A PROFILE OF DEATHS IN CHILDREN AT THE DIEPKLOOF FORENSIC PATHOLOGY SERVICES MORTUARY FROM 1 JANUARY 2019 TO 31 DECEMBER 2020

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A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, in partial fulfilment of requirements for the degree of Master of Medicine (MMed)

DECLARATION

I, Malerato Ramela declared that this Research Report is my own, unaided work. It is being submitted for the Degree of Master of Medicine in the Department of Forensic Medicine and Pathology at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.

…….

(Signature of candidate)

…16th ……. day of ……September……2024……. in ……Johannesburg.

DEDICATION

To my greatest blessings,

my parents, Steven and Constance Ramela,

and my beautiful children Buhlebenkosi and Bokamaso Mashile.

Thank you for your unconditional love and support.

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I would like to express my sincere gratitude and appreciation to the following staff members at Diepkloof Forensic Pathology Service for their assistance and patience while I conducted my research.

1. Mr M.J Mosikili

Facility Manager

2. Mrs R.J Dinala-Moloi

Forensic Pathology Officer

3. Miss B. Mohuba

Administrative Clerk

LIST OF ABBREVIATIONS

FPS	Forensic Pathology Services
SAPS	South African Police Service
GW 7/24	Medicolegal document completed by treating clinician
D28	Medicolegal document completed by treating clinician
RTA	Road Traffic Accidents
NIMSS	National Injury Mortality Surveillance System
StatsSA	Statistics South Africa
WHO	World Health Organization
LMIC	Low to Middle Income Countries
HIC	High Income Countries
USA	United States of America
USD	United State Dollar
SPCB	Shanghai Public Security Bureau

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AUTHORS GUIDELINES FOR INTENDED JOURNAL

This research follows the University of the Witwatersrand MMED submissible format with extended literature review (refer to document University of the Witwatersrand 2023 School of Clinical Medicine MMed Information Pack vs 1.4).

The research report below will be submitted to the South African Medical Journal.

Please refer to Appendix 4.1 for the journal author guidelines.

CHAPTER 1: EXTENDED LITERATURE REVIEW

The original research approved protocol for this research (approved on the 23rd of August 2022 by University of the Witwatersrand Faculty of Health Sciences) is included as Appendix 2A.

1.1. Definition of "death in children"

A child is defined as any person under the age of 18 years as stipulated in the South African Constitution (1).

Therefore, deaths in children are any deaths occurring in any person aged from birth to 17 years and 364 days.

1.2. Epidemiology of deaths in children

It is important to understand the scale of this issue both locally and globally.

The National Injury Mortality Surveillance System (2,3) and the Statistics South Africa: Mortality and Causes of Death report (4) are the primary sources of data on childhood deaths in South Africa. NIMSS was a mortuary-based study that profiled the causes of fatal injuries using data from post mortem examinations conducted at 62 medicolegal laboratories from 7 of the 9 provinces of South Africa.

According to the United Nations 2022 global child health report, more deaths in children were observed in low to middle income countries(LMIC) such as Argentina, Angola and Indonesia than in high income countries(HIC) such as the United States of America, Germany and Canada (5) . South Africa is classified as a LMIC (6).

Data collected from StatsSA2018 indicated a total of 454014 deaths in South Africa of which childhood deaths constituted 8.6% (39045 deaths) (4). Of the deaths in children the largest

number of deaths was recorded in children below 1 year (4.4% or 20132 deaths) and the smallest number of deaths was observed in children between 5-9 years (0.6% or 2760 deaths) (4).

1.3. Demographics of deaths in children.

Studies conducted in the USA (2000-2009), Brazil (2001-2008), Sub-Saharan Africa (2004) and South Africa (2009) on deaths in children all illustrated a higher number of deaths in males than in females (8,9,10,11).

The 2018 national mortality report by StatsSA showed that in South Africa, male children constituted 9% of all deaths observed in male subjects inclusive of adults (21321 from 238543 deaths) while female children formed 8.2% (17220 from 213802 deaths) of all deaths observed in the female population (4). These included both natural and unnatural deaths.

The report further revealed that the highest number of deaths per sex was observed in children less than 1 year (4.5 % of all deaths in the male population and 4.3% of all deaths in females) and the least number of deaths was observed in the 5-9 years age group (4). Male children in the latter group constituted 0.7% of all deaths in the male population and female children in this group constituted 0.6% of all deaths in females (4).

1.4. Causes of death, mechanism of death and post mortem examination findings

1.4.1 Causes of death:

Causes of death in children vary according to their ages.

Children below the age of 1 year have risk factors related to birth defects and are predisposed to various infections (13). In older children and young adolescents, there is a

shift away from infectious diseases, which more commonly occur in children below the age of 5 years, towards accidental and non-accidental injuries (14).

According to the StatsSA 2018 national mortality report which included both natural and unnatural deaths, unintentional injuries such as those related to road traffic accidents, burns, drowning, electrocution and falls were the leading causes of death in children 0-19 years. (2,3,4). Of the 11084 unnatural deaths recorded in Gauteng in 2010, children constituted 59.6% of all drowning deaths (108/180 deaths), 30.9% of all burns related deaths (113 of 365 deaths), 23.4% of all electrocution related deaths (15/64 deaths) and 13.5% of road traffic related deaths (410/3037 deaths) (3).

In their study conducted in the WHO European region consisting of 51 countries, from 1990 to 2016, Kyu et al indicated that injuries due to road traffic accidents, drowning and falls resulted in 38.7% (4163 out of 10740 deaths) of deaths in children aged 5-9 years and 43% (4468 out of 10279 deaths) of deaths in children 10-14 years of age (15).

An Indian study by Debata et al on causes of unnatural deaths among children and adolescents in northern India from April 2010 to March 2011, showed that of the 434 unnatural deaths identified, the leading causes of death observed were flame burns (58.3%), injuries from road traffic accidents (15%), electrocution (7.8%) and poisoning (6%) (16).

Similar studies conducted in Istanbul, Turkey (between 2001-2005) and Nebraska, USA (between 2003-2010) on children between 0-18 years showed that the leading causes of death in children were due to road traffic accidents, natural diseases, drowning and poisoning (17,18).

1.4.2 Post mortem findings and mechanisms of death

Mechanism of death is described as the specific physiological change in the body that resulted in death. Certain post mortem findings and mechanisms of death may be more specific to children as compared to adults.

In deaths related to road traffic accidents a range of injuries can be observed at post mortem examination depending on whether the deceased was a passenger, pedestrian or driver. Passenger injuries can result from airbags, ill-fitting safety belts or ejection of the individual from the vehicle (19). Younger children below the age of 12 years are at a higher risk of sustaining neck and spinal cord injuries, ocular injuries, rib fractures and intrathoracic organ injuries such as contused and/or ruptured lungs and heart. This is due to their small stature and weaker skeleton being impacted by the airbag that dislodges at very high speeds. Ill-fitting safety belts can lead to neck injuries and intra-abdominal organ injuries, that may be complicated by hypovolemia (19).

Children under 4 years who are involved in pedestrian vehicle collisions usually sustain blunt force head injuries with intracranial haemorrhages or brain swelling. This is due to their small stature with the point of impact usually at the level of the head or chest (19). Adolescents may sustain injuries to the lower extremities similar to adults (19).

Ossei et al, in their study on unnatural deaths conducted between 2008 and 2016 in both adults and children in Ghana, demonstrated that in road traffic accidents, head, abdominal and chest injuries were the most common fatal injuries (7).

1.5. Circumstances of death

It is imperative to understand child deaths in the context of the circumstances in which they occur.

The United Nations 2022 report on child deaths indicated that infectious (natural) diseases accounted for the majority of deaths in children below the age of 5 years while accidental trauma was the major cause of death in children aged 7 years and older (4,13,14).

A Chinese study conducted by He et al in Shanghai between 2000 and 2009 on all unnatural deaths seen at the Shanghai Public Security Bureau (SPCB) recorded a total of 10135 deaths of which 491 (4.8%) were deaths in children aged 16 years and younger. Of all the deaths in children, 278 cases (56.6%) were accidental deaths, 108 (22%) were homicides, 5 (1%) were suicides and 12 (2.4%) of the deaths were due to natural causes. The cause of death was undetermined in 88 (17.9%) of the deaths in children (19). Of the 108 child homicides, 60 victims (55.5%) were male and 48 (45.5%) were female. The leading cause of death in the homicide cases was strangulation (19).

Holakouie-Naieni et al and Okoye et al, in studies in Iran and the USA respectively, showed that accidental deaths were the leading manner of death in children (17,21). In the Iranian study, accidents accounted for 84% (1029/1222 deaths) of the deaths in children followed by suicides at 9.8% (120/1222 deaths) and the cause remained undetermined in 3.2% (39/ 1222 deaths) (21). The American study conducted in the city of Nebraska between 2003 and 2010, recorded 71 accidental deaths out of a total of 140 deaths in children (50.7%) with 42 natural deaths (30%), 19 suicides (13.6%), 7 homicides (5%) and 1 death where the cause remained undetermined (0.7%) (17).

A Swiss study conducted by Steck et al (22) between 1991 and 2013 on a total of 2.3 million adolescents recorded 592 suicides in the study population which corresponded to a suicide rate of 3.7 per 100000. These figures increased with age, rising from 0 per 100000 at 10 years for both girls and boys to 14.8 per 100000 by age 18 for boys and 5.4 per 100000 for girls (22). The risk factors found to have a strong association with committing suicide were being

a male child, being raised by a single parent, being an only or middle child and residing in rural areas. Hanging was the method of choice in boys while railway suicides were more common in girls (22).

Stockl et al conducted an international study on child homicide perpetrators involving 35 countries (23). The study revealed that children between 15-19 years constituted 57% of global child homicide victims as well as children younger than 5 years (20%) (22). Furthermore, the study indicated that 90% of child victims of homicide lived in low-to-middle income countries with the largest child homicide rates identified in Latin America (23). Parents were responsible for the majority of child homicides (56.5%) and the least number of homicides were committed by strangers, (2.1%) (23). Mothers committed 54.7% of all parental homicides. High income countries recorded the largest number of parental homicides inflicted on children at 64.2%, followed by the East Asia and Pacific regions at 61.7% (23).

According to data sourced through NIMSS Gauteng 2010, approximately 11084 non-natural deaths were reported in Gauteng alone (3). The overall leading manner of death reported in children 0-19 years was unintentional non-transport related fatalities with a total of 29% (329/1130 deaths) (3). This was followed by transport related accidental deaths where children constituted 13.5% (410/3037 deaths), suicidal deaths comprising 7.2% (90/1241 deaths) and lastly violence related deaths with 6.1% (203/3331 deaths) (3).

In all the unnatural deaths recorded in Gauteng in 2010, the scene of injury was known in only 8156 of the deaths (76,8%) (3). The top 5 scenes of death/injury were roads (46,4%), private homes (22%) , residential institutions (8,5%), informal settlements (7,3%) and open land (4,8%) for all deaths inclusive of adults and children. No age distribution was applied to this criterion (3).

The NIMSS report further showed that the peak periods for deaths were reported as follows: between 8-11pm Friday to Sunday for violent deaths; 7-10am and 12-1pm Monday, Sunday and Tuesday; 5-9pm and 7-8am Friday to Sunday for transport related deaths and 2-3pm,5-6pm and 9-10pm on a Saturday, Sunday and Wednesday for unintentional non-transport related injuries. This data applied to all deaths inclusive of adults and children. No age distribution filter was applied (3).

According to the South African Society of Psychiatrists, one in ten teenage deaths every year is due to suicide, and up to 20% of high school learners have attempted to end their own lives (24). Risk factors associated with an increased risk of suicide in teenagers included issues relating to personal substance abuse or a history of substance abuse in the family, an already diagnosed mental illness, and a previous suicide attempt (24).

A study on child homicides conducted by Mathews et al in South Africa, in 2009 involving 38 medicolegal laboratories nationwide, discovered a much higher homicide incidence in males than in females, with 6.9 homicides per 100000 children in males as opposed to 3.9 homicides per 100000 children in females (10). Of the 1018 homicides, most deaths occurred in the 15-17 years and <5 years age groups with 416/1018(40.9%) homicides and 405/1018 homicides (39.8%) respectively (10). The least number of homicides were in children between 5 and 9 years (87/1018 homicides;8.5%) (9). Most of the homicides (45.9%) occurred in public places or in the victim's home (34%), and it was found that girls were more likely to be killed at their homes than boys, with a 44% likelihood in girls as opposed to 28% in boys (10). Approximately 35.5% of the victims were killed by an acquaintance and in 30% of the cases the perpetrator was the mother (9). In 44.5% of the child homicides there was pre-existing history of abuse, and sexual assault was suspected in 10% of all the cases (10).

1.6 Ancillary examinations

Whilst conducting a post mortem examination sample collection for various ancillary investigations (e.g histology, toxicology) may be performed either to aid in ascertaining a cause of death, where there was no obvious cause of death identified at autopsy, or to assist in better understanding the circumstances of death (e.g skeletal surveys in cases of suspected non-accidental injury).

Van Deventer et al undertook a study at the Pretoria medicolegal laboratory in South Africa, focusing on sudden and unexpected childhood deaths between 2007 and 2011 (25). The study sampled various biological specimens in 98 victims at autopsy for ancillary histology and toxicology investigations, to ascertain the degree of usefulness of these investigations towards determining a cause of death (25). The study demonstrated that histological examination did not contribute to ascertaining the cause of death in 54.8% of deaths while it confirmed the macroscopic diagnosis in 24,7% of the cases (25). A cause of death was identified in 20.5% via histological examination alone. The leading cause of death determined by histological examination was pneumonia followed by unspecified natural causes and meningitis. Due to the crippling backlogs in the Forensic Chemistry Laboratories the toxicology results were not available at the time of publishing, therefore the significance of this investigation in formulating or confirming a suspected cause of death could not be determined nor discussed (25).

1.7 Rationale for study

The scarcity of literature on deaths in children including the specific findings at autopsy in trauma related deaths prompted this study. Most of the literature on childhood deaths focuses on child mortality in children below the age of 5 years. Childhood trauma

related studies are mostly conducted in clinical trauma centres with minimal information available on post mortem examination findings in childhood trauma related deaths.

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CHAPTER 3: RESEARCH REPORT DRAFT ARTICLE FORMAT

Abstract

Background:

This study was conducted to address the scarcity of knowledge around unnatural deaths in children in South Africa. Nationally and internationally, the focus has largely been on child mortality in children below the age of 5 years.

Objectives:

The study had two main objectives: (1) to profile the incidence, causes and circumstances of death, as well as all ancillary investigations requested at autopsy in child decedents at Diepkloof Forensic Pathology Services (FPS) between 1 January 2019 and 31 December 2020, and (2) to evaluate the effects of the Covid 19 pandemic on trauma related child deaths during the study period.

Methods:

This was a restrospective review study using FPS death register records and case files to identify and collect data on all child deaths admitted to the Diepkloof FPS mortuary during the study period.

Results:

In the study 535 child deaths were observed out of a total of 4704 decedents admitted to the Diepkloof FPS mortuary (11.4%), with the majority of deaths observed in male children (n=297/535;55,5%). The greatest proportion of deaths was observed in the Black population (94.8%), followed by the Coloured, Asian and White population at 4.3%, 0.7% and 0.2% respectively. The leading manner of death was accidental (n=228/535;42.6%), followed by natural deaths (n=100/535;18.7%) and deaths where the cause remained under investigation due to pending results for ancillary investigations (n=61/535;11.3%). Within the accidental deaths category, road traffic accidents (RTA), burns (both open flame and hot water burns) and aspiration were primary causes of death and jointly accounted for 80.3% (n=183/535) of all accidental deaths. In addition, 35 suspected homicides were identified, which accounted for 6.5% (n=35/535) of all the deaths. The most prevalent cause of homicidal death was sharp force injuries (n=12/35; 34.2%) followed closely by gunshot injuries (n=11/35; 31.4%). Injuries due to blunt force trauma from assaults were identified in 22.9% (n=8/35) of the decedents. Asphyxial deaths accounted for 8.6% (n=3/35) of the homicide deaths and 2.8% (n=1/35) was due to poisoning. Cranio-cerebral injuries were the most common fatal injury, and they were observed in 80.7% (n=109/135) of the trauma related deaths. The population movement restrictions that were implemented during the Covid 19 pandemic resulted in an approximately 22% decrease in trauma related deaths, from 76 trauma related deaths in 2019 to 59 in 2020.

Conclusion:

This study revealed that accidental deaths are the leading manner of unnatural deaths in children in the Diepkloof FPS catchment region. Therefore a large number of deaths in children are potentially avoidable by educating our communities on child safety and by the governmental implementation of safety measures to protect children.

Introduction:

One of the eight United Nations Millennium Development Goals agreed upon and committed to by all 191 member states in September 2000 is to decrease child mortality (1). Therefore South Africa as a member state does not only have the societal obligation to protect children but has to be held accountable to this international agreement (1). According to the South African Constitution children are persons below the age of 18 years and they comprise approximately 34% of the South African population (2,3). Most studies of childhood mortality focus on deaths occurring in children below 5 years of age. There is very little literature available on unnatural deaths in children in South Africa.

According to the United Nations 2022 global child heath report , an evaluation of deaths in children in both low to middle-income countries (LMIC) as well as high-income countries (HIC), revealed that children born in poorer households are twice as likely to die before they reach 5 years than their counterparts in wealthier households (4). South Africa is classified as a LMIC. The Statistics South Africa 2018 report (5) showed a total of 454014 deaths in South Africa of which deaths in the 0-19 years group constituted 8.6% (39045 deaths). Of the deaths in children the largest number of deaths was recorded in children younger than 1 year (4.4% or 20132 deaths) and the smallest number of deaths was observed in children between 5-9 years (0.6% or 2760 deaths). Male children constituted 9% of all deaths recorded in the male population (21321 from 238543 deaths) and female children accounted for 8.2% (17220 from 213802 deaths) of all deaths recorded in the female population (5). Similarly, several international studies found that a larger number of deaths occurred in male children than in female children (5,6,7,8). The StatsSA 2018 national mortality report, as well as international studies conducted in Africa, USA, Turkeye and India, revealed that accidental deaths such as those related to road traffic accidents, burns, drowning, electrocution and falls were the leading causes of death in children, followed by natural causes of death e.g. bronchopneumonia. (5,8,12,13)

This study focused on unnatural deaths in children within the realm of the Forensic Pathology Services (FPS) in South Africa whose core function is the medicolegal investigation of all unnatural deaths. South African Law defines an unnatural death as (9):

1. “any death due to physical or chemical influence, direct or indirect, and/or related complications;”
2. “any death, including those deaths which would normally be considered to be a death due to natural causes, which in the opinion of the medical practitioner, has been the result of an act of commission or omission which may be criminal in nature;”
3. “any death as contemplated in section 56 of the Health Professions Amendment Act, Act 29 of 2007 (“The death of a person undergoing, or as the result of, a procedure of a therapeutic, diagnostic or palliative nature, or of which any aspect of such has been a contributory cause, shall not be deemed to be a death from natural causes as contemplated by the Inquest Act, 1959 (Act 58 of 1959), or the Births and Deaths Registration Act, 1992 (Act 51 of 1992).”
4. “where the death is sudden and unexpected, or unexplained, or where the cause of death is not apparent;”

During the Covid-19 pandemic, South Africa instituted legally mandated population movement restrictions and curfews that ranged from a “hard lock down’, where people were confined to their homes and only essential service personnel were given permits to allow travelling for job-related purposes (level 5) to level 1 where all movement was permitted. These “lock down”

restrictions were implemented between March 2020 and April 2022. The effects of these restrictions on the unnatural deaths in children are described in the study.

Methods

This was a retrospective descriptive case file study of all unnatural deaths in children who were admitted to the Diepkloof Forensic Pathology Services (FPS) Mortuary between 1 January 2019 and 31 December 2020. The Diepkloof FPS Mortuary is situated in Soweto, which is the largest township in South Africa located in the south of Johannesburg. A township in South Africa refers to an often underdeveloped racially segregated urban area that was reserved for non-Whites during the apartheid era (10). Although apartheid restrictions have been legally lifted, these areas remain relatively under-developed and racially segregated. There are 12 South African Police Service (SAPS) stations which fall within the jurisdiction of Diepkloof FPS. The study site is one of 8 FPS mortuaries that service the Southern Gauteng region. Approximately 17900 autopsies are performed annually in this region, with 2779 of those performed at the Diepkloof FPS.

On admission to the FPS facility, the details of the deceased are manually recorded in the death registers and a case file is opened. The FPS case files include the SAPS 180, which is a form completed by the South African Police Service official documenting details about the deceased and the death scene. In the cases where the decedent had died in a medical facility, the forms D28 (clinical history) and GW7/24 (surgical and anaesthetic records), are completed by the clinicians detailing the medical and surgical interventions during admission.

The FPS death registers and case files were used to identify all deaths in children, and collection of data required for the study.

The study aimed to profile all child deaths admitted to the Diepkloof FPS mortuary, focusing on the number of child deaths, the demographics of the deceased children, the causes and mechanisms of the deaths, the circumstances of the deaths which included the temporality and geographic location of the deaths, and the manners of the death. All ancillary investigations performed at autopsy, and where relevant, the injury patterns were recorded. In addition, this study aimed to determine the effects of Covid-19 population movement restriction measures on all trauma related deaths in children. For the study period, there were a total of 4704 post mortem examinations conducted at the site, of which 12.5%(n=586) met the inclusion criteria for the study**.** All abandoned fetuses, stillbirths and severely decomposed or skeletonized remains where age could not be determined through history or scientific methods were excluded from the study. Ethical approval for the study was obtained from the University of the Witwatersrand Human Medical Research Ethics Committee (Clearance certificate number M220839).

Results

1. Incidence and demographics of child deaths:

A total of 535 child deaths were recorded in the study. These child deaths comprised 11.4% of the total 4704 cases admitted to the Diepkloof FPS Mortuary during the study period of 1 January 2019 to 31 December 2020. A total of 51 cases we excluded as 4 cases were determined to be adults, 12 cases were stillbirths and 35 cases had missing files.

The greatest proportion of deaths was observed in the Black population (n=507/535; 94.8%) and the smallest proportion was observed in the White population (n=1/535;0.2%) largely reflecting the population demographics of South Africa and Soweto (3). The Coloured (mixed race) and Asian (includes East Asian and Indian population) populations accounted for 4.3%

(n=23/535) and 0.7% (n=4/535) of the deaths respectively. The majority of the deceased children were males (n=297/535; 55.5%). More deaths occurred in males than in females across all age groups except in the 7-12 year group. The greatest number of deaths was observed in the 1-6 years age group and the smallest number of deaths were in the 7-12 year group. The mean female age at death was 5.8 years (SD=1.1 years), males were 6.4 years (SD =1.2 years), and 6.1 years for both sexes (SD =1.1 years) **Refer to figure 1.**

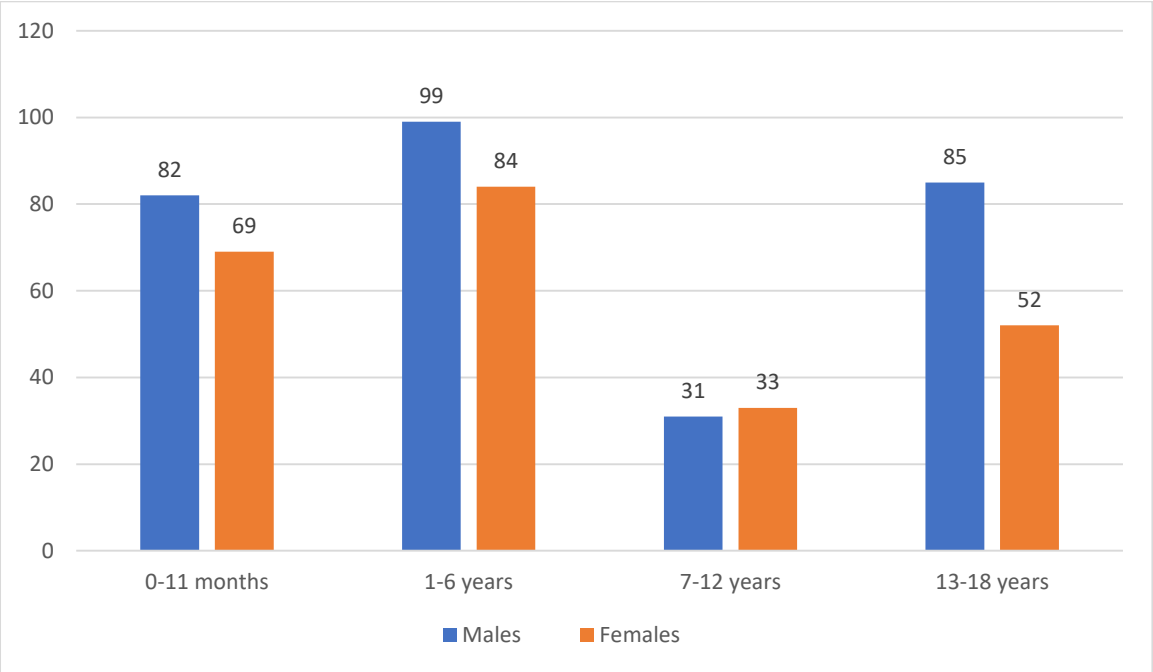

Figure 1: Age and sex distribution of child deaths at Diepkloof FPS between 1 January 2019 and 31 December 2020. (N=535)

2. Circumstances of death.

2.1 Manner of death:

The manner of death indicates the circumstances under which the children died. It is broadly categorized as unnatural (homicidal, suicidal, accidental), natural or undetermined (not enough information or evidence is available to make a determination).

Accidental deaths were the most common manner of death at 42.6% (n=228/535) followed by natural deaths (n=100/535; 18.7%) and deaths that remain under investigation, i.e where a cause of death could not be established at autopsy and/or results for ancillary examinations performed are still pending (n=61/535;11.3%) (**See Figure 2).** The largest proportion of the accidental deaths was observed in the 1-6 year group (46.1%) followed by the 13 and 18 year group (22.4%) **(See Figure 3).**

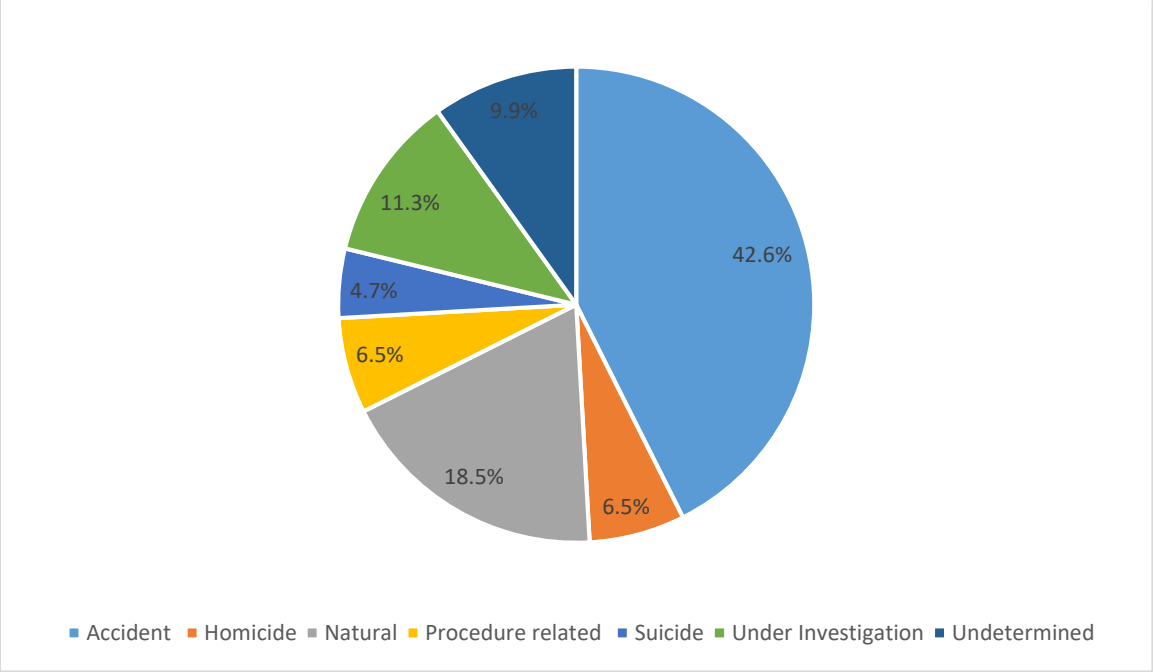

Figure 2: Distribution of the manner of death in child deaths at Diepkloof FPS between 1 January 2019 and 31 December 2020. (N=535).

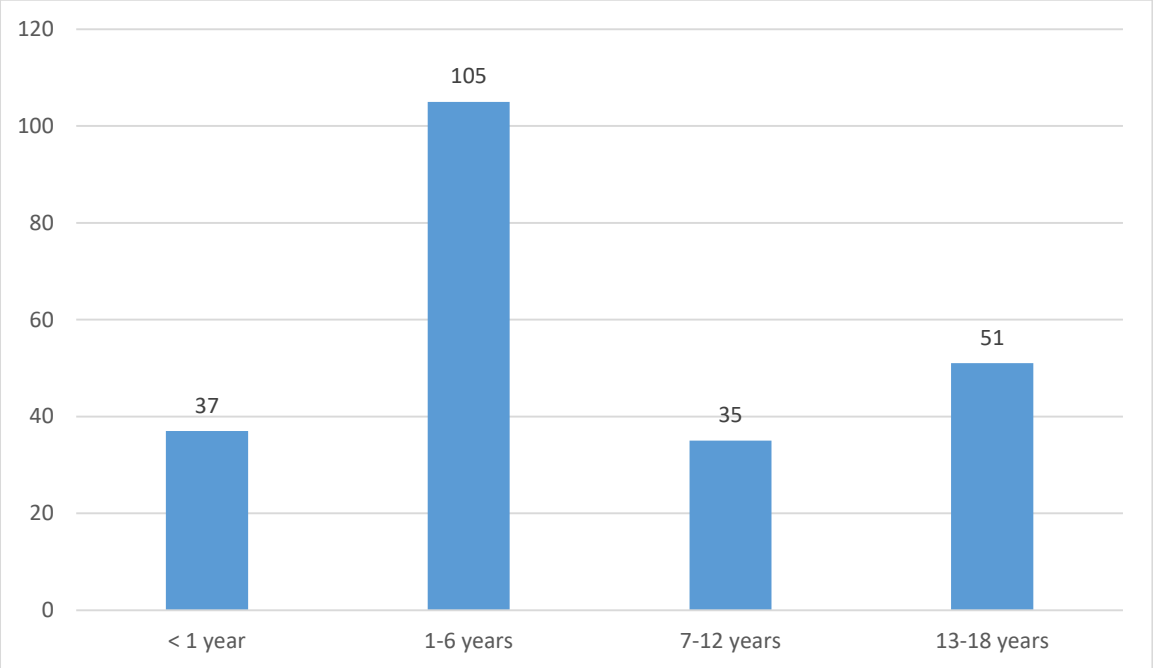

Figure 3: Age distribution of accidental deaths in children at Diepkloof FPS between 1 January 2019 and 31 December 2020. (n=228)

The most common categories of accidental deaths were road traffic accidents (n=84/228; 36.9%) followed by burns (n=73/228; 32%) and aspiration (n=26/228; 11.4%). Aspiration is the inhalation of gastric or oropharyngeal contents into the larynx and lower respiratory tract. Of the 26 cases of aspiration, 6 occurred in children above the age of 1 year and 20 were in children below 1 year. The most prevalent histories in the cases of aspiration was that of the child being found unresponsive after a feed (**Refer to figure 4).**

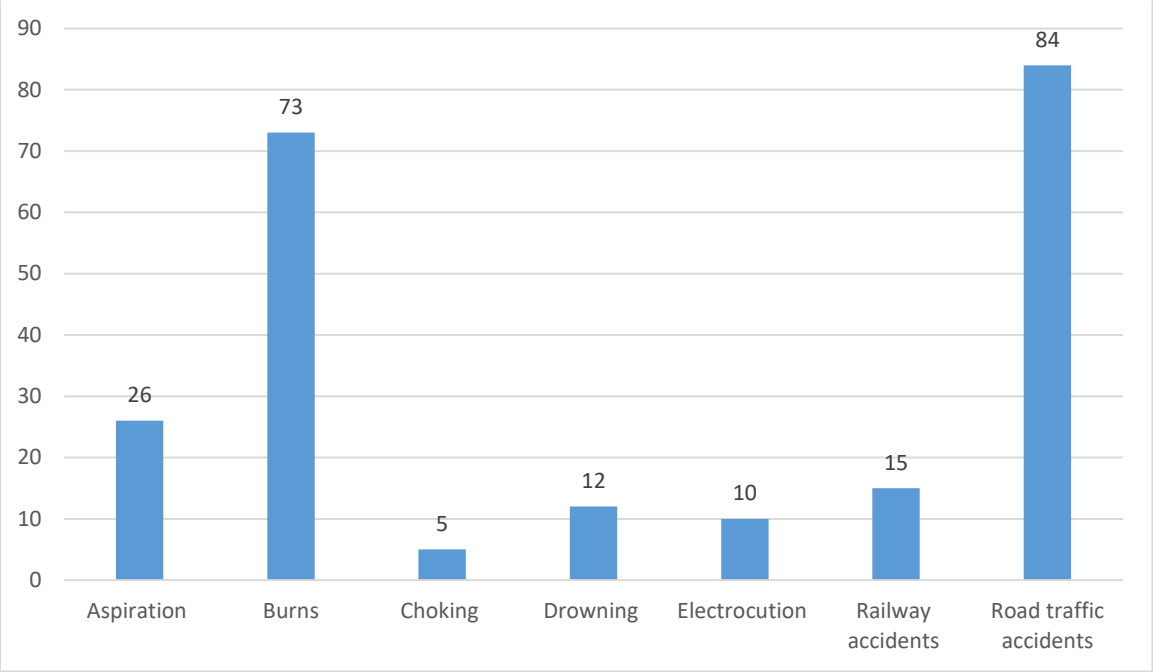

Figure 4: Number of death in the different categories of accidental deaths in children at Diepkloof FPS between 1 January 2019 and 31 December 2020. (n=228)

During the study period, 35 suspected homicides were recorded, which accounted for 6.5% (n=35/535) of all the deaths. The perpetrator was unknown in 68.5% (n=24/35) of the cases. In 20% of the suspected homicide cases, the perpetrators were reportedly the parents of the children. Two of the victims (5.7%) were reportedly murdered by a relative other than the parents.

One child was killed by mob assault or mob justice. This is a type of assault committed by vigilantes who punish people identified by the community as having committed crimes (10).

One child was allegedly killed by the South African Police Service. The circumstances of that death were as follows: During the Covid 19 lockdown, three police officers allegedly shot and killed a teenage boy while patrolling the area to enforce lockdown regulations.

The leading cause of death in homicides was sharp force injuries (n=12/35; 34.2%) followed closely gunshot injuries (n=11/35; 31.4%). In 22.9% (n=8/35) of the homicides, the cause of death was due to blunt force injuries resulting from assaults. Asphyxial deaths accounted for 8.6% (n=3/35) of the homicide deaths and 2.8% (n=1/35) was due to poisoning. Sexual assault evidence collection kits were completed in eight (22.9%) of the suspected homicides. These were collected in 8 of the female homicide victims where the SAPS official had requested the investigation based on the evidence identified at the scene of death or the doctor performing the autopsy had determined it to be necessary after reviewing the history of the victim and their own observations at the time of post mortem examination.

There were 25 apparent suicides of which 14 (56%) were observed in females and 11 (44%) in males. All the male suicide decedents were in the 13-18 year group, while in the female group 2 decedents (18%) were in the 7-12 year group and 12 (82%) were in the 13-18 year group. All of the male decedents used hanging as a method to commit suicide. Of the female decedents 7 (50%) used hanging, 4 (28.6%) were suspected to have ingested poison and 3 (21.4%) were due to a suspected drug overdose. At the time of the study forensic toxicology results were still pending in all of the suspected poison ingestion and drug overdose deaths.

2.2 Temporality and geographical location of the deaths:

Most of the deaths reportedly occurred during the week (n=263/535; 49.2%) and the least number of deaths occurred during public holidays (n=24/535;4.4%). 46.4% of all the deaths were observed on weekends.

The majority of deaths occurred at medical facilities (n=344/535;64.3%) followed by residential areas (n=128/535; 23.9%) and in and around roads or streets (n=34/535; 6.4%) **Refer to table 1.** Although the majority of deaths appear to have occurred at medical facilities, 192 of these were children declared dead on arrival at the medical facility.

Geographical location of death	Proportion
Medical facility	344 (64.3%)
Residential area	128 (23.9%)
Road/street	34 (6,4%)
Railway	16 (3%)
Water source	7 (1.3%)
Open space	6 (1.1%)

Table 1: Geographical locations of child deaths admitted to Diepkloof FPS between 1 January 2019 and 31 December 2020

3. Causes and mechanisms of death, and patterns of injury.

3.1 Causes of death

The cause of death is the disease or injury which initiated the chain of morbid events leading to death.

Most of the deaths were as a result of physical trauma including injuries sustained in road traffic crashes, railway incidents, sharp force trauma (stabbing incidents), gunshot injuries, assaults, and other deaths due to blunt force trauma where the mechanism of injury was not apparent, (n=135/535; 25.2%). This was followed by natural deaths 15.5% (n=83/535), which included bronchopneumonia, congenital heart disease and bowel necrosis (n=100/535; 18.7%), then deaths due to thermal injuries (n=83/535; 15.5%), which included electrocutions (n=10/83; 12%), and flame and hot water burns (n=73/83; 88%). **Refer to table 2 and 3, and figure 6.**

Apparent cause of death	Proportion
Trauma related deaths	135 (25.2%)
Natural deaths	100 (18.7%)
Thermal deaths	83 (15.5%)
Asphyxial deaths	66 (12.3%)
Under Investigation	61 (11.4%)
Poisoning deaths	59 (11.1%)
Procedure related deaths	30 (5.6%)
Drug reaction	1 (0.2%)

Table 2: Distribution of the causes of death in children at Diepkloof FPS between 1 January 2019 and 31 December 2020. (N=535)

Causes of Natural Death	Proportion
Lower respiratory tract infection (LRTI)	54 (54%)
LRTI and congenital heart disease	12 (12%)
Gastroenteritis	10 (10%)
Congenital heart disease	6 (6%)
Perforated/necrotic bowel	5 (5%)
Other	5 (5%)
Cerebral infarct/haemorrhage	3 (3%)
Meningitis	3 (3%)
Fibrinous pericarditis	1 (1%)
Septic arthritis	1 (1%)

***Other:Abruptio placentae; Chrorioamnionitis; Glomerulonephritis and Human Immunodeficiency Virus**

Table 3: Distribution of the natural causes of death in children at Diepkloof FPS between 1 January 2019 and 31 December 2020. (n=100)

Natural causes of death were most common in the less than 1-year age group, with their incidence decreasing with age. **See figure 5.**

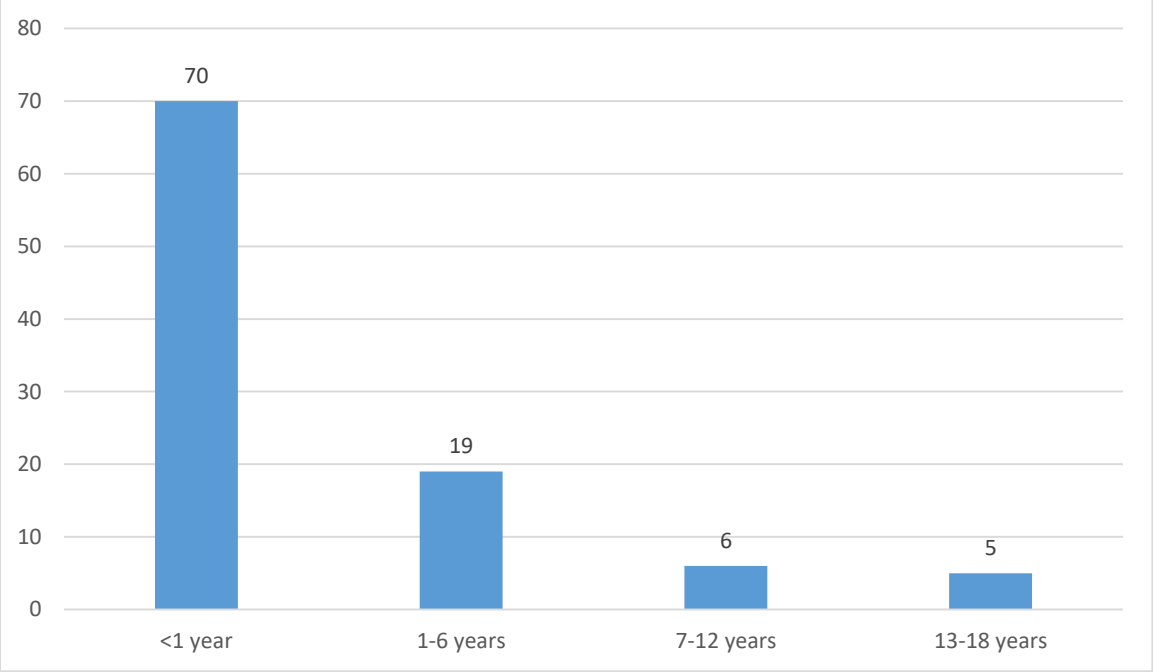

Figure 5: Age distribution of natural causes of child deaths at Diepkloof FPS between 1 January 2019 and 31 December 2020. (n=100)

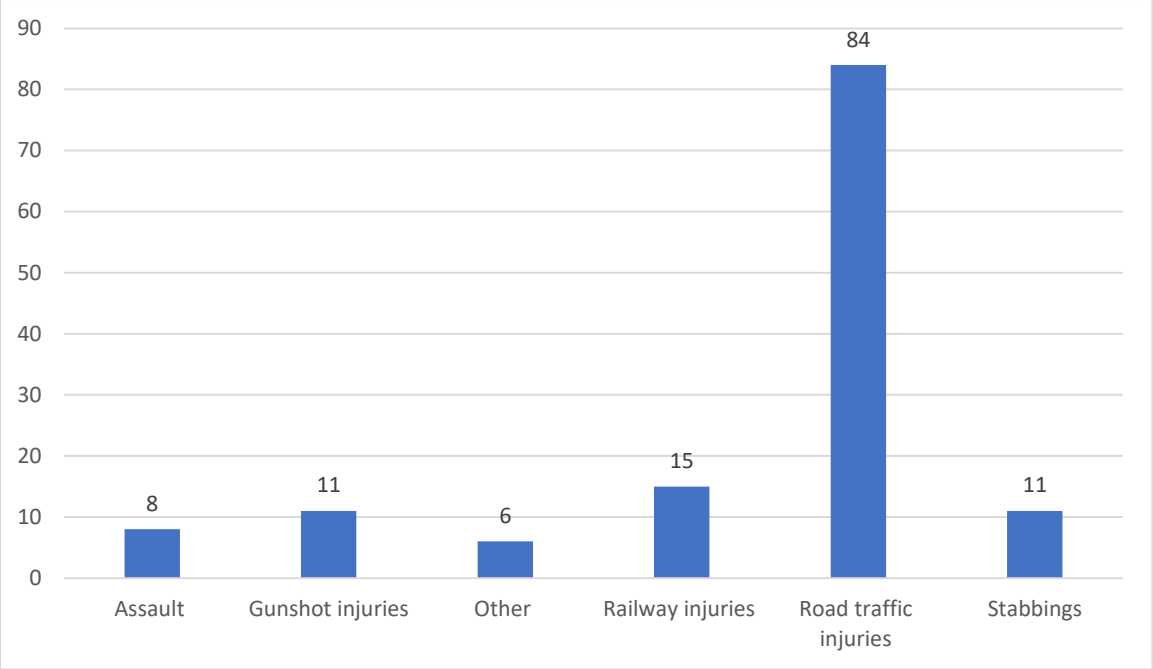

Figure 6: Distribution and frequency of physical trauma related deaths in children at Diepkloof FPS between 1 January 2019 and 31 January 2020. (n=135)

3.2 Mechanisms of death

The mechanism of death is defined as the physiological derangement that results from the primary cause of death.

Asphyxia or hypoxia was the most common mechanism of death and was identified in 27% of all deaths (n=145/535), followed by brain death and multi-organ failure at 19.8% (n=106/535) and 17.6% (n=94/535) respectively. Other mechanisms of death that were described included hypovolemia (n=57/535; 10.7%), neurotoxicity (n=54/535; 10.1%), cardiac arrest (n=10/535; 1.9%) and neurogenic shock (n=7/535; 1.3%). Due to pending ancillary investigation results, 62 cases (11.6%) were under investigation at the time of completion of the study.

3.3 Post mortem findings in trauma-related deaths

The majority of the injuries in trauma-related deaths were to the cranio-cerebral areas (n=109/135; 80.7%), followed by intra-thoracic (n=96/135; 71%) and intra-abdominal injuries (n=35/135; 26%).

There were skull fractures present in 57% (n=62/135) of the cranio-cerebral injuries described. The most common intracranial finding was a subdural haemorrhage complicated by cerebral swelling (n=18/109; 16.5%). This was followed by skull fractures complicated by brain swelling in the absence of intracranial haemorrhage (n=16/109; 14.7%) and isolated cerebral swelling (n=12/109; 11%).

The most common intrathoracic injury was contusion of the lungs (n=62/135; 45.9%). Out of the 6 injuries to the heart, 5 were due to stabbing (n=5/135) and 1 case (0.7%) was due to blunt force trauma from an assault. Fractured ribs were observed in 15.6% (n=21/135) of the cases. Of the cases where intrathoracic injuries were present, 12.6% (n=17/62) were complicated by a haemothorax.

The most common intra-abdominal injuries were a ruptured liver (n=28/135; 20.7%) followed by a ruptured spleen (n=4/135; 3%) and bowel injuries due to both sharp and blunt force trauma (n=4/135; 3%). Haemo-peritoneums were observed in 21 (15.6%) cases with intra-abdominal injuries.

Genital injuries were identified in 1 case (0.2%). The deceased was a 2 year old female who demised a few days after admission to a health care facility due to blunt force trauma of the head. There was no clear history on the circumstances of the incident.

Of the 135 trauma-related deaths, a total of 35 fractures were identified at autopsy. Of these, 16 (45.7%) were long bone fractures, 13 (37.1%) were fractures of the spinal column and 6 (17.1%) were pelvic fractures.

3.4 Ancillary investigations performed at autopsy:

Toxicological analysis was the most common requested ancillary investigation and was requested in 20% of the decedents (n=107/535), followed by blood alcohol concentration testing (n=69/535; 12.9%) and histological analysis (n=65/535; 12.1%). At the time of finalizing the study, laboratory results remained outstanding **See table 4.**

Ancillary Investigations	**Requested at autopsy**	**Frequencies**		
		Positive	**Negative**	**Not available**
Toxicology	**107**	**1 (0.9%)**	**1 (0.9%)**	**105 (98.2%)**
Blood alcohol concentration	**69**	**1 (1.4%)**	**7 (10.1%)**	**61 (88.5%)**
Histology	**65**	**4 (6.2%)**	**0**	**61 (93.8%)**
DNA profiling	**28**	**0**	**0**	**28 (100%)**
Sexual assault kit	**8**	**0**	**0**	**8 (100%)**
Carboxyhaemoglobin analysis as a biomarker for carbonmonoxide exposure	**5**	**0**	**0**	**5 (100%)**
Ballistics	**4**	**0**	**0**	**4 (100%)**
Xray	**2**	**0**	**2 (100%)**	**0**
Skeletal survey	**1**	**0**	**1 (100%)**	**0**

Table 4: Ancillary investigations performed at autopsy and results/outcomes thereof in child deaths at Diepkloof FPS between 1 January 2019 and 31 December 2020. (N=535)

4. Effects of Covid-19 pandemic restrictions.

The government regulations that were instituted during the Covid-19 pandemic resulted in the implementation of different stages of restrictive population movement or lockdown processes

which included the closure of schools. This led to a noticeable decrease of trauma related deaths (road traffic accidents, stabbings, gunshot injuries and assaults) from 76 in 2019 to 59 in 2020 **(See table 5).** The largest proportion of trauma related deaths were as a result of blunt force trauma (from assaults or road traffic accidents), followed by sharp force and gunshot injuries, both in 2019 and 2020. There was a decrease in road traffic accidents and gunshot injuries from 47/76 to 37/59 cases and 6/76 to 5/59 cases in 2019 and 2020 respectively. There was a slight increase in stabbings from 5/76 cases in 2019 to 7/59 cases in 2020. Overall deaths due to blunt force trauma increased by almost 50% from 5/76 cases in 2019 to 9/59 cases in 2020.

Cause of death	**2019 (n=76)**	**2020 (n=59)**
Road traffic accidents	47 (61.8%)	37 (62.7%)
Railways accidents	13 (17.1%)	2 (3.4%)
Gunshot injuries	6 (7.9%)	5 (8.5%)
Stabbing incidents	5 (6.6%)	6 (10.2%)
Assaults	3 (3.9%)	5 (8.5%)
Other (blunt force trauma where mechanism of injury was not specified)	2 (2.6%)	4 (6.8%)

Table 5: Effects of Covid-19 movement restrictions of trauma related child deaths during study period of 1 January 2019 and 31 December 2020 at Diepkloof FPS.

Discussion

This study was conducted to address the paucity of knowledge of unnatural deaths in children in South Africa.

The distribution of death according to race observed in the study reflected the racial demographics of South Africa with most deaths (94.8%) observed in the Black population, followed by the Coloured(mixed race), Asian(Indian and East Asian) and White population. The South African population is predominantly Black (81.4%), and Coloured, Asian and White people collectively constitute 18.6% of the population (3).

The United Nations 2022 global child health report revealed that infectious (natural) diseases account for the majority of deaths in children below the age of 5 years while accidental trauma is the leading cause of death in older children (4,12,13,14). Similarly, the leading manner of death in this study was accidental, accounting for 42.6% of all deaths, followed by natural deaths in 18.5% of the cases. The majority of natural deaths (89%) were in children younger than 6 years old, of which the majority occurred in children less than 1-year-old (70%). The leading category of accidental death in this study was road traffic accidents (36.8%), followed by flame and hot water burns (32%); and railway accidents (6.6%). Similar findings were presented in studies, conducted in other African countries, India, the United States of America (USA) and Europe, where RTA's were amongst the top three leading categories of accidental deaths (12,13,14,20). A suggestion for the prevalence of RTA's in this study could be related to the impact of interprovincial and international migration to major cities, resulting in the birth of many informal settlements, due to the dawn of democracy of South Africa. Children living in these areas have to commute long distances to school, often by foot, putting them at a greater risk of being victims of RTA's. In addition, there is a lack of access to vital services e.g. electricity, resulting in the utilisation of other

often unsafe methods to warm houses and cook such as, open fires which could potentially cause disastrous and fatal accidents.

The study also revealed that deaths relating to interpersonal violence and suicide increased with age. Of the suicides identified in this study, 92% occurred in the 13-18 years age group, with the commonest method of suicide being hanging in the male decedents. In the female decedents, hanging and suspected poison ingestion each accounted for 50% of all suicide cases. Carbamate or organophosphate poison was suspected macroscopically at autopsy in all the suspected cases of poisoning. This may be related to the ease of access to this pesticide for both industrial and domestic use in South Africa (16). Perhaps greater regulations and restriction of access to these harmful toxins could potentially prevent these types of death.

According to Stockl et al, more than 70% of child homicides globally are observed in children in the 15 to 19 years and 0-5 years age groups. They account for 57% and 20% of these homicides respectively. Similar trends were identified in local studies (17,18). In this study, the majority (71%) of homicide victims were teenagers and predominantly male. This may be related to an increase in drug abuse among adolescents, leading to crime and violence, as observed in a National Youth Risk Behaviour survey conducted at South African high schools.

This study illustrated that the majority of the injuries in trauma-related deaths were cranio-cerebral injuries, followed by intrathoracic and intra-abdominal injuries. Of the musculoskeletal injuries, long bone fractures were the most common. These findings were similar to a Ghanaian study by Ossei et al highlighting road traffic accidents, head, abdominal and chest injuries being the most common fatalities (20).

Most of the deaths in this study occurred at medical facilities (n=344/535; 64.3%). However, in 58.1% (n=192/344), the children were actually declared dead on arrival to the facilities, meaning they died elsewhere, or en-route to the medical facilities.

Most of the deaths reportedly occurred during the week (n=263/535; 49.2%) and the least number of deaths occurred during public holidays (n=24/535; 4.4%). This may be attributed to the lack of supervision during the week, with adults being at their places of employment.

At the time of completion of the study, the majority of the results of the ancillary investigations (n=272/289; 94.1%) performed at autopsy were still pending, reflecting the crippling scarcity of resources, including human resources in Forensic Pathology Services in South Africa as a whole. This has resulted in 11.3% of the cases remaining under investigation four years after the study.

The population movement restrictions implemented due to the Covid 19 pandemic resulted in a notable decrease in overall trauma-related deaths, especially in those deaths that occurred from road traffic and railway accidents. There was no significant change in deaths due to gunshot injuries. However blunt force injuries due to assaults, and where the mechanism of injury was not specified increased by almost 50% from 2019 to 2020.

Conclusion

This study revealed that accidental deaths are the leading cause of unnatural deaths in children in Soweto, South Africa. Therefore a large number of deaths in children are potentially avoidable by educating our communities on child safety and by the governmental

implementation of safety measures to protect children. Road traffic accidents and burns were the commonest categories of accidental deaths while lower respiratory tract infections were the most common cause of natural deaths. The study illustrated that older children and teenagers are at a higher risk of suicide or of being a victim of a homicide. Though most of the deaths were reported to have occurred at a medical facility, a significant number of those were deaths on arrival therefore pointing towards a different geographical location of death. This study was conducted at only one of 121 national FPS facilities, therefore these findings might not be a true reflection of national statistics. It would be of great benefit if a national study could be conducted in order to seek and implement national guidelines to assist in decreasing avoidable or accidental deaths.

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APPENDICES

APPENDIX 4.1

South African Medical Journal Submission Guidelines (as obtained from website accessed on 15 February 2023).

Submissions

Submission Preparation Checklist

All submissions must meet the following requirements.

- Please ensure you have submitted a regular version of the manuscript i.e. full text with author details and an anonymised version (author details remove). Failure to do so will result in your manuscript being returned to you.
- The submission has not been previously published, nor is it before another journal for consideration (or an explanation has been provided in Comments to the Editor).
- The submission file is in Microsoft Word document file format.
- The text is single-spaced; uses a 12-point font; employs italics, rather than underlining (except with URL addresses); and all illustrations, figures, and tables are placed within the text at the appropriate points, rather than at the end.
- The text adheres to the stylistic and bibliographic requirements outlined in the Author Guidelines.

Research

Guideline word limit: 4 000 words

Research articles describe the background, methods, results and conclusions of an original research study. The article should contain the following sections: introduction, methods, results, discussion and conclusion, and should include a structured abstract (see below). The introduction should be concise – no more than three paragraphs – on the background to the research question, and must include references to other relevant published studies that clearly lay out the rationale for conducting the study. Some common reasons for conducting a study are: to fill a gap in the literature, a logical extension of previous work, or to answer an important clinical question. If other papers related to the same study have been published previously, please make sure to refer to them specifically. Describe the study methods in as much detail as possible so that others would be able to replicate the study should they need to. Results should describe the study sample as well as the findings from the study itself, but all interpretation of findings must be kept in the discussion section, which should consider primary outcomes first before any secondary or tertiary findings or post-hoc analyses. The conclusion should briefly summarise the main message of the paper and provide recommendations for further study.

Select figures and tables for your paper carefully and sparingly. Use only those figures that provided added value to the paper, over and above what is written in the text.

Do not replicate data in tables and in text.

Structured abstract

- This should be 250-400 words, with the following recommended headings:
  Background: why the study is being done and how it relates to other published work.
  Objectives: what the study intends to find out
  Methods: must include study design, number of participants, description of the intervention, primary and secondary outcomes, any specific analyses that were done on the data.
  Results: first sentence must be brief population and sample description; outline the results according to the methods described. Primary outcomes must be described first, even if they are not the most significant findings of the study.
  Conclusion: must be supported by the data, include recommendations for further study/actions.

- Please ensure that the structured abstract is complete, accurate and clear and has been approved by all authors.
- Do not include any references in the abstracts.

Here is an example of a good abstract.

Please refer to these guidelines for further information on the format of a research article.

In Practice

Guideline word limit: 2 000 - 3 000words

This section includes articles that would previously have been accepted into the Forum section, and case reports.

In practice articles are those that draw attention to specific issues of clinical, economic or political interest regarding medicine and healthcare in southern Africa. They are assigned to a topic:

- Case report
- Clinical practice
- Clinical alert
- Issues in medicine
- Issues in public health
- Healthcare delivery
- Medicine and the environment
- Medicine and the law
- Cochrane corner

An In Practice article should follow the following format – sub-headings are not necessary, but may be used for clarity:

- Author affiliations and qualifications: to be the same as for Research. Provide all authors'
- names and initials, qualifications and full affiliations, and corresponding author.
- Short abstract: does not need to be structured, but should capture the essential features of the article

- Introduction: the reason for the article and the issue being addressed
- Recent research, discussion, local policy around the issue – include your own research where appropriate
- All statements should be referenced and, if opinion only, this should be stated
- Discussion: how this article adds to the discussion around a particular topic
- If a clinical practice or policy point is at issue, this needs to be emphasised, using a box with highlights if appropriate.

Essentially In practice is an opportunity for a more discursive approach to topics of clinical, economic or political importance in southern African health systems. It is not an opportunity to put forward unsubstantiated opinions!

Guidelines for case reports can be found here.

Editorials

Guideline word limit: 1 000 words

These opinion or comment articles are usually commissioned but we are happy to consider and peer review unsolicited editorials. Editorials should be accessible and interesting to readers without specialist knowledge of the subject under discussion and should have an element of topicality (why is a comment on this issue relevant now?) There should be a clear message to the piece, supported by evidence.

Please make clear the type of evidence that supports each key statement, e.g.:

- expert opinion
- personal clinical experience
- observational studies
- trials
- systematic reviews.

CME

CME is intended to provide readers with practical, up-to-date information on medical and related matters. It is aimed at those who are not specialists in the field.

From January 2016, all CME articles will be printed in full in the *SAMJ*. Please try to adhere strictly to the guidelines on word count as we have a page limit for the print issue of the *SAMJ*. We reserve the right to place some tables and reference lists online if this is necessary for space.

In practice, this means that each CME topic usually covers two issues of the print issue of the *SAMJ*.

The guest editor, in consultation with the editor, is responsible for convening a team of authors, deciding on the subjects to be covered and for reviewing the manuscripts submitted. The suggestion is for 4 - 5 articles, although there is some room for flexibility contingent on discussions with the editor.

For queries about these guidelines please feel free to contact the CME editor, Dr Bridget Farham, by email (ugqirha@iafrica.com) or telephone (+27 (0)82 452 2860)

Review process

The guest editor reviews the articles and returns them to the CME editor for review and final approval.

Guest editorials

Guideline word limit: 1 000 words

- Include the guest editor's personal details (qualifications, positions, affiliation, e-mail address, and a short personal profile (50words)).
- If possible, include a photograph of the author(s) at high enough resolution for print. It is
- preferable to provide two guest editorials, one for each issue, so that the content of the articles in each issue is covered.

Articles

Guideline word limit: 2 000 - 3 000 words

- Each article requires an abstract of ±200 words.
- The editor reserves the right to shorten articles but will send a substantially shortened article back for author approval.

Personal details

Please supply: Your qualifications, position and affiliations and MP number (used for CPD points); Address, telephone number and fax number, and your e-mail address; and a short personal profile (50words)and a few words about your current fields of interest.

Review

Guideline word limit: 4 000 words

These are welcome, but should be either commissioned or discussed with the Editor before submission. A review article should provide a clear, up-to-date account of the topic and be aimed at non-specialist hospital doctors and general practitioners.

Please ensure that your article includes:

- Abstract: unstructured, of about 100-150 words, explaining the review and why it is important
- Methods: Outline the sources and selection methods, including search strategy and keywords used for identifying references from online bibliographic databases. Discuss the quality of evidence.

- When writing: clarify the evidence you used for key statements and the strength of the evidence. Do not present statements or opinions without such evidence, or if you have to, say that there is little or no evidence and that this is opinion. Avoid specialist jargon and abbreviations, and provide advice specific to southern Africa.
- Personal details: Please supply your qualifications, position and affiliations and MP number (used for CPD points); address, telephone number and fax number, and your e-mail address; and a short personal profile (50 words) and a few words about your current fields of interest.

Correspondence

Guideline word limit: 500 words

Letters to the editor should relate either to a paper or article published by the SAMJ or to a topical issue of particular relevance to the journal's readership

- May include only one illustration or table
- Must include a correspondence address.

Obituary

Should be offered within the first year of the practitioner's death, and may be accompanied by a photograph.

Book Review

Guideline word limit: 400 words

Should be about 400 words and must be accompanied by the publication details of the book. Provide a hi-res image of the cover if possible (with permission from the copyright holder).

Clinical trials

Guideline word limit: 4000 words

As per the recommendations published by the International Committee of Medical Journal Editors (ICMJE), clinical trial research is any research that assigns individuals to an intervention, with or without a concurrent comparison/control group to study the cause-and-effect relationship between the intervention and health outcomes. All clinical trials should be registered with the appropriate national clinical trial registry (or any international primary register, if relevant), and the trial registration number should be cited at the end of the abstract. Since 1 December 2005, all clinical trials conducted in South Africa have been required to be registered in the South African National Clinical Trials Register. The *SAMJ* therefore requires that clinical trials be registered in the relevant public trials registry at or before the time of first patient enrollment as a condition for publication.
The trial registry name and registration number must be included in the manuscript.

Please refer to the general guidelines for all papers at the top of this article for additional requirements with respect to ethics approval, funding, author contributions, etc. The format of original research articles should be followed for reporting of clinical trial results.

Guidelines

Guidelines should always be discussed with the Editor prior to submission.

Because of the intensive review process required to ensure Guidelines are independent, evidence-based and free from commercial bias, they are usually published as a supplement to the *SAMJ*, the costs of which must be covered by sponsorship, advertising or payment by the guideline authors/association. We will provide a quote based on the expected length of the guideline and whether it is to appear online only, or in print, which must be accepted by the body putting the guidelines together before submitting the work to the SAMJ.

The Editor reserves the right to determine the scheduling of supplements. Understandably, a delay in publication must be anticipated dependent upon editorial workflow.

All guidelines should include a clear, transparent statement about all sources of funding and an explicit, clear statement of conflicts of interest of any of the participants in the guidelines about industry funding for lectures, research, conference participation etc.

All guidelines should be structured according to Agree II.

Please access this website before putting the guidelines together, download the Agree 11 instrument and use this to put the guidelines together.

All submitted guidelines will be sent to the local Agree II appraisal committee for review and must be endorsed by an appropriate body prior to consideration and all conflicts of interest expressed.

A structured abstract not exceeding 400 words (recommended sub-headings: *Background, Recommendations, Conclusion*) is required. Sections and sub-sections must be numbered consecutively (e.g. 1. Introduction; 1.1 Definitions; 2.etc.) and summarised in a Table of Contents.

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2022 Impact factor: 2.2

Information

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APPENDIX 4.2

4.2 A: Approved Research Report Protocol

A PROFILE OF DEATHS IN CHILDREN AT THE DIEPKLOOF FORENSIC PATHOLOGY SERVICES MORTUARY

By Dr M.A Ramela (for submission for MMed Degree)

Student Number: 9801009R

A Proposal for A research Report Submitted to The Faculty of Health Sciences,University of Witwatersrand,Johannesburg.

Supervisors:

Dr Shakeera Holland ; MBCHB(UCT), DMH(SA), MMED(WITS), FC For Path(SA)

Mrs Ildiko Jean Wainer; MSc(Analytical and Pharmaceutical Science) LoughboroughUniversity(UK)

1. INTRODUCTION

Children are amongst the most vulnerable members of society and their dependency on adults worsens their vulnerability. One of the eight United Nations Millennium Development Goals agreed upon and committed to by all 191 member states in September of 2000 is to decrease child mortality (The United Nations Millennium Declaration,2000). Therefore South Africa as a member state does not only have the societal obligation to protect children but has to be held accountable as party to this international agreement (The United Nations Millennium Declaration,2000).

2. LITERATURE REVIEW

2.1. Definition of "death in children"

According to the South African constitution children are persons below the age of 18 years and they comprise approximately 34% of the South African population (The Constitution of the Republic of South Africa,1996). Therefore these are deaths occurring in any person from birth up to 18 years(not inclusive of 18 year olds).

2.2. Epidemiology of deaths in children

According to the World Health Organization(WHO),Global burden of disease:2004 update, more deaths in children were observed in low to middle-income countries(LMIC) such as Argentina, Angola and Indonesia than in high-income countries(HIC) such as the United States of America, Germany, and Canada. Data collected through StatsSA2018 showed a total of 454014 deaths in South Africa of which deaths in the 0-19 years group constituted 8,6% (39045 deaths). Of the

deaths in children the greatest proportion of deaths was observed in children less than 1 year of age (4.4% or 20132 deaths) and the smallest number of deaths was observed in children between 5-9 years (0,6% or 2760 deaths).

2.3. Demographics of deaths in children.

Studies conducted in the United States of America(USA) (Fraga et al 2010), Brazil (Ruiz-Casares 2007), Sub-Saharan Africa (Athani et al 2016) and South Africa(Mathews et al 2013) on deaths in children showed a larger number of deaths in males than in females. Similar findings were documented in South Africa in 2018 where children constituted 9% of all deaths observed in male subjects inclusive of adults (21321 from 238543 deaths) and female children formed 8.2% (17220 from 213802 deaths) of all deaths observed in the female population (StatsSA 2018). The largest number of deaths per gender was observed in children less than 1 year (4,5 % of all deaths in the male population and 4.3% of all deaths in females) and the lowest number of deaths was observed in the 5-9 years age group (StatsSA2018).

2.4. Causes and circumstances of death.

Globally, majority of childhood deaths occur from infectious diseases, drowning and injuries from road traffic accidents (WHO Global burden of disease 2004). An Indian study focusing on causes of unnatural deaths among children and adolescents(n=434) in northern India from April 2010 to March 2011 showed that the leading causes of death observed were flame burns (58,3% of all deaths), injuries from road traffic accidents(15% of all deaths), electrocution (7,8% of all deaths) and poisoning, which was seen in 6% of all deaths (Debata et al 2014).

With specific regard to child homicides in South Africa a study conducted by Mathews et al between 1 January and 31 December 2009 using data from 38 medicolegal Forensic Pathology Mortuaries in South Africa indicated that there were 1018 child homicides in 2009. Most child homicides (45,9%) occurred in public places followed by the victims' home in 34% of all homicides. In 43% of the cases, the victims were cared for by a single mother and 29,8% lived with both parents(Mathew et al 2013). Approximately 65,5% of the victims were killed by an acquaintance and in 30% of those cases, the acquaintance was the mother (Mathew et al 2013). In 44,5% there was a pre-existing history of abuse and sexual assault was suspected in 10% of all the cases (Mathew et al 2013).

A Swiss study conducted on a total of 2,396 million adolescents between 1991 and 2013 recorded 592 suicides in the study population which corresponded to a suicide rate of 3.7 per 100000. The rates increased with age with no suicides recorded in the 10-year age group for both girls and boys to 14.8 per 100000 by age 18 years for boys and 5.4 per 100000 for girls (Steck et al 2017). The risk factors for adolescent suicides that were identified in the study included being a male child, being raised in a single parent household, being an only or middle child and living in rural regions (Steck et al 2017). Hanging was the method of choice in boys while railway suicides were more common in girls (Steck et al 2017).

2.5. Postmortem findings, mechanism of death and ancillary examinations

The literature reviewed has not shown any major difference in autopsy findings between adults and children. However, Non Accidental Injury Syndrome(NAIS) is

specific to children. NAIS is a constellation of findings that occurs in a child or infant due to repetive,deliberate physical force inflicted by a caregiver (Saukko & Knight 2016).The injuries that are specific to NAIS can be identified at autopsy and include posterior rib fractures, retinal haemorrhage, characteristic metaphyseal fractures, complicated skull fractures, and fractures of the scapulae, sternum and vertebral spinous processes (McDonald 2007).

In terms of ancillary investigations that are indicated in the medicolegal examination of childhood deaths, a South African study conducted at the Pretoria Medicolegal Forensic Pathology Services Mortuary on sudden and unexpected childhood deaths between 2007 and 2011, indicated that histology and toxicology samples were taken from a total of 98 autopsies. The study demonstrated that histological examination did not contribute to ascertaining the cause of death in 54,8% of deaths but it confirmed the macroscopic diagnosis in 24,7% of the cases. In 20,5% of the cases, the cause of death was determined by means of histological examination alone. The leading cause of death from the histological examination was pneumonia followed by unspecified natural causes and meningitis. The toxicology results were not available at the time of publishing therefore the significance of this examination in formulating or confirming a suspected cause of death could not be determined (Van Deventer, Rossouw & duToit-Prinsloo 2016).

2.6. **Rationale for study**

The core function of the Forensic Pathology Service (FPS) in South Africa is the medicolegal investigation of unnatural death per The Inquest Act 58 of 1959, The Births and Deaths Registration Act 51 of 1992, and the National Health Act 61 of

2003. By profiling childhood deaths, this study aims to gather vital information which could aid the investigative process of unnatural childhood deaths, and thereby facilitate the judiciary process relating to these deaths; the identification of risk factors in childhood deaths which could be used to formulate policies to reduce preventable deaths.

3.STUDY AIM AND OBJECTIVES:

This study aims to provide a detailed profile of all deaths in children at the Diepkloof Forensic Pathology Service (FPS) Mortuary between 1 January 2018 and 31 December 2021. Mortuary records for 2018-2021 are readily available and accessible. In March of 2020 the Covid-19 pandemic in South Africa resulted in the declaration of a state of disaster and the country being placed under lockdown restrictions from 27 March 2020. Thereafter restrictions were gradually eased from level 5 of the lockdown until the country reached level 1 of the lockdown in September 2020. During this time schools were closed and only workers offering essential services had to be on-site at their places of employment (Regulations To Address And Combat The Spread of Coronavirus COVID-19, 2020). For this reason, the first two years of the pandemic were included in the study period in order to compare pre-Covid-19 (01 January 2018 – 28 February 2020) and Covid-19 (01 March 2020 - 31 December 2021; with no breakdown into different levels of the lockdown) profile of childhood deaths.

The objectives of this study are:

1. To determine the incidence of deaths occurring in children below 18 years (which include neonates-from birth until 28 days- children and adolescents)

but not inclusive of stillbirths and abandoned fetuses for the period of 1 January 2018 to 31 December 2021.

2. To describe the demographic profiles (age, race and sex) of these children
3. To describe the causes of death, mechanism of death and post-mortem findings/patterns of injury(organ systems and individual organ injuries - bruises, abrasions, lacerations, incised wounds, burns, gunshot wounds, fractures).
4. To evaluate the circumstances of death which will be defined as the suspected manner of death as reported by the South African Police Service(SAPS), date of death/discovery of the body, body retrieval location, temporality, and the relationship of the alleged/reported perpetrator(if available) to the deceased in cases of homicides.
5. To profile the ancillary examinations performed at post-mortem examination and results thereof in individuals below the age of 18 years.
6. To determine the effects of the Covid-19 pandemic and lockdown on childhood deaths, especially trauma-related deaths such as road traffic accidents, stabbing, gunshot injuries, and assaults, by visually comparing the frequency of these particular deaths in the pre-Covid-19 and Covid-19 periods.

4. METHODS AND MATERIALS:

This study will be a retrospective descriptive study using data contained in the case files.

a. Site of Study

This study will be conducted at the Diepkloof Forensic Pathology Service Mortuary situated at 02 Collinder Road, Diepkloof, which is one of eight mortuaries in the Southern cluster of the Gauteng Forensic Pathology Service. Approximately 2400 post-mortem examinations are conducted at the site on a yearly basis. This facility is situated in Soweto, the biggest township in South Africa, and has 12 South African Police Service(SAPS) stations under its jurisdiction. The area is characterized by a multicultural and multinational population and consists of approximately 1,3 million people in both formal and informal settlements.

b. Demographics of samples

The population sample group includes all individuals assessed at the Diepkloof Forensic Pathology Service Mortuary between 1 January 2018 to 31 December 2021. The study sample group will be all cases of deaths in individuals below the age of 18 years (< 18 years) but excluding all abandoned fetuses and stillbirths, that were admitted to the Diepkloof Forensic Pathology Service between 1 January 2018 and 31 December 2021. All decedents admitted to Diepkloof Forensic Pathology Service for a medico-legal post-mortem examination as required by The Inquest Act 58 of 1959 are recorded in a death register, assigned a specific death register number, and allocated a Forensic Pathology Service case file. All deceased that are below 18 years of age and form part of the study population will be identified through the abovementioned documents.

The inclusion criteria for the sample are:

- All deaths occurring in individuals below 18 years of age(< 18 years but not inclusive) including decomposed or skeletonized remains that on examination have confirmed identification as to age at the time of death(anthropological or formal confirmed identification) from the history provided form part of this group.

The exclusion criteria for the sample is:

- All cases where the remains are too decomposed or skeletonized for age to be assessed with accuracy (through anthropological assessment or formal identification procedures), and partial remains that on suspicion by the SAPS are those of children but cannot be confirmed scientifically or medically.
- All abandoned fetuses or stillbirths
- All cases evaluated after meeting the inclusion criteria, however once reviewed in the case file it is discovered that the victim was 18 years or older (> or = to 18 years).

Estimated sample size is 450.

c. Data Collection

Information will be gathered from the FPS case files of individuals that have been identified as below 18 years of age from the death registry and case file information. The case file contains several documents including the SAPS 180, the D28 and

anaesthetic forms, the hospital records, the scribe notes, and the provisional or final report.

The following information will be collected from the case files and recorded on Data Sheet A(See attached Appendix A):

- Age, sex, race, date of death/date when the body was discovered, temporality(day of the week, weekend, public holiday), the relationship of the alleged perpetrator to the deceased in case of homicide, and date of post mortem examination

The following information will be collected from the case files and recorded in Data Sheet B:

- Cause of death (natural, unnatural-sharp force, blunt force, firearm discharge, aspiration, choking, hanging, strangulation, drowning, poisoning or procedure-related, unascertained); Mechanism of death (hypovolemia, asphyxia, brain death, neurotoxicity, septicaemia, multi-organ failure); suspected manner of death as per SAPS180 (natural, homicide, accident, suicide, unknown); post mortem findings/patterns of injury (cranio-cerebral injuries, neck injuries, intrathoracic injuries, intraabdominal injuries, skeletal injuries), and ancillary examinations performed at autopsy -DNA, Sexual Assault kit, radiological studies(skeletal survey, X-ray or Lodox) blood alcohol and carbon monoxide levels, toxicology, histology and spent bullets for ballistic examination.

d. Data Analysis

Data that has been recorded on the Data sheets A and B will be entered into a Microsoft Excel spreadsheet and evaluated using Stata 14.0 statistics software package (Stata Corp, College Station, TX).

Objective one will be represented using descriptive statistics, frequencies and bar graphs to determine the frequency in which deaths occur at the site of the study. Objective two will be represented using descriptive statistics, frequencies and bar graphs to illustrate and compare the demographics of deaths. Objective three will be represented using descriptive statistics, frequencies and bar graphs to compare the causes of death, mechanism of death and patterns of injury observed at post mortem examination in all deaths .The post mortem findings will be recorded according to systems and individual organ injury. These will then be assessed in relation to each cause of death to determine the most common organ injuries in each category of the causes of death. Objective four will be represented using descriptive statistics, frequencies and bar graphs to compare the suspected manner of death as reported by the South African Police Service, the date of death, geographical location of the death, the seasonality and the alleged perpetrator in cases of homicide. The temporality of the death will be determined by assessing the yearly calendars. Objective 5 will be represented using descriptive statistics and frequencies to visually represent all ancillary examinations performed and the results thereof. Information pertaining to the ancillary examinations will be gathered from the contemporaneous notes or the typed post-mortem report when available. The results thereof will be retrieved from the case files when available or from the SAPS docket through the investigating officer. Objective 6 will be represented using descriptive statistics bar

graphs and pie charts to compare the frequencies of the overall traumatic deaths and the different categories thereof during the pre-Covid 19 and Covid 19 periods.

5. ETHICS

An application to the Wits Human Medical Research Ethics Committee is pending. The body numbers of recorded cases will be kept in a password-protected file separate from all other information. No body numbers or names will be mentioned in the final write-up.

6.TIMING

	Jan '22	Feb '22	Mar '22	Apr '22	May '22	Jun '22	Jul '22	Aug '22	Sep '22	Oct '22	Nov '22	Dec '22	Jan '23
Proposal write up	X	X	X										
Proposal assessment				X									
Ethics course			X										
Ethics application							X	X	X				
Data collection										X	X		
Data analysis										X	X		
Write up											X	X	
Submission													X

7. LIMITATIONS

Forensic Pathology Service does not have an electronic data collection system and relies on manually stored data in the death registers. Since no proper archiving system exists, some of these registers might be misplaced therefore limiting the researcher's ability to identify all cases. There is often a lack of details with regard to the circumstances surrounding the death in the SAPS180 which might hinder the

collection of important data. Some of the post-mortem reports may not be typed and finalized, with only the contemporaneous notes available in the case files. Since these notes are often written using abbreviations or short descriptions this might limit data collection pertaining to post-mortem findings. There is currently a delay in obtaining the results of ancillary tests performed due to backlogs in the laboratories that conduct the testing which may result in incomplete data collection in cases where no final cause of death is indicated.

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Appendix A

Data Sheet A

Case file number	Age	Gender	Race	Date of death	Geographical location of death	Temporality (day of the week, weekend, public holiday)	Relationship of alleged perpetrator to the deceased in cases of homicide	Date of post mortem examination

Data Sheet B

Case file number	Cause of death	Mechanism of death	Suspected manner of death	Post mortem findings/patterns of injury	Ancillary examinations and results

4.2 B: Faculty Protocol Approval Letter

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Private Bag 3 Wits, 2050
Fax: 027117172119
Tel: 02711 7172076

Reference: Mrs Sandra Benn
E-mail: sandra.benn@wits.ac.za

23 August 2022
Person No: 9801009R
PAG

Dr MA Ramela
P O Box 207
Pimville
1808
South Africa

Dear Dr Malerato Ramela

Master of Medicine: Approval of Title

We have pleasure in advising that your proposal entitled *A profile of deaths in children at the Diepkloof Forensic Pathology services mortuary* has been approved. Please note that any amendments to this title have to be endorsed by the Faculty's higher degrees committee and formally approved.

Yours sincerely

Mrs Sandra Benn
Faculty Registrar
Faculty of Health Sciences

APPENDIX 4.3:

University of the Witwatersrand HREC Ethics Certificate

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

R14/49 Dr Malerato Ramela

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M220839

NAME: (Principal Investigator)	Dr Malerato Ramela
DEPARTMENT:	Forensic Medicine and Pathology Diepkloof Forensic Pathology Service
PROJECT TITLE:	A Profile of Deaths in Children at the Diepkloof Forensic Pathology Service
DATE CONSIDERED:	26/08/2022
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Dr S. Holland and Mrs I. Wainer
APPROVED BY:	Dr CB Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL:	04/10/2022

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

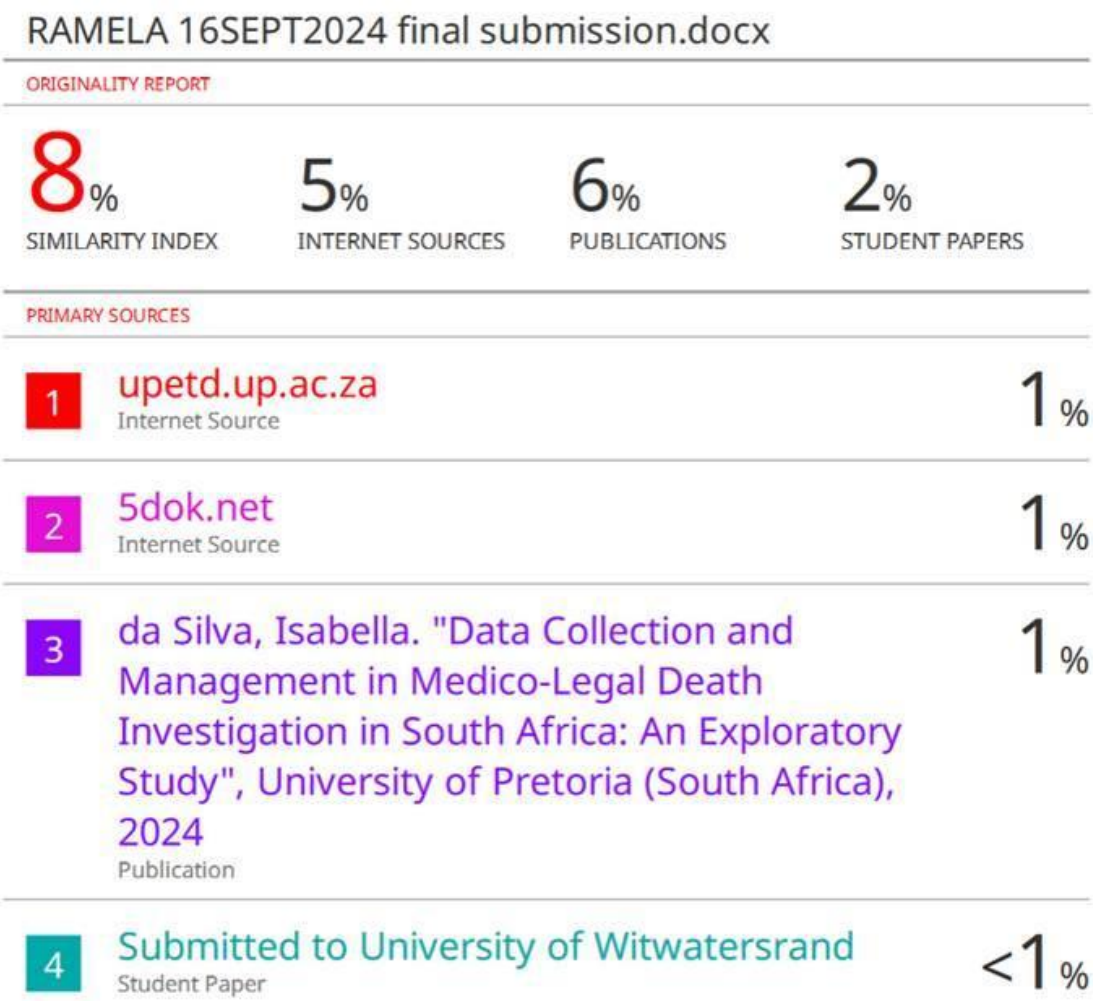
To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary on the Third Floor, Faculty of Health Sciences, Phillip Tobias Building, 29 Princess of Wales Terrace, Parktown, 2193, University of the Witwatersrand. I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions.Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report.** The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. In this case, the study was initially reviewed in **August** and will therefore be due in the month of **August** each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature _____ Date _____

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

APPENDIX 4.4:

Plagiarism/Turnitin report



RAMELA 16SEPT2024 final submission.docx

ORIGINALITY REPORT

8%	5%	6%	2%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	upetd.up.ac.za Internet Source	1%
2	5dok.net Internet Source	1%
3	da Silva, Isabella. "Data Collection and Management in Medico-Legal Death Investigation in South Africa: An Exploratory Study", University of Pretoria (South Africa), 2024 Publication	1%
4	Submitted to University of Witwatersrand Student Paper	<1%