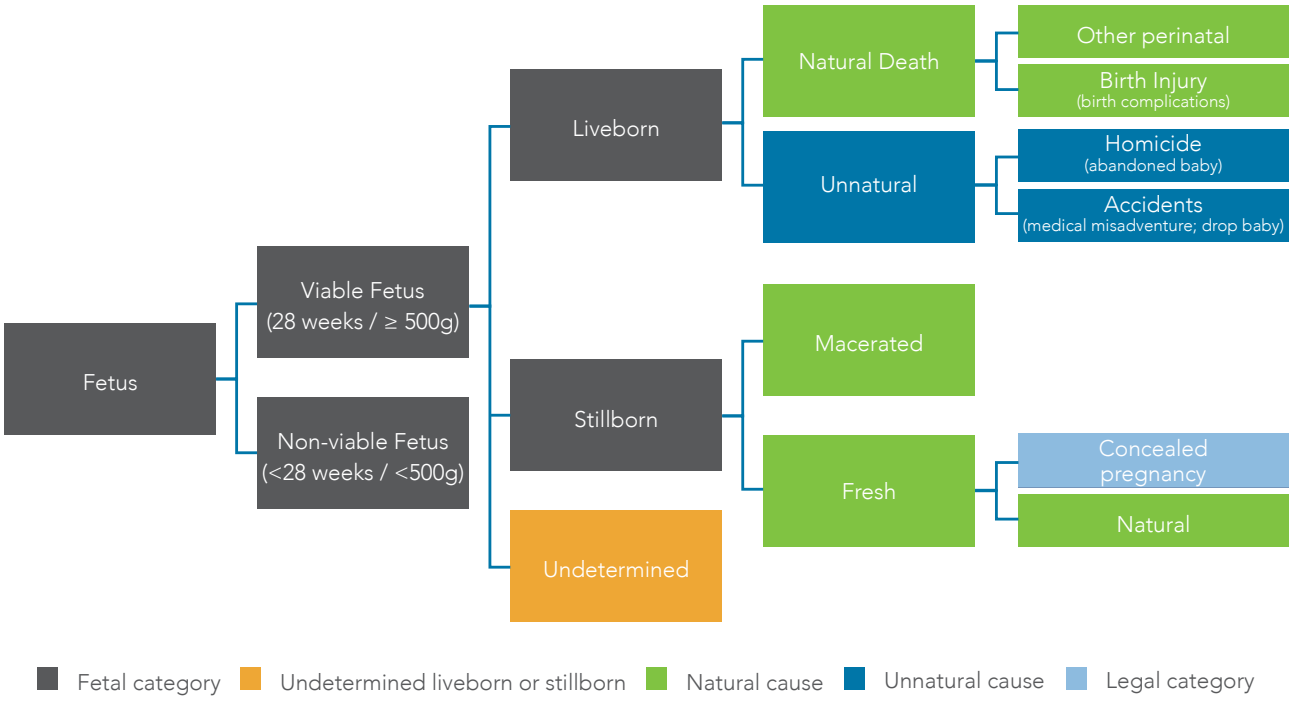



*Figure 24: Decision tree developed to identify causes of death in fetuses and infants*

### 8.3.2 Initial quality assessment conducted on all cases

1. The summaries of each case as well as the causal sequence were reviewed and approved if these met the following criteria:
   a. Case summary and causal sequence correlate
   b. Underlying cause of death was valid and not unknown
   c. Valid causal sequence with sufficient detail (e.g. road traffic fatality detailing the role of the deceased – pedestrian/ car occupant, passenger or driver)
   d. No outstanding toxicology or histology results
   e. Not stillbirths
   f. Natural causes where the causal sequence and UCOD was clear
2. If the above criteria were not met the QAAO would mark the case "On Hold" and review the case records themselves to ascertain if further information was available to clarify the sequence of events. If indeed more information was gathered, the reviewer would use their best medical judgement and clinical experience to edit the case submitted and then mark the case as "Approved."

3. If no further clarification was possible, either because of scanty information or difficult cases – these were then referred to the panel for discussion. Given that the UCOD in FPS cases was easier to identify than in medical cases, not many FPS cases required panel discussion thus the panel met only twice to discuss the difficult cases. Consensus on the causal sequence and the underlying cause of death was reached through discussion by all the forensic QAAO.

### 8.3.3 Assessment of 10% sample

A review of the case records along with the causal sequence of every tenth case in each batch was done, even if the initial review of the case summary and cause of death correlated. This was to ensure the quality of the batch was of an acceptable standard. If the QAAO did not agree with half or more of the 10% sample, the case records for the whole batch were reviewed.

A total of 5,602 forensic cases (including duplicates) were reviewed and submitted. In 5,390 (96%) cases, the QAAO agreed with the reviewer's causal sequence. The remaining 212 records (4%) required editing of the causal sequence and or UCOD.

## 8.4 Basic NBD list and VA list

The basic NBD list of 145 categories that was used in this analysis is shown in Table 22 and the VA list is shown in Table 23.

*Table 22: ICD-10 codes for each category of the basic NBD list.*

| Basic NBD list | | ICD-10 code |
|---|---|---|
| 1 | Tuberculosis | A15 - A19; U51 & U52; B90; J90 |
| 2 | STD/excl HIV | A50 - A64; N70 - N73 |
| 3 | HIV/AIDS | B20 - B24; C46 |
| 4 | Diarrhoeal diseases | A00 - A04; A06 - A09 |
| 5 | Childhood (vaccine preventable) cluster | A33 - A37; A80; B03; B05; B06; B91 |
| 6 | Bacterial meningitis | A39; G00; G03 |
| 7 | Hepatitis | B15 - B19 |
| 8 | Malaria | B50 - B54 |
| 9 | Schistosomiasis and other tropical diseases | B55 - B56; B65; B74 |
| 10 | Leprosy | A30; B92 |
| 11 | Intestinal parasites | B76 - B81 |
| 12 | Septicaemia | A40; A41 |
| 13 | Other infectious and parasitic | A05; A20 – A28; A31; A32; A38; A42 – A49; A65 - A69; A70 - A74; A75 - A79; A81 - A89; A90 - A99; B00 - B02; B04; B07 - B09; B25 - B34; B35 - B49; B57 – B64; B66 – B73; B75; B82 – B89; B94 – B99 |
| 14 | Lower respiratory infections | J09 - J18; J20 - J22 |
| 15 | Upper respiratory infections | J00 - J06 |
| 16 | Otitis media | H65; H66 |
| 17 | Maternal haemorrhage | O20; O44 - O46; O67; O72 |
| 18 | Maternal sepsis | O85 |
| 19 | Hypertension in pregnancy | O10 - O16 |

| Basic NBD list | | ICD-10 code |
|---|---|---|
| 20 | Obstructed labour | O64 - O66 |
| 21 | Abortion | O00 - O08 |
| 22 | Other maternal | O21 - O29; O30 - O43; O47 - O48; O60 - O63; O68 - O71; O73 - O75; O80 - O84; O86 - O92; O95 - O99 |
| 23 | Low birth weight | P05 - P07; P22 |
| 24 | Birth asphyxia and trauma | P03; P10 - P15; P20 - P21 |
| 25 | Other perinatal respiratory conditions | P23 - P29 |
| 26 | Neonatal infections | P35 - P39 |
| 27 | Other perinatal | P00 - P02; P04; P08; P29; P50 - P61; P70 - P94; P96 |
| 28 | Ill-defined perinatal | P95 |
| 29 | Protein-energy malnutrition | E40 - E46; D50 - D53; D64 |
| 31 | Pellagra and other nutritional deficiencies | E00 - E02; E50 - E64 |
| 32 | Mouth and oropharynx ca | C00 - C14 |
| 33 | Oesophagus ca | C15 |
| 34 | Stomach ca | C16 |
| 35 | Colo-rectal ca | C18 - C21 |
| 36 | Liver ca | C22 |
| 37 | Pancreas ca | C25 |
| 38 | Larynx ca | C32 |
| 39 | Trachea/bronchi/lung ca | C33 - C34 |
| 40 | Bone and connective tissue ca | C40; C41; C47; C49 |
| 41 | Melanoma of skin | C43 |
| 42 | Other skin cancer | C44 |
| 43 | Breast ca | C50 |
| 44 | Cervix ca | C53 |
| 45 | Corpus uteri ca | C54; C55 |
| 46 | Ovary ca | C56 |
| 47 | Prostrate ca | C61 |
| 48 | Bladder ca | C67 |
| 49 | Kidney ca | C64 - C66; C68 |
| 50 | Brain ca | C71 |
| 51 | Lymphoma | C81 - C90; C96 |
| 52 | Leukemia | C91 - C95 |
| 53 | Other malignant neoplasms | C17; C23 - C24; C26; C30 - C31; C37 - C39; C45; C48; C51 - C52; C57 - C58; C60; C62 - C63; C69 - C70; C72 - C75 |
| 54 | Ill-defined cancers | C76 - C80; C97 |
| 55 | Benign neoplasms | D00 - D48 |
| 56 | Diabetes mellitus | E10 - E14 |
| 57 | Albinism | E70 |

| Basic NBD list | | ICD-10 code |
|---|---|---|
| 58 | Other endocrine and metabolic | D55 - D63; D65 - D89; E03 - E07; E15 - E16; E20 - E34; E65 - E68; E71 - E89 |
| 59 | Alcohol dependence | F10 |
| 60 | Drug use | F11 - F16; F18 - F19 |
| 61 | Schizophrenia | F20 - F29 |
| 62 | Unipolar | F32 - F33 |
| 63 | Bipolar | F30 - F31 |
| 64 | Anorexia Nervosa | F50 |
| 65 | Obsessive compulsive/ panic disorders | F40 - F42 |
| 66 | Hyperkinetic | F90 |
| 67 | Adjustment reaction (PTSS) | F43 |
| 68 | Mental disability | F70 - F79 |
| 69 | Other mental disorders | F17; F34 - F39; F44 - F48; F51 - F59; F60 - F69; F80 - F89; F91 - F98; F99 |
| 70 | Alzheimer and other dementias | G30 - G31; F01 - F09 |
| 71 | Parkisons disease | G20 - G21 |
| 72 | Multiple sclerosis | G35 |
| 73 | Epilepsy | G40 - G41 |
| 74 | Encephalitis and brain abscess | G04; G06; G09 |
| 75 | Other nervous system disorders | G08; G10 - G12; G23 - G25; G36 - G37; G36 - G37; G43 - G47; G50 - G58; G60 - G64; G70 - G72; G80 - G83; G90 - G98 |
| 76 | Glaucoma | H40 |
| 77 | Cataracts | H25 - H26 |
| 78 | Other visual disorders | H00 - H21; H27 - H35; H42 - H59 |
| 79 | Hearing loss and other ear disorders | H60 - H62; H68 - H95 |
| 80 | Rheumatic heart disease | I01 - I09 |
| 81 | Ischaemic heart disease | I20 - I25 |
| 82 | Stroke | I60 - I69 |
| 83 | Inflammatory heart disease | I30; I33; I38; I40; I42 |
| 84 | Hypertensive heart disease | I10 - I13 |
| 85 | Non-rheumatic valvular disease | I34 - I37 |
| 86 | Pulmonary embolism | I26 |
| 87 | Aortic aneurism | I71 |
| 88 | Peripheral vascular disorders | I72 - I78; I80 - I84; I86 - I89; |
| 89 | Other cardiovascular | I00; I28; I31; I44 - I45; I95 - I99 |
| 90 | Ill-defined cardio - heart failure etc | I46 - I49; I50 - I51; J81 |
| 91 | Atherosclerosis | I70 |
| 92 | COPD | J40 - J44; I27 |
| 93 | Asthma | J45 - J46 |
| 94 | Aspiration pneumonia/ lung abscess | J69; J85 - J86 |

| Basic NBD list | | ICD-10 code |
|---|---|---|
| 95 | Other respiratory | J30 - J39; J47; J60 - J68; J70; J80; J82 - J84; J92 - J98 |
| 96 | Peptic ulcer | K25 - K28 |
| 97 | Appendicitis | K35 - K37 |
| 98 | Noninfective gastroenteritis and colitis | K50 - K52 |
| 99 | Cirrhosis of liver | K70; K74; K76; I85 |
| 100 | Hepatic failure | K72 |
| 101 | Gall bladder disease | K80 - K83 |
| 102 | Pancreatitis | K85; K86 |
| 103 | Other digestive | K20 - K22; K29 - K31; K38; K40 - K46; K55; K66; K71; K73; K75; K90; K91 |
| 104 | Ill-defined digestive | K92 |
| 105 | Nephritis/nephrosis | N00 - N19 |
| 106 | Benign prostatic hypertrophy | N40 |
| 107 | Other genito-urinary | N20 - N23; N25 - N39; N41 - N50; N60 - N64; N75 - N98 |
| 108 | Skin disease | L00 - L98 |
| 109 | Rheumatoid | M05 - M06 |
| 110 | Osteoarthritis | M15 - M19 |
| 111 | Other | M00 - M02; M08; M10 - M13; M20 - M99 |
| 112 | Neural tube defects | Q00 - Q07 |
| 113 | Cleft lip/palate | Q35 - Q37 |
| 114 | Congenital heart disease | Q20 - Q28 |
| 115 | Congenital disorders of GIT | Q38 - Q45 |
| 116 | Down syndrome and other chromosomal anomalies | Q90 - Q99 |
| 117 | Fetal alcohol syndrome | Q86 |
| 118 | Other congenital abnormalities | Q10 - Q18; Q30 - Q34; Q50 - Q56; Q60 - Q64; Q65 - Q79; Q80 - Q85; Q87 |
| 119 | Ill | Q89 |
| 120 | Dental caries | K02 |
| 121 | Periodontal disease | K05 |
| 122 | Other oral health | K00; K01; K03; K04; K06 - K14 |
| 123 | Cot death | R95 |
| 124 | Ill-defined natural | R00 - R09; R10 - R19; R20 - R23; R25 - R29; R30 - R39; R40 - R46; R47 - R49; R50 - R69; R70 - R79; R80 - R82; R83 - R94; R96 - R98; R99 |
| 125 | Road traffic accidents | V01 - V04; V06; V09 - V80; V87; V89; V99 |
| 126 | Non motor vehicle traffic accidents | V05; V81 - V86; V88; V90 - V94; V95 - V98 |
| 127 | Mining accidents | Y37 |
| 128 | Poisoning | X40 - X49 |
| 129 | Surgical / medical misadventure | Y60 - Y69; Y70 - Y82; Y83 - Y84; Y88 |
| 130 | Falls | W00 - W19 |
| 131 | Fires | X00 - X09 |

| Basic NBD list | | ICD-10 code |
|---|---|---|
| 132 | Natural and environmental factors | W53 - W64; X20 - X29; X30 - X39; X50 - X57 |
| 133 | Drowning | W65 - W74 |
| 134 | Suffocation and foreign bodies | W75 - W84 |
| 135 | Other unintentional injuries specified | W20 - W49; W50 - W52; W85 - W99; X10 - X19; X58; Y38; Y39; Y40 - Y59 |
| 136 | Ill-defined transport | Y85 |
| 137 | Ill-defined other unintent | X59; Y86 |
| 138 | Undetermined whether intentional or unintentional | Y10 - Y34; Y87; Y89 |
| 139 | Suicide | X60 - X84 |
| 140 | Homicide with firearm | X93 - X95 |
| 141 | Homicide without firearm | X85 - X92; X96 - X99; Y00 -Y08 |
| 142 | Ill-defined homicide | Y09 |
| 143 | War | Y35; Y36 |

*Table 23: ICD-10 codes for each category of the VA list.*

| VA List | | ICD-10 code |
|---|---|---|
| 101 | Sepsis | A40 - A41 |
| 102 | Acute respiratory infection, including pneumonia | J00 - J22 |
| 103 | HIV/AIDS related death | B20 - B24 |
| 104 | Diarrhoeal diseases | A00 - A09 |
| 105 | Malaria | B50 - B54 |
| 106 | Measles | B05 |
| 107 | Meningitis and encephalitis | A39; G00 - G05 |
| 108 | Tetanus | A33 - A35 |
| 109 | Pulmonary tuberculosis | A15 - A16; U51 - U52 |
| 110 | Pertussis | A37 |
| 111 | Haemorrhagic fever | A92 - A99 |
| 112 | Dengue fever | A91 |
| 199 | Other and unspecified infectious disease | A17 - A19; A20 - A38; A42 - A44; |
| 201 | Oral neoplasms | C00 - C06 |
| 202 | Digestive neoplasms | C15 - C26 |
| 203 | Respiratory neoplasms | C30 - C39 |
| 204 | Breast neoplasms | C50 |
| 205 | Female reproductive neoplasms | C51 - C58 |
| 206 | Male reproductive neoplasms | C60 - C63 |
| 299 | Other and unspecified neoplasms | C07 - C14; C40 - C49; C60 - D48 |
| 301 | Severe anaemia | D50 - D64 |
| 302 | Severe malnutrition | E40 - E46 |
| 303 | Diabetes mellitus | E10 - E14 |

| VA List | | ICD-10 code |
|---|---|---|
| 401 | Acute cardiac disease | I20 - I25 |
| 402 | Stroke | I60 - I69 |
| 403 | Sickle cell with crisis | D57 |
| 499 | Other and unspecified cardiac disease | I00 - I09; I10 - I15; I26 - I52; I70 - I99 |
| 501 | Chronic obstructive pulmonary disease (COPD) | J40 - J44 |
| 502 | Asthma | J45 - J46 |
| 601 | Acute abdomen | K35 - K37; K40 - K46; K56; R10 |
| 602 | Liver cirrhosis | K70 - K76 |
| 701 | Renal failure | N17 - N19 |
| 801 | Epilepsy | G40 - G41 |
| 9800 | Other and unspecified non-communicable disease | D55 - D89; E00 - E07; E15 - E35; E50 - E90; F00 - F99; G06 - G09; G10 - G37; G43 - G47; G50 - G99; H00- H95; J30 - J39; J47 - J99; K00 - K31; K35- K38; K40 - K93; L00 - L99; M00 - M99; N00- N16; N20 - N99; R00 - R09; R11 - R94 |
| 901 | Ectopic pregnancy | O00 |
| 902 | Abortion-related death | O03 - O08 |
| 903 | Pregnancy-induced hypertension | O10 - O16 |
| 904 | Obstetric haemorrhage | O46; O67; O72 |
| 905 | Obstructed labour | O63; O66 |
| 906 | Pregnancy-related sepsis | O85 |
| 907 | Anaemia of pregnancy | O99 |
| 908 | Ruptured uterus | O71 |
| 999 | Other and unspecified maternal cause | O01 - O02; O20 - O45; O47 - O62; O68 - O70; O73 - O75; O76 - O84; O86 - O98 |
| 1001 | Prematurity | P05 - P07 |
| 1002 | Birth asphyxia | P20 - P22 |
| 1003 | Neonatal pneumonia | P23 - P25 |
| 1004 | Neonatal sepsis | P36 |
| 1005 | Neonatal tetanus | A33 |
| 1006 | Congenital malformation | Q00 - Q99 |
| 1099 | Other and unspecified perinatal cause of death | P00 - P04; P08 - P15; P26 - P35; P37 - P94; P96 |
| 1100 | Stillbirths | P95 |
| 1201 | Road traffic accident | V01 - V89 |
| 1202 | Other transport accident | V90 - V99 |
| 1203 | Accidental fall | W00 - W19 |
| 1204 | Accidental drowning and submersion | W65 - W74 |
| 1205 | Accidental exposure to smoke, fire and flames | X00 - X19 |
| 1206 | Contact with venomous animals and plants | X20 - X29 |
| 1207 | Accidental poisoning and exposure to noxious substance | X40 - X49 |
| 1208 | Intentional self-harm | X60 - X84 |

| VA List | | ICD-10 code |
|---|---|---|
| 1209 | Assault | X85 - Y09 |
| 1210 | Exposure to force of nature | X30 - X39 |
| 1299 | Other and unspecified external cause of death | S00 - T99; W20 - W64; W75 - W99; X50 - X59; Y10 - Y98 |
| 9900 | Cause of death unknown | R95 - R99 |

## 8.5 Geographic distribution of sample

Table 24 shows the geographic spread of the sample of medical and forensic pathology records that were collected and reviewed.

*Table 24: Number and percentage of medical and forensic pathology records reviewed by health sub-district, NCODV 2017/18.*

| | Medical records | | FPS records | |
|---|---|---|---|---|
| **Health district and code** | **Number** | **%** | **Number** | **%** |
| Bergrivier_101 | 488 | 4.8 | 433 | 7.9 |
| Bitou_102 | 208 | 2.1 | 8 | 0.2 |
| Kannaland_103 | 215 | 2.1 | 8 | 0.2 |
| Buffalo city_201 | 1066 | 10.5 | 394 | 7.2 |
| Nelson Mandela bay C_202 | 883 | 8.7 | 805 | 14.7 |
| Port St Johns_203 | 408 | 4.0 | 80 | 1.5 |
| Joe Morolong_301 | 300 | 3.0 | 153 | 2.8 |
| Kareeberg_302 | 62 | 0.6 | 299 | 5.5 |
| Khara Hais_303 | 181 | 1.8 | 82 | 1.5 |
| Dihlabeng_401 | 249 | 2.5 | 158 | 2.9 |
| Kopanong_402 | 85 | 0.8 | 135 | 2.5 |
| Maluti a Phofung_403 | 583 | 5.8 | 69 | 1.3 |
| Emnambithi/Ladysmith_501 | 527 | 5.2 | 0 | 0.0 |
| Jozini_502 | 396 | 3.9 | 0 | 0.0 |
| Richmond_503 | 150 | 1.5 | 0 | 0.0 |
| City of Matlosana_601 | 559 | 5.5 | 449 | 8.2 |
| Moses kotane_602 | 91 | 0.9 | 108 | 2.0 |
| Ratlou_603 | 514 | 5.1 | 244 | 4.5 |
| Ekurhuleni east 2_701 | 590 | 5.8 | 476 | 8.7 |
| Ekurhuleni north 2_702 | 892 | 8.8 | 12 | 0.2 |
| Johannesburg F Health Sub-District_703 | 236 | 2.3 | 289 | 5.3 |
| Emalahleni_801 | 231 | 2.3 | 301 | 5.5 |
| Lekwa_802 | 215 | 2.1 | 147 | 2.7 |
| Msukaligwa_803 | 343 | 3.4 | 235 | 4.3 |
| Maruleng_901 | 333 | 3.3 | 323 | 5.9 |
| Mutale_902 | 281 | 2.8 | 96 | 1.8 |
| Thabazimbi_903 | 46 | 0.5 | 156 | 2.9 |
| **Total** | **10,132** | **100.0** | **5,460** | **100.0** |

## 8.6 Examples of concerns

There were eight categories of treatment concerns identified through the audit of concerns flagged by the clinical reviewers in combination with the issues highlighted by QAAOs when they reflected on the QA process. These include missing medical notes, poor record keeping, poor patient management (inadequate diagnostic investigation, incorrect or inadequate treatment, delay in starting treatment, missed opportunities, e.g., for HIV testing, and possible negligence). Examples of these concerns are grouped into poor record keeping and categories that fall under poor management.

1. Poor record keeping examples:
    - Emergency medical services notes and details on the ambulance transfer form were often very difficult to read. These notes play an important role in providing information on the condition, medication, or medical history of the patient. However, the forms are very detailed with little space for writing and are carbon copied which often made them more difficult to read.
    - The admitting doctors in the Emergency Departments did not always record sufficient details in terms of the history and the presenting complaint.
    - Medical notes from the wards documenting the initial assessment of the patient were incomplete (poor history, no management plan), particularly in smaller institutions with limited staff
    - Handwriting was on occasion so illegible that it was impossible to decipher the medical notes on the diagnosis or treatment plan.
    - Some doctors used abbreviations that are not accepted medical abbreviations making it difficult to understand what the differential diagnosis might have been.
    - Missing notes or missing essential information was problematic. Basic demographics, such as the sex or age were often not recorded in the folder. Patient forms and nursing charts were incomplete, and, in some cases, there was no documentation of the patient's death (no written death entry or date of death recorded).
    - There were occasions where the patient, according to notes, had been discharged from care, but remained in the ward whilst waiting for their family to arrive (which was sometimes as long as a few weeks). During this period of waiting, the patient demised, and it was difficult to ascertain the cause of death given that no recent clinical notes were available.
    - In some folders only nursing notes were available with no or infrequent doctors' notes. (with no/infrequent doctors notes),
    - Generally nursing notes were useful in providing insight into the diagnosis, treatment and general condition of the patient but could be improved especially with regard to describing the patient's general appearance.
    - In some cases, nurses appeared to write pre-determined follow up notes instead of documenting a current assessment of the patient's condition. For example, notes describing the condition of a patient as stable for a number of days were followed suddenly by notes describing the patient as in extremis and dying.
    - In some hospitals clinical notes from the allied health professionals, such as dieticians and physiotherapists, often provided better information on the patients' condition than notes written by doctors and nurses.
    - Laboratory investigation forms are often not completed fully which can create difficulties in finding the results online on the National Health Laboratory services system.

2. Poor management examples:
    - In a few cases, patients appeared to have been admitted to hospital, but no clinical notes were available for some time after admission, and it appeared that the patient had not been clinically examined at all during this time. The first clinical notes were the records of the demise of the patient. The reasons for this need further investigation.
    - At some institutions it was evident that the medical management was poor. The junior doctors often did not clearly document a management/ treatment plan for the patient and there was no clear indication of a patient review by a consultant or senior medical officer.
    - In some HIV infected patients, especially those who had defaulted treatment, the treatment was not re-initiated

(as per protocol) and investigations for potentially treatable conditions were not done, and the patient demised. It is possible that these were very ill patients who were "not for active resuscitation" however this was not documented in the medical notes. Clear protocols regarding the decision on whether a patient is not for active resuscitation, including the documentation of this decision in the medical records, would ensure that there is no confusion about this.

- At some hospitals, the HIV status of patients is not routinely being checked but patients are routinely tested for malaria. There also appears to be poor application of rapid HIV testing and counselling and testing, which leads to a delay in obtaining the patient's HIV status.
- Antibiotic stewardship protocols do not appear to be adhered to
  - patients with persistent fevers were treated with the same antibiotic spectrum cover for 2-3 weeks, with persistent fevers yet no consideration was given to changing the regime and no investigations were done to determine the source or site of the infection or organism.
  - The antibiotic protocols followed were inconsistent. This may be due to inadequate resource allocation and/or stocks in the various centers.
  - Intravenous Metronidazole was regularly prescribed in certain areas despite there being no apparent indication for this treatment documented.
- Some patients who warranted urgent investigations or interventions were given follow up appointments 2 -3 weeks later and died before the follow up. This was noted for CT scans in particular, in many parts of the country.
- In some cases, the results of special investigations were available, but management was not changed accordingly. In other cases, the results were not followed up and recorded. Often the formal imaging (e.g. radiology; ultrasound) reports were not included or documented in the file.
- The medical notes for cases who were dead on arrival (DOA) were scanty with date of death often not clearly documented and very little information on medical history or events preceding the death.

Following the audit, the panel of clinician reviewers identified three recommendations that could contribute to resolving the concerns:

1. Review and standardisation of medical and nursing record templates.

The templates of the medical records and related forms completed by medical staff impacts the level of detail of the information recorded as well as the consistent and systematic recording of notes. Uniform use of standard medical record templates, that conform to the national guidelines for medical records, would assist in ensuring that all relevant information is documented. For example, the layout of the forms in the Western Cape were uniform between rural and metro making it easy to understand the flow of the records.

Similarly, standardised observation charts completed by nurses could ensure that observations are clearly documented and that it is possible to visualize a trend.

2. Patient identifiers for laboratory and other special investigations.

This study highlighted the importance of completing investigation forms as accurately as possible especially with regard to the identifiers of the patient. The bar-coded stickers in medical records are extremely useful for looking up laboratory investigation results but it is still important to make sure that the patient identifiers are captured correctly on the request form.

3. Dissemination and monitoring the implementation of patient management protocols.

This study suggests that there is room for improvement with regards to the implementation of patient management protocols, particularly with regard to record keeping where it is important to document a differential diagnosis, the management plan (including whether the case is not for active resuscitation), results of special investigations and any changes to the

management plan, and the reasons for non-adherence to antibiotic protocols or a delay in apparently urgent investigations or interventions. In addition, there is evidence of missed opportunities for case finding of HIV and TB.

## 8.7 Cause of death profile of sample of medical and FPS records and Stats SA data

An overall summary of the causes of death from the NCODV medical and FPS records against the cause of death profile for the 2017 Stats SA deaths and the subset of Stats SA hospital deaths is shown in Table 23 for males, females and persons. The causes have been aggregated according to the NBD list (excluding some conditions which do not appear as a cause of death: Anorexia nervosa; Obsessive compulsive/ panic disorders; Hyperkinetic syndrome of childhood; Adjustment reaction (PTSS)).

*Table 24 : Comparison of cause of death profiles from Stats SA 2017 total and hospital deaths and NCOD Validation medical and FPS records and for persons, males and females according to the NBD list, SA NCOD Validation Project 2017/18.*

| Category | Stats SA all deaths 2017 | | | Stats SA hospital deaths 2017 | | | NCOD Validation 2017/18 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Medical records | | | Forensic pathology records | | |
| | Person | Male | Female | Person | Male | Female | Person | Male | Female | Person | Male | Female |
| **N** | **446,546** | **235,691** | **210,515** | **190,235** | **96,265** | **93,935** | **10,091** | **5,131** | **4,960** | **5,315** | **4,123** | **1,186** |
| **NBD list** | | | | | | | | | | | | |
| Tuberculosis | 6.48% | 7.65% | 5.19% | 9.62% | 11.53% | 7.67% | 5.13% | 6.86% | 3.35% | 1.66% | 1.63% | 1.77% |
| STD/excl | 0.02% | 0.01% | 0.04% | 0.04% | 0.02% | 0.06% | 0.05% | 0.02% | 0.08% | 0.00% | 0.00% | 0.00% |
| HIV/AIDS | 4.92% | 4.81% | 5.05% | 8.76% | 8.94% | 8.57% | 32.94% | 33.46% | 32.40% | 0.47% | 0.36% | 0.84% |
| Diarrhoeal diseases | 1.49% | 1.34% | 1.66% | 1.28% | 1.13% | 1.43% | 1.60% | 1.07% | 2.14% | 0.24% | 0.22% | 0.34% |
| Childhood vaccine-preventable cluster | 0.01% | 0.01% | 0.01% | 0.01% | 0.01% | 0.01% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Bacterial meningitis | 0.46% | 0.47% | 0.45% | 0.70% | 0.76% | 0.65% | 0.52% | 0.66% | 0.36% | 0.11% | 0.12% | 0.08% |
| Hepatitis | 0.09% | 0.11% | 0.08% | 0.18% | 0.22% | 0.14% | 0.29% | 0.35% | 0.22% | 0.00% | 0.00% | 0.00% |
| Malaria | 0.14% | 0.16% | 0.12% | 0.28% | 0.33% | 0.22% | 0.26% | 0.39% | 0.12% | 0.00% | 0.00% | 0.00% |
| Leprosy | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Intestinal parasites | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Septicaemia | 1.19% | 1.04% | 1.35% | 1.95% | 1.77% | 2.13% | 0.46% | 0.31% | 0.60% | 0.00% | 0.00% | 0.00% |
| Schistosomiasis and other tropical diseases | 3.21% | 2.95% | 3.50% | 5.68% | 5.39% | 5.98% | 0.21% | 0.31% | 0.10% | 0.08% | 0.02% | 0.25% |
| Lower respiratory infections | 5.14% | 5.08% | 5.21% | 5.00% | 5.20% | 4.80% | 3.26% | 3.16% | 3.37% | 2.05% | 1.82% | 2.87% |
| Upper respiratory infections | 0.04% | 0.04% | 0.05% | 0.02% | 0.02% | 0.02% | 0.00% | 0.00% | 0.00% | 0.02% | 0.00% | 0.08% |
| Otitis media | 0.01% | 0.01% | 0.01% | 0.01% | 0.01% | 0.01% | 0.03% | 0.02% | 0.04% | 0.02% | 0.02% | 0.00% |
| Maternal haemorrhage | 0.02% | 0.00% | 0.04% | 0.02% | 0.00% | 0.05% | 0.00% | 0.00% | 0.00% | 0.09% | 0.00% | 0.42% |
| Maternal sepsis | 0.23% | 0.27% | 0.19% | 0.41% | 0.49% | 0.32% | 0.00% | 0.00% | 0.00% | 0.02% | 0.00% | 0.08% |
| Hypertension in pregnancy | 0.04% | 0.00% | 0.09% | 0.07% | 0.00% | 0.14% | 0.02% | 0.00% | 0.04% | 0.08% | 0.00% | 0.34% |
| Obstructed Labour | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.02% | 0.00% | 0.08% |
| Abortion | 0.02% | 0.00% | 0.05% | 0.02% | 0.00% | 0.04% | 0.02% | 0.00% | 0.04% | 0.11% | 0.00% | 0.51% |
| Other maternal conditions | 0.07% | 0.00% | 0.14% | 0.11% | 0.00% | 0.21% | 0.08% | 0.00% | 0.16% | 0.24% | 0.00% | 1.10% |

| Category | Stats SA all deaths 2017 | | | Stats SA hospital deaths 2017 | | | NCOD Validation 2017/18 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Medical records | | | Forensic pathology records | | |
| | Person | Male | Female | Person | Male | Female | Person | Male | Female | Person | Male | Female |
| Low birth weight | 0.55% | 0.57% | 0.53% | 1.05% | 1.14% | 0.96% | 0.98% | 1.01% | 0.95% | 0.13% | 0.10% | 0.25% |
| Birth asphyxia and trauma | 0.16% | 0.18% | 0.14% | 0.30% | 0.34% | 0.26% | 0.05% | 0.06% | 0.04% | 0.02% | 0.00% | 0.08% |
| Other perinatal respiratory conditions | 0.27% | 0.28% | 0.26% | 0.41% | 0.46% | 0.36% | 0.25% | 0.35% | 0.14% | 0.19% | 0.05% | 0.67% |
| Neonatal infections | 0.25% | 0.27% | 0.23% | 0.52% | 0.58% | 0.46% | 0.67% | 0.62% | 0.73% | 0.00% | 0.00% | 0.00% |
| Other perinatal conditions | 0.69% | 0.73% | 0.65% | 1.63% | 1.78% | 1.45% | 1.02% | 1.15% | 0.87% | 0.15% | 0.17% | 0.08% |
| Protein-energy malnutrition | 0.26% | 0.25% | 0.26% | 0.45% | 0.45% | 0.45% | 0.33% | 0.29% | 0.36% | 0.17% | 0.10% | 0.42% |
| Deficiency anaemias | 0.45% | 0.35% | 0.57% | 0.77% | 0.64% | 0.90% | 0.08% | 0.04% | 0.12% | 0.00% | 0.00% | 0.00% |
| Pellagra and other nutritional deficiencies | 0.02% | 0.01% | 0.02% | 0.02% | 0.02% | 0.03% | 0.03% | 0.02% | 0.04% | 0.00% | 0.00% | 0.00% |
| Mouth and oropharynx cancer | 0.26% | 0.35% | 0.16% | 0.29% | 0.41% | 0.16% | 0.24% | 0.39% | 0.08% | 0.00% | 0.00% | 0.00% |
| Oesophagus cancer | 0.60% | 0.67% | 0.51% | 0.90% | 1.07% | 0.73% | 1.02% | 1.07% | 0.97% | 0.09% | 0.10% | 0.08% |
| Stomach cancer | 0.27% | 0.29% | 0.24% | 0.33% | 0.36% | 0.30% | 0.22% | 0.25% | 0.18% | 0.04% | 0.02% | 0.08% |
| Colorectal cancer | 0.63% | 0.63% | 0.64% | 0.80% | 0.84% | 0.77% | 0.69% | 0.76% | 0.63% | 0.06% | 0.02% | 0.17% |
| Liver cancer | 0.39% | 0.44% | 0.34% | 0.60% | 0.71% | 0.50% | 0.62% | 0.60% | 0.65% | 0.04% | 0.02% | 0.08% |
| Pancreas cancer | 0.34% | 0.34% | 0.34% | 0.44% | 0.47% | 0.40% | 0.36% | 0.35% | 0.36% | 0.00% | 0.00% | 0.00% |
| Larynx cancer | 0.10% | 0.15% | 0.04% | 0.14% | 0.22% | 0.04% | 0.06% | 0.12% | 0.00% | 0.00% | 0.00% | 0.00% |
| Trachea/bronchi/lung cancer | 1.32% | 1.64% | 0.96% | 1.64% | 2.19% | 1.09% | 1.68% | 2.34% | 1.01% | 0.04% | 0.05% | 0.00% |
| Bone and connective tissue cancer | 0.07% | 0.07% | 0.08% | 0.11% | 0.10% | 0.12% | 0.03% | 0.02% | 0.04% | 0.00% | 0.00% | 0.00% |
| Melanoma | 0.09% | 0.10% | 0.08% | 0.10% | 0.12% | 0.08% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Other skin cancer | 0.09% | 0.11% | 0.06% | 0.11% | 0.14% | 0.07% | 0.12% | 0.14% | 0.10% | 0.00% | 0.00% | 0.00% |
| Breast cancer | 0.81% | 0.04% | 1.68% | 1.02% | 0.05% | 2.02% | 0.81% | 0.06% | 1.59% | 0.00% | 0.00% | 0.00% |
| Cervix cancer | 0.87% | 0.00% | 1.84% | 1.41% | 0.00% | 2.85% | 0.78% | 0.00% | 1.59% | 0.04% | 0.00% | 0.17% |
| Corpus uteri cancer | 0.15% | 0.00% | 0.31% | 0.20% | 0.00% | 0.41% | 0.16% | 0.00% | 0.32% | 0.00% | 0.00% | 0.00% |
| Ovary cancer | 0.20% | 0.00% | 0.43% | 0.32% | 0.00% | 0.65% | 0.23% | 0.00% | 0.46% | 0.00% | 0.00% | 0.00% |
| Prostate | 0.76% | 1.44% | 0.00% | 0.92% | 1.82% | 0.00% | 0.92% | 1.81% | 0.00% | 0.02% | 0.02% | 0.00% |
| Bladder cancer | 0.14% | 0.19% | 0.09% | 0.18% | 0.25% | 0.12% | 0.17% | 0.21% | 0.12% | 0.00% | 0.00% | 0.00% |
| Kidney cancer | 0.09% | 0.11% | 0.08% | 0.11% | 0.14% | 0.09% | 0.09% | 0.08% | 0.10% | 0.00% | 0.00% | 0.00% |
| Brain cancer | 0.12% | 0.12% | 0.12% | 0.13% | 0.14% | 0.13% | 0.19% | 0.21% | 0.16% | 0.04% | 0.05% | 0.00% |

| Category | Stats SA all deaths 2017 | | | Stats SA hospital deaths 2017 | | | NCOD Validation 2017/18 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Medical records | | | Forensic pathology records | | |
| | Person | Male | Female | Person | Male | Female | Person | Male | Female | Person | Male | Female |
| Lymphoma | 0.48% | 0.50% | 0.45% | 0.78% | 0.85% | 0.70% | 0.31% | 0.25% | 0.36% | 0.00% | 0.00% | 0.00% |
| Leukaemia | 0.25% | 0.25% | 0.25% | 0.39% | 0.41% | 0.37% | 0.22% | 0.25% | 0.18% | 0.00% | 0.00% | 0.00% |
| Other malignant neoplasms | 0.33% | 0.28% | 0.39% | 0.50% | 0.43% | 0.58% | 0.69% | 0.58% | 0.81% | 0.08% | 0.07% | 0.08% |
| Ill-defined cancers | 0.88% | 0.84% | 0.93% | 1.20% | 1.20% | 1.21% | 1.24% | 1.17% | 1.31% | 0.09% | 0.05% | 0.25% |
| Benign neoplasms | 0.30% | 0.29% | 0.32% | 0.46% | 0.46% | 0.47% | 0.04% | 0.04% | 0.04% | 0.02% | 0.02% | 0.00% |
| Diabetes mellitus | 5.67% | 4.24% | 7.29% | 6.57% | 5.12% | 8.05% | 4.65% | 3.66% | 5.67% | 0.08% | 0.02% | 0.25% |
| Albinism | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Other endocrine and metabolic disorders | 2.95% | 2.67% | 3.27% | 4.56% | 4.33% | 4.80% | 0.27% | 0.27% | 0.26% | 0.09% | 0.07% | 0.17% |
| Alcohol dependence | 0.09% | 0.13% | 0.05% | 0.11% | 0.15% | 0.06% | 0.15% | 0.25% | 0.04% | 0.02% | 0.00% | 0.08% |
| Drug use | 0.04% | 0.06% | 0.01% | 0.06% | 0.11% | 0.01% | 0.04% | 0.06% | 0.02% | 0.00% | 0.00% | 0.00% |
| Schizophrenia | 0.05% | 0.06% | 0.05% | 0.05% | 0.06% | 0.05% | 0.01% | 0.02% | 0.00% | 0.00% | 0.00% | 0.00% |
| Unipolar depression | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.02% | 0.00% | 0.08% |
| Bipolar depression | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 0.01% | 0.00% | 0.00% | 0.00% | 0.02% | 0.02% | 0.00% |
| Mental disability | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 0.02% | 0.00% | 0.00% | 0.00% |
| Other mental disorders | 0.02% | 0.03% | 0.02% | 0.01% | 0.02% | 0.01% | 0.08% | 0.08% | 0.08% | 0.00% | 0.00% | 0.00% |
| Alzheimer and other dementias | 0.56% | 0.41% | 0.74% | 0.41% | 0.36% | 0.45% | 0.72% | 0.53% | 0.93% | 0.02% | 0.02% | 0.00% |
| Parkinson's | 0.10% | 0.10% | 0.09% | 0.07% | 0.08% | 0.06% | 0.02% | 0.04% | 0.00% | 0.00% | 0.00% | 0.00% |
| Multiple sclerosis | 0.01% | 0.01% | 0.02% | 0.01% | 0.01% | 0.01% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Epilepsy | 0.75% | 0.92% | 0.57% | 0.59% | 0.73% | 0.45% | 0.57% | 0.57% | 0.58% | 0.30% | 0.34% | 0.17% |
| Encephalitis and brain abscess | 0.05% | 0.06% | 0.05% | 0.09% | 0.10% | 0.09% | 0.01% | 0.00% | 0.02% | 0.02% | 0.02% | 0.00% |
| Other nervous system disorders | 0.53% | 0.56% | 0.51% | 0.79% | 0.85% | 0.73% | 0.47% | 0.55% | 0.38% | 0.02% | 0.00% | 0.08% |
| Glaucoma | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cataracts | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Other visual disorders | 0.01% | 0.01% | 0.01% | 0.01% | 0.01% | 0.01% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Hearing loss and other ear disorders | 0.00% | 0.00% | 0.00% | 0.01% | 0.01% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Rheumatic heart disease | 0.08% | 0.05% | 0.10% | 0.12% | 0.08% | 0.16% | 0.11% | 0.08% | 0.14% | 0.02% | 0.02% | 0.00% |
| Ischaemic heart disease | 2.86% | 3.05% | 2.65% | 1.74% | 1.90% | 1.58% | 1.65% | 1.56% | 1.75% | 1.96% | 1.89% | 2.19% |

| Category | Stats SA all deaths 2017 | | | Stats SA hospital deaths 2017 | | | NCOD Validation 2017/18 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Medical records | | | Forensic pathology records | | |
| | Person | Male | Female | Person | Male | Female | Person | Male | Female | Person | Male | Female |
| Stroke | 4.98% | 4.09% | 5.99% | 5.90% | 5.14% | 6.69% | 7.96% | 7.07% | 8.87% | 0.49% | 0.46% | 0.59% |
| Inflammatory heart disease | 0.73% | 0.73% | 0.73% | 0.92% | 0.97% | 0.87% | 0.50% | 0.55% | 0.44% | 0.41% | 0.39% | 0.51% |
| Hypertensive heart disease | 4.46% | 3.28% | 5.78% | 3.36% | 2.67% | 4.06% | 4.65% | 3.47% | 5.87% | 0.43% | 0.39% | 0.59% |
| Non-rheumatic valvular disease | 0.08% | 0.06% | 0.09% | 0.10% | 0.09% | 0.11% | 0.06% | 0.02% | 0.10% | 0.02% | 0.00% | 0.08% |
| Pulmonary embolism | 0.32% | 0.23% | 0.41% | 0.36% | 0.28% | 0.45% | 0.12% | 0.08% | 0.16% | 0.30% | 0.17% | 0.76% |
| Aortic aneurism | 0.09% | 0.11% | 0.07% | 0.09% | 0.12% | 0.06% | 0.10% | 0.12% | 0.08% | 0.17% | 0.22% | 0.00% |
| Peripheral vascular disorders | 0.34% | 0.30% | 0.38% | 0.51% | 0.49% | 0.54% | 0.89% | 0.78% | 1.01% | 0.19% | 0.05% | 0.67% |
| Other cardiovascular conditions | 0.08% | 0.07% | 0.09% | 0.09% | 0.08% | 0.10% | 0.00% | 0.00% | 0.00% | 0.09% | 0.07% | 0.17% |
| Ill-defined cardiovascular (heart failure etc) | 4.17% | 3.65% | 4.76% | 2.54% | 2.21% | 2.88% | 0.61% | 0.51% | 0.73% | 0.70% | 0.58% | 1.10% |
| Atherosclerosis | 0.02% | 0.02% | 0.03% | 0.02% | 0.02% | 0.02% | 0.00% | 0.00% | 0.00% | 0.02% | 0.02% | 0.00% |
| Chronic obstructive pulmonary disease | 2.35% | 2.79% | 1.85% | 2.81% | 3.54% | 2.07% | 2.80% | 3.24% | 2.36% | 0.30% | 0.29% | 0.34% |
| Asthma | 0.78% | 0.77% | 0.80% | 0.32% | 0.29% | 0.36% | 0.52% | 0.47% | 0.56% | 0.13% | 0.12% | 0.17% |
| Aspiration pneumonia/ lung abscess | 0.18% | 0.20% | 0.16% | 0.29% | 0.34% | 0.24% | 0.07% | 0.02% | 0.12% | 0.06% | 0.05% | 0.08% |
| Other respiratory conditions | 1.04% | 1.10% | 0.99% | 0.81% | 0.95% | 0.68% | 0.27% | 0.23% | 0.30% | 0.09% | 0.05% | 0.25% |
| Peptic ulcer | 0.33% | 0.33% | 0.34% | 0.32% | 0.32% | 0.32% | 0.68% | 0.60% | 0.77% | 0.26% | 0.24% | 0.34% |
| Appendicitis | 0.03% | 0.04% | 0.03% | 0.05% | 0.06% | 0.05% | 0.10% | 0.12% | 0.08% | 0.11% | 0.07% | 0.25% |
| Noninfective gastroenteritis and colitis | 0.23% | 0.20% | 0.26% | 0.36% | 0.33% | 0.39% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cirrhosis of liver | 0.44% | 0.52% | 0.35% | 0.70% | 0.85% | 0.55% | 0.80% | 1.07% | 0.52% | 0.08% | 0.10% | 0.00% |
| Hepatic failure | 0.28% | 0.28% | 0.28% | 0.48% | 0.50% | 0.46% | 0.20% | 0.18% | 0.22% | 0.00% | 0.00% | 0.00% |
| Gall bladder disease | 0.13% | 0.10% | 0.17% | 0.24% | 0.19% | 0.29% | 0.19% | 0.14% | 0.24% | 0.06% | 0.00% | 0.25% |
| Pancreatitis | 0.11% | 0.14% | 0.08% | 0.17% | 0.23% | 0.12% | 0.22% | 0.33% | 0.10% | 0.04% | 0.05% | 0.00% |
| Other digestive diseases | 1.03% | 0.98% | 1.09% | 2.42% | 2.40% | 2.43% | 1.17% | 1.13% | 1.21% | 0.73% | 0.53% | 1.43% |
| Nephritis/nephrosis | 1.85% | 1.78% | 1.94% | 3.12% | 3.09% | 3.16% | 0.49% | 0.55% | 0.42% | 0.00% | 0.00% | 0.00% |
| Benign prostatic hypertrophy | 0.04% | 0.08% | 0.00% | 0.06% | 0.11% | 0.00% | 0.14% | 0.25% | 0.02% | 0.00% | 0.00% | 0.00% |
| Other genito-urinary conditions | 0.22% | 0.20% | 0.25% | 0.34% | 0.31% | 0.38% | 0.49% | 0.45% | 0.52% | 0.02% | 0.02% | 0.00% |
| Skin disease | 0.30% | 0.21% | 0.40% | 0.46% | 0.35% | 0.57% | 0.40% | 0.33% | 0.46% | 0.02% | 0.02% | 0.00% |

| Category | Stats SA all deaths 2017 | | | Stats SA hospital deaths 2017 | | | NCOD Validation 2017/18 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Medical records | | | Forensic pathology records | | |
| | Person | Male | Female | Person | Male | Female | Person | Male | Female | Person | Male | Female |
| Rheumatoid arthriis | 0.04% | 0.02% | 0.07% | 0.05% | 0.02% | 0.07% | 0.03% | 0.02% | 0.04% | 0.02% | 0.02% | 0.00% |
| Osteoarthritis | 0.04% | 0.02% | 0.06% | 0.01% | 0.01% | 0.02% | 0.06% | 0.02% | 0.10% | 0.00% | 0.00% | 0.00% |
| Other muculo-skeletal conditions | 0.32% | 0.23% | 0.42% | 0.37% | 0.29% | 0.45% | 0.22% | 0.16% | 0.28% | 0.04% | 0.00% | 0.17% |
| Neural tube defects | 0.06% | 0.06% | 0.06% | 0.10% | 0.11% | 0.09% | 0.02% | 0.04% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cleft lip/palate | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Congenital heart disease | 0.17% | 0.16% | 0.17% | 0.24% | 0.26% | 0.22% | 0.17% | 0.18% | 0.16% | 0.13% | 0.10% | 0.25% |
| Congenital disorders of GIT | 0.05% | 0.04% | 0.05% | 0.08% | 0.07% | 0.09% | 0.03% | 0.02% | 0.04% | 0.06% | 0.02% | 0.17% |
| Down syndrome and other chromosomal | 0.09% | 0.07% | 0.10% | 0.14% | 0.12% | 0.16% | 0.15% | 0.08% | 0.22% | 0.00% | 0.00% | 0.00% |
| Fetal alcohol syndrome | 0.02% | 0.02% | 0.02% | 0.03% | 0.04% | 0.03% | 0.00% | 0.00% | 0.00% | 0.02% | 0.00% | 0.08% |
| Other congenital abnormalities | 0.08% | 0.08% | 0.08% | 0.15% | 0.15% | 0.14% | 0.05% | 0.04% | 0.06% | 0.02% | 0.00% | 0.08% |
| Ill-defined congenital conditions | 0.07% | 0.07% | 0.07% | 0.13% | 0.14% | 0.11% | 0.08% | 0.08% | 0.08% | 0.00% | 0.00% | 0.00% |
| Dental caries | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Periodontal disease | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 0.02% | 0.00% | 0.00% | 0.00% |
| Other oral health | 0.01% | 0.01% | 0.02% | 0.02% | 0.01% | 0.02% | 0.01% | 0.02% | 0.00% | 0.02% | 0.02% | 0.00% |
| Cot death | 0.05% | 0.05% | 0.05% | 0.01% | 0.01% | 0.02% | 0.08% | 0.06% | 0.10% | 0.23% | 0.22% | 0.25% |
| Ill-defined natural | 13.34% | 12.33% | 14.45% | 1.77% | 1.78% | 1.76% | 3.27% | 3.31% | 3.23% | 3.84% | 3.59% | 4.47% |
| Road traffic | 1.30% | 1.78% | 0.75% | 0.33% | 0.47% | 0.20% | 0.77% | 1.01% | 0.52% | 26.17% | 26.12% | 26.48% |
| Non-motor vehicle traffic accidents | 0.02% | 0.03% | 0.01% | 0.00% | 0.01% | 0.00% | 0.02% | 0.02% | 0.02% | 0.55% | 0.58% | 0.42% |
| Ill-defined transport | 0.00% | 0.01% | 0.00% | 0.00% | 0.01% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Mining accidents | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Poisoning | 0.16% | 0.17% | 0.15% | 0.30% | 0.32% | 0.28% | 0.62% | 0.72% | 0.52% | 0.60% | 0.61% | 0.59% |
| Surgical / medical misadventure | 0.17% | 0.17% | 0.18% | 0.19% | 0.20% | 0.18% | 0.16% | 0.21% | 0.10% | 0.34% | 0.12% | 1.10% |
| Falls | 0.04% | 0.06% | 0.03% | 0.03% | 0.04% | 0.02% | 0.59% | 0.55% | 0.65% | 0.83% | 0.73% | 1.18% |
| Fires | 0.53% | 0.62% | 0.42% | 0.25% | 0.26% | 0.24% | 0.24% | 0.23% | 0.24% | 2.18% | 1.96% | 2.95% |
| Natural and environmental factors | 0.08% | 0.11% | 0.05% | 0.03% | 0.04% | 0.02% | 0.06% | 0.08% | 0.04% | 0.56% | 0.51% | 0.76% |
| Drowning | 0.33% | 0.49% | 0.13% | 0.03% | 0.04% | 0.01% | 0.01% | 0.00% | 0.02% | 2.22% | 2.47% | 1.35% |
| Suffocation and foreign bodies | 1.13% | 1.71% | 0.48% | 0.15% | 0.18% | 0.11% | 0.01% | 0.02% | 0.00% | 0.53% | 0.58% | 0.34% |

| Category | Stats SA all deaths 2017 | | | Stats SA hospital deaths 2017 | | | NCOD Validation 2017/18 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Medical records | | | Forensic pathology records | | |
| | Person | Male | Female | Person | Male | Female | Person | Male | Female | Person | Male | Female |
| Other unintentional injuries | 3.85% | 5.51% | 1.97% | 1.61% | 2.16% | 1.05% | 0.18% | 0.21% | 0.18% | 0.60% | 0.49% | 1.01% |
| Undetermined | 0.38% | 0.45% | 0.31% | 0.22% | 0.26% | 0.17% | 0.47% | 0.60% | 0.32% | 5.21% | 4.83% | 6.41% |
| Suicide and self-inflicted | 0.08% | 0.11% | 0.04% | 0.02% | 0.03% | 0.02% | 0.42% | 0.47% | 0.36% | 12.04% | 12.61% | 10.12% |
| Homicide | 1.72% | 2.87% | 0.43% | 0.33% | 0.57% | 0.09% | 1.02% | 1.79% | 0.22% | 28.47% | 31.58% | 17.71% |
| Legal intervention | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| **Total** | **100.0%** | **100.0%** | **100.0%** | **100.0%** | **100.0%** | **100.0%** | **100.0%** | **100.0%** | **100.0%** | **100.0%** | **100.0%** | **100.0%** |

NCOD – National Cause-of-Death; NBD – National burden of disease


**Contact**

Tel: +27 21 938 0911
Fax: +27 21 938 0200
Email: info@mrc.ac.za