Utilisation of fingerprint analysis for human identification at SRM/OFPI

Rachael Eromosele

KYDRAC001

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Department of Pathology

Faculty of Health Sciences

University of Cape Town

Supervisors: Mrs. Kate Reid and A/Prof Laura J Heathfield

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ABSTRACT

The identification of human decedents is a critical aspect of medico-legal investigation. However, many bodies remain unidentified, with South Africa reporting high numbers each year. Fingerprint analysis is a valuable identification method, though the success rate of using fingerprints for identification at Salt River Mortuary in Cape Town, South Africa, is unclear. This research investigated the frequency and success rate of fingerprints used for identification at this forensic mortuary in 2021. Medico-legal case reports of all cases admitted in 2021 were reviewed (n = 3738) and non-viable foetuses (n = 26) were excluded, resulting in a total of 3712 cases. At admission, 76.6 % had a suspected identity and 23.4 % were unknown. Seven days after admission, 16.1 % (n = 599 / 3712) had not yet been visually identified, but only 2.5 % (n = 15 / 599) had fingerprints taken for analyses. Thirty days post-admission, 7.4 % (n = 273 / 3712) of the total caseload was still unidentified. Total cases with fingerprint analysis requests at all time points in 2021 were 143, with 89.2 % (n = 115 / 129) of the cases having a successful identification outcome. A median of 7 days (Std.dev = 61 days) was taken to request a fingerprint analysis, while it took a further 30 days (median) (Std.dev = 120 days) to obtain a report. Overall, 141 cases from 2021 remained unidentified at the time of this study, with 19 of these cases having 'suitable fingers' but no fingerprint analysis request. Given the affordability and high success rates of identification associated with fingerprint analyses, investigating officers are urged to take fingerprints from more bodies that are not identified. The unsuccessful attempts were due to no matching records on the searched databases, suggesting that a transnational approach is needed to improve identification rates.

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ABBREVIATIONS

AFIS	Automated Fingerprint Identification System
et al.	Et alia (and others)
EIS	Europol Information System
DNA	Deoxyribonucleic acid
FPS	Forensic Pathology Services
HANIS	Home Affairs Identification System
HREC	Human Research Ethics Committee
IBM	Incorporated Business Machines
ICRC	International Committee of the Red Cross
ID	Identification
i.e	Id Est (that is)
LCRC	Local Criminal Record Center
N	Number
OFPI	Observatory Forensic Pathology Institute
POPIA	Protection of Personal Information Act
SAPS	South African Police Service
SOP	Standard Operating Procedure
SPSS	Statistical Package for Social Sciences
SRM	Salt River Mortuary
Std Dev	Standard deviation
UCT	University of Cape Town
USA	United States of America
USB	Universal Serial Bus
VIC	Victim Identification Center
%	Percentage
$<$	Less than

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CHAPTER 1 : INTRODUCTION AND LITERATURE REVIEW

1.1 Introduction

Identification of deceased individuals is vital in a medico-legal investigation due to its significant forensic, legal, social and humanitarian values, as every person has the right to an identity (de Boer et al., 2020). Identification allows family members of the deceased to mourn and give a befitting burial to the deceased individual. Additionally, procedures such as inheritance or life insurance claims by the decedent's next-of-kin and the issuance of a death certificate are limited without a confirmed identity of the decedent (Ward & Beuscher, 1950; Sykes, Uys & Bernitz, 2016). Identification has helped reunification of a missing deceased individual with their family members, which may allow the next-of-kin to accept their loss (Ward & Beuscher, 1950).

Globally, the number of unidentified bodies was reportedly more than double in developing countries (9.56 % at admission) compared to developed countries (4.40 % at admission) (Reid, Martin & Heathfield, 2023). The high rate of unidentified bodies in developing countries, which is a financial burden on state facilities, has been attributed to many reasons, including inadequate resources, poor infrastructure, and limited personnel to manage and maintain the bodies (Reid, Martin & Heathfield, 2023). In South Africa, the Forensic Pathology Service (FPS) is mandated to establish the cause of death of the decedent and may assist with the identification process by following established guidelines for identification in South Africa (South African National Health Act, Regulation Regarding the Rendering of Forensic Pathology Service 2005).

In cases where visual identification of a decedent is not possible due to advanced decomposition, mutilation or burns, then scientific identification methods should be employed (Watherston et al., 2018). The implementation of scientific identification methods such as fingerprint analysis, deoxyribonucleic acid (DNA) analysis, anthropology, and/or odontology depends on the nature of the case and the availability of specimens (Saini & Kapoor, 2016). Research has previously investigated unidentified bodies at Salt River Mortuary (SRM), however, information on specific success rates of fingerprint identification methods is lacking (Reid, Martin & Heathfield, 2023). This literature review will focus on using fingerprints to identify the deceased individuals, with a particular focus on the South African context and its use locally at Salt River Mortuary/Observatory Forensic Pathologist Institute (SRM/OFPI), in Cape Town, South Africa.

1.2 Unidentified persons in South Africa and at SRM/OFPI

In South Africa, all unnatural deaths undergo a medico-legal investigation according to the Inquests Act 58 of 1959 (Republic of South Africa, Inquest Act 58 of 1959). The National Health Act 61 of 2003, Regulations Regarding the Rendering of Forensic Pathology Service, guides the timeline for the identification process at forensic facilities in South Africa (South African National Health Act, Regulation Regarding the Rendering of Forensic Pathology Service 2005). In cases where the decedent has no confirmed identity within seven days of admittance, scientific means of identification, including fingerprint analysis, should be requested (South African National Health Act, Regulation Regarding the Rendering of Forensic Pathology Service, 2005). If a decedent is unidentified after 30 days, then the state holds responsibility for any pauper burial arrangements (South African National Health Act: Regulations Regarding the Rendering of Forensic Pathology Service, 2005).

SRM/OFPI is a FPS facility in the Western Cape, South Africa, which is affiliated with the University of Cape Town (UCT) (Swart et al., 2025). Reid et al., (2020) retrospectively reviewed unidentified decedents at SRM/OFPI from 2010-2017 (Reid, Martin & Heathfield, 2020). The unidentified cases were found to make up 9.2 % (n = 2476/27060) of the total admitted cases for the study period. However, the use of fingerprints for identification was not investigated in that study (Reid, Martin & Heathfield, 2020).

A study at the Pretoria medico-legal forensic facility in South Africa investigated unidentified bodies and associated problems (Evert, 2011). Over the four years of review (2005 - 2008), there were 848 cases of unidentified bodies, accounting for 7 % – 10 % of the total admissions to the facility. Fingerprint analysis for identification purposes was requested in 54 % (n = 458 / 848) of unidentified cases. While the average time it took to obtain a result was approximately two weeks, the number of cases identified through this analysis method was not stated (Evert, 2011).

Keyes et al., (2022) at the Johannesburg Forensic Pathology Services medico-legal mortuary and an associated Identification Unit at the University of Witwatersrand (WITS) in Johannesburg, South Africa, analysed methods of identification and their success rate utilised at the mortuary (Keyes, Mahon & Gilbert, 2022). This was achieved by reviewing 31 months of cases from the Identification unit (ID unit) from January 2018 to July 2020, which found that 8.1 % (n = 693 / 8560) of the total caseload remained unidentified. Out of 693 of the unidentified cases, 55.6 % (n = 385 / 693) of the cases were processed by the ID unit and 22.6 % (n = 87 / 385) cases were subsequently identified (Keyes, Mahon & Gilbert, 2022). The method with the highest success rate for identification was fingerprinting (98.9 %; n = 86 / 87), while DNA profiling only led to a single identification (1.1 %; n = 1).

The ID unit employed various methods to obtain fingerprints from decedents, including degloving, rehydration and photographing of desiccated finger pads. The collection of fingerprints was often repeated using these technical methods by the ID Unit, even if fingerprints had been collected at admission or during the autopsy by the South African Police Service (SAPS). This was shown to be beneficial, especially if the fingerprint analysis initially failed due to poor finger quality or decomposition (Keyes, Mahon & Gilbert, 2022). Generally, in cases where fingerprint analyses are required, fingerprints are collected and matched with existing fingerprints on fingerprint databases, which aid in identifying an individual (Karu & Jain, 1996). Therefore, it is important to highlight the legislation in South Africa that regulates the use and storage of template fingerprints on these fingerprint databases and various databases.

1.3 Legislation regulating the use of fingerprints in South Africa

The Criminal Law (Forensic Procedures) Amendment Act 6 of 2010 was implemented to regulate the collection, removal and retention of fingerprints on databases for identification and criminal purposes in South Africa (Republic of South Africa, Criminal Law (Forensic Procedures Amendment) Act 6 of 2010). Section 37 and the insertion of section 36 of the Act allowed police officers and courts to collect fingerprints, footprints, or palmprints of an accused/convicted offender including children in juvenile detention and then store them in a fingerprint database (Republic of South Africa, Criminal Law (Forensic Procedures Amendment) Act 6 of 2010). Sections 15B and 36B made provision for the use of existing fingerprint databases within Home Affairs and SAPS for the identification of a missing person/unidentified decedent and crime detection. The legislation also enabled the removal of fingerprints of a child in juvenile detention from the databases by the National Commissioner after the Certificate of Expungement is received, according to the Child Justice Act (Republic of South Africa, Criminal Law (Forensic Procedures Amendment) Act 6 of 2010). Generally, existing fingerprints on databases (fingerprint templates) are compared and matched to an unknown fingerprint using a matching system based on the type of the fingerprint (Jain & Pankanti, 2000).

1.4 Fingerprint classifications and matching system

Fingerprints consist of ridges and furrows, formed into different patterns during an individual's fetal development, which remain unchanged throughout the person’s life, unless altered due to trauma, diseases, or burns (Kumar et al., 2012). Fingerprint patterns are classified into different types, which are (1) arches (plain arch or tented); (2) loops (plain loop or central pocket loop), and (3) whorls (Galton, 1892) (Figure 1.1). A single fingerprint ridge is characterised by minutiae, such as bifurcation, trifurcation, termination, or an ending, which can occur at various points and contribute to the uniqueness of each fingerprint (Kumar et al., 2012).

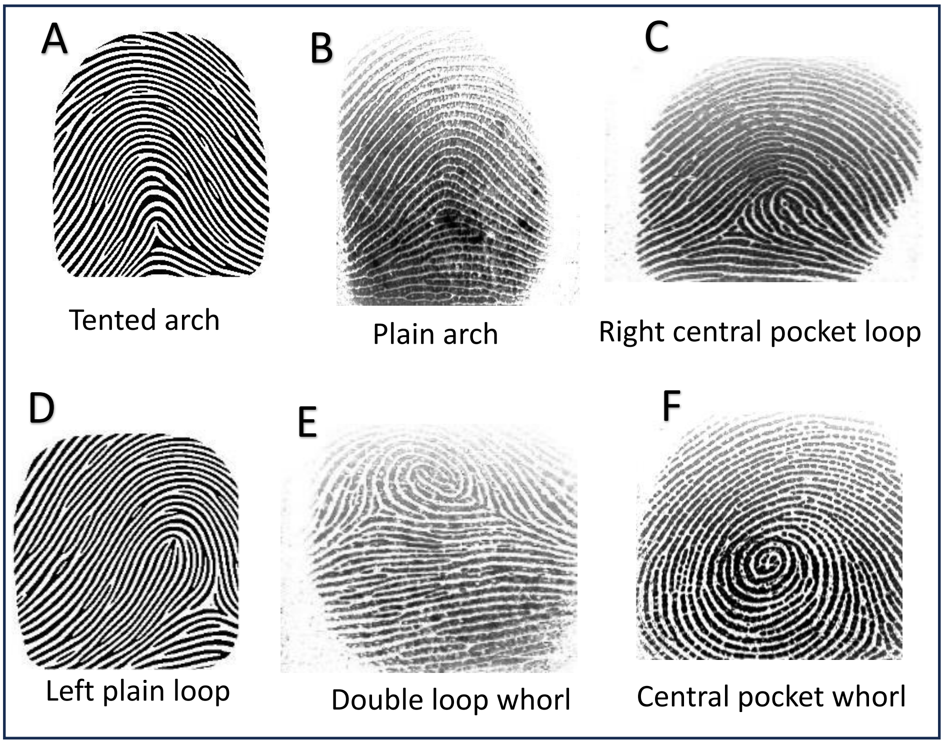

Figure 3.1: Types of fingerprint patterns used for fingerprint matching (Dey et al., 2019).

Minutiae are used for fingerprint classification on a fingerprint-matching system where an input or unknown fingerprint is compared to a reference in a fingerprint database (Zhang et al., 2016). The fingerprint matching system uses the characteristics in the minutiae ridge patterns to check for similarities between the reference fingerprints in the database and the unknown fingerprints to establish a match record (Jain & Pankanti, 2000). A more efficient automated technique that binarised fingerprints into ridges and furrows, highlighting them as black-and-white for fingerprint verification, was developed, and the working algorithm depended on the quality of input fingerprint images

(Saraswat and Kumar, 2010). This technique used a minutiae matcher to compare two minutiae using the ridges; if a match were on the first ridge, then the rest of the fingerprint ridges would align and match. In cases where the image quality was poor, an enhancer was incorporated into the algorithm, and the region of interest was extracted from the print to eliminate non-informative ridges (Saraswat and Kumar, 2010).

Several studies conducted in the 1970s, including by Wegstein 1970 and Stock 1972, led to the development of the Automated Fingerprint Identification System (AFIS), which used an algorithm to search for features between reference images, latent prints, and ten-print cards (Wegstein, 1970; Banner & Cooper, 1972; Stock, 1972). Studies have shown that AFIS has made fingerprint search more accessible and reliable, improving the efficiency of fingerprint search, matching and comparison for identification (Neumann, Armstrong & Wu, 2016; Chigando, 2017).

Fingerprints obtained from decedents in South Africa are typically first searched against the SAPS local criminal record system (LCRC) internal fingerprint database(s), which contains the fingerprints of arrestees and convicted offenders (Omar, 2008; Republic of South Africa, Criminal Law (Forensic Procedures Amendment) Act 6 of 2010). Forensic experts and police investigators at the SAPS manually searched for documented fingerprints of arrestees and convicted criminals before they began using AFIS (Breckenridge, 2005). Thereafter, fingerprints are searched against the HANIS database, which is managed by the Department of Home Affairs. This department (Home Affairs), manages the identification services of South Africa, including migration and other related affairs like registration of birth, death, marriage, and processing of identification documents (Van der Straaten, 2019). Processing of these documents by their system includes fingerprint capturing, which is saved on their database known as HANIS (Van der Straaten, 2019). The HANIS database is linked with both private and public biometric databases for verification purposes and it utilises the National Population Register Database, which collects fingerprints of migrants, permanent residents and South African citizens (McKinley, 2018). This database helps to monitor criminal activities and can be used for verification or identification of an individual, as it gives access to governmental organisations during an investigation (McKinley, 2018).

Fingerprint matching on these databases may not always yield a match due to problems with the fingerprint quality or the matching system (Joshi, Mazumdar & Dey, 2020). Generally, problems encountered when matching fingerprints on a database(s) be as a result of deviation in minutiae due to defects introduced during image or print processing, fingerprint deformation, unavailability of the print on databases, a defined threshold for the matching system, and malfunctioning sensors in the capturing system caused unsuccessful matching (De Alcaraz-Fossoul et al., 2016; Zhang, Yin & Yang, 2016; AlShehri et al., 2018). Studies have recommended that obtaining a good-quality fingerprint using a validated fingerprint-matching system and a clear scanned fingerprint image during the fingerprinting of a decedent is paramount for positive matching analysis (Ratha et al., 1996; Saraswat & Kumar, 2010; Kumar et al., 2012; Zhang, Yin & Yang, 2016; AlShehri et al., 2018).

1.5 Challenges with fingerprinting in the post-mortem context

In South Africa, thumbprints (if intact) of decedents admitted to a forensic mortuary and who are above 16 years old, are collected on their death certificates for documentation (Republic of South Africa, Births and Deaths Registration Act 51 of 1992). However, for an unidentified body that requires fingerprint analysis for identification, the full 10-print set is collected depending on the condition and availability of the fingerprints. This is standardly done manually using cards and ink (Morgan et al., 2018). While electronic methods to capture fingerprints exist, manual methods are commonly preferred in the post-mortem context, as they enhance the quality of fingerprints obtained and overcome challenges of lack of blood flow, shrinkage and wrinkles (Marais & van den Dool, 2021).

Morgan et al. (2018) described the fingerprint powder technique, which involves dusting the decedent's fingers with fingerprint powder and a brush to create an impression with an adhesive label on a white finger pad. This technique prevents smudging, but wet fingers can cause distorted prints (Morgan et al., 2018). However, several factors could cause a complete or partial loss of fingerprints, making fingerprint collection challenging.

1.5.1 Adermatoglyphia

Adermatoglyphia is a condition where fingerprint ridges are entirely or partially absent on a finger, and this could occur due to an alteration in genes (genetic factors) during the embryological formation of ridges (Burger et al., 2011). Alternatively, it can be acquired due to aging, external injury, medication, skin diseases, the use of drugs, chemicals, or biological or environmental factors (Sarfraz, 2019). Acquired adermatoglyphia can occur due to ridge atrophy or disruption caused by external trauma like amputation, decomposition, skin slippage due to immersion, burns, injuries, age, some medications like corticosteroids, and harsh chemicals (Haber et al., 2015).

Adermatoglyphia condition has been reported to be seen in one out of 2 - 4 million people, with most cases of the condition being acquired due to the destruction or alteration of the epidermal skin ridge that forms the fingerprint (Hussain & Ahmed, 2012). Haber et al. (2015) conducted a population study using 2013 data on fingerprints from the Ministry of International Affairs of the Lebanese population. The results showed that 0.18 % of the population had no fingerprints; this condition was predominant in people above 65 years and was more common in women (Haber et al., 2015).

1.5.2 Fingerprint recovery from burnt deceased individuals

Recovery of fingerprints from burnt bodies can be challenging due to the loss of the epidermal ridge skin that forms the fingerprint ridges (O'Hagan & Calder, 2020). However, several steps and techniques can be adopted to achieve prints clear enough to give the information that will aid with identification. For example, palm prints, fingerprints, and plantar prints were recovered from decedents with fire-related trauma by Verdon and Hamilton (2019) by removing the burnt epidermal ridge and exposing the dermal layer of the skin. The exposed dermal layer was enhanced with a fingerprint black powder and stretching of the ridges was enabled by a cut made on the epidermis (Verdon & Hamilton, 2019).

1.5.3 Decomposition and mummification

Decomposition can also affect the quality of a fingerprint as body cells apoptose after death, which affects, among other things, the integrity of soft tissues (Marks, Love & Dadour, 2009). Soft tissue breakdown can make the dermal layer of the skin slip or separate from the epidermal layer, which affects the ability to obtain good-quality fingerprints. This is compounded in advanced decomposition, with skeletonisation making fingerprints unobtainable (Bolme et al., 2016).

Dehydrated bodies may be mummified, leading to shrinkage, rigid fingerprints, and in some cases, a complete lack of detailed fingerprint ridges (Chen et al., 2017). Marais and van den Dool (2017) developed a method of restoring and rehydrating mummified fingerprint ridges using sodium carbonate and sodium acetate mixtures on mummified fingers (Marais & van den Dool, 2021). This rehydrating, non-destructive technique softened mummified tissues and increased their turgor, elasticity, and flexibility. The process improved the quality of fingerprints obtained from the dehydrated tissues (Marais & van den Dool, 2021). Additionally, in aquatic environments, factors such as temperature, microorganism activity, predator presence, and water currents can increase the rate of decomposition, further affecting the preservation of fingerprints (Caruso, 2016). Environmental conditions can further impact fingerprint quality as fingerprints obtained from dried surfaces are generally more identifiable than those from wet surfaces (Gülekçi, 2021). The availability of a good fingerprint quality is dependent on the body's physical condition, but if collected, it could ultimately yield a match, assisting in the identification of the individual (Bolme et al., 2016).

1.6 Study Rationale

SRM/OFPI has a high intake of cases, with the total caseload rising from 2610 cases in 2010 (Reid, Martin & Heathfield, 2020) to more than 4500 unnatural deaths in 2023 (in-house data). From 2010 to 2017, approximately 9.2 % (n = 2 476 / 27060) of cases admitted to the mortuary were unidentified (Reid, Martin & Heathfield, 2020). Cases that were difficult to visually identify, due to inhibiting factors (decomposition, burns or skeletonisation), accounted for 345 cases (14.1 %). DNA was used in 23.5 % (n = 582 / 2476) of cases for identification, with forensic anthropology biological profiles being requested in 36 cases (1.5 %). However, the use of fingerprint analysis for identification was not investigated (Reid, Martin & Heathfield, 2020).

To date, no study has critically evaluated the success rate, challenges, or limitations in fingerprint requests, performance, and communication of results related to fingerprint analysis at SRM/OFPI. There has not been any study that reported fingerprint quality regarding the body's condition and how it affected fingerprint analysis at SRM/OFPI. Research in this area of study was anticipated to help identify the gaps associated with such analyses and facilitate improved identification to reduce the burden associated with unidentified decedents at SRM/OFPI. These data would also contribute to a larger ongoing study at SRM/OFPI for the period 2015 – 2022, focusing on all identification methods used and the success rates thereof.

1.7 Aim and Objectives

This study evaluated the frequency and success of fingerprint analysis used for identification at SRM/OFPI from 1 January 2021 to 31 December 2021.

To this end, the following objectives were defined:

1. Describe the unidentified population at SRM/OFPI in 2021.
2. Report on the success rate of fingerprint analysis reports utilised for identification at SRM/OFPI in 2021.
3. Determine the average turnaround time for fingerprint analysis and identify any gaps associated with processing.

CHAPTER 2 : METHODOLOGY

2.1 Study design

This study was a descriptive and retrospective review of medico-legal case files relating to cases admitted to SRM/OFPI between 1 January 2021 and 31 December 2021. This study analysed all admitted cases in 2021, except for non-human remains and non-viable foetuses, as these were excluded. Additionally, within each variable analysis, the denominator further excludes cases where the information could not be gathered.

2.2 Data collection

Medico-legal documents pertaining to every case were retrieved and reviewed. The variables reviewed are available in Appendix A, but briefly, include postmortem details, demographics, date of notification to claim and release the body, identification methods used, the environment of recovery and physical condition of the body and details relating to the use of fingerprints.

Preliminary data were collected from the Office Autopsy Database (OAD) (HREC REF: R036/2014). Thereafter, the electronic repository (Open Text™ Content Management) of mortuary documents was reviewed. Documents from which data were obtained included the Incident form (reference number FPS 001), the scene script (FPS 002), Identification (ID) documents, notice to claim and remove body document/acknowledgment of receipt or release documents and post-mortem doctors' reports. Collectively, these documents were used to gather information regarding each variable (Appendix A, Table A1 & A2). Cases with documents or post-mortem reports that were unavailable on the online repository during data collection were requested from the doctors who performed the autopsy, and/or mortuary personnel. Any reports and documents not obtained by 2 December 2024 were recorded as 'missing' for this current study.

Regarding fingerprint analysis, the date of fingerprint collection, analysis request and when reports were returned, were recorded. Further details recorded included the outcome of the analysis, the facilities that performed the analysis and which database(s) were searched. The death notification (locally referred to as the BI 1663) document of all cases was also reviewed as thumbprints are usually obtained on the document for persons over 16 years of age. Additional variables were obtained for use in the larger ongoing research and will not be discussed in this dissertation.

All the variables were obtained from medico-legal documents of decedents and entered into an Excel sheet using Microsoft Excel 365 (Microsoft Corporation, Washington, USA). Data were managed as per the UCT data management plan (https://dmp.lib.uct.ac.za/plans/4868) (Appendix C). In brief, data were saved on a password-protected flash drive, which was stored in a safe location at UCT. Confidentiality was maintained throughout the study.

2.3 Quality assurance measures

During data collection, quality measures were implemented, such as the use of drop-down menus to capture categorical variables and to limit free text. After data collection, an independent researcher recollected the variables from a random subset of 49 cases (n = 49 / 3742; 1.3 %). Cohen's Kappa statistics were performed using IBM SPSS Statistics (version 29.0.2.0, manufacturer details), a score of 0.9 and above indicated congruence between the datasets. For one variable (secondary identifiers) validated for the larger ongoing study, a score of 0.84 was obtained. Following the investigation, this was due to errors in the secondary dataset collected, and thus, the original dataset was accurate and reliable. Additionally, some of the differences between the compared variables were as a result in misspellings or punctuation.

2.4 Data analysis

First, cases with suspected and unknown identities at admission were differentiated. Hereafter, bodies were catergorised into those who were identified versus unidentified at key time points, as aligned with the South African legislation (i.e. at seven and thirty days after admittance). Considering the end point of this study, all bodies were grouped into one of four categories: (i) 'identified' (these bodies were identified and claimed by next-of-kin), (ii) 'unidentified' as of the 2 December 2024, (iii) 'unclaimed' if there was a decedent with a confirmed identity but who had a pauper burial release due to the application for internment/destitute by next of kin, (iv) 'unclear' where there was no documentation relating to identification attempts or burial type. The data from the remaining variables were stratified based on these categories and then analysed using descriptive statistics. This involved calculating the mean, mode, range, standard deviation, proportions and percentages of total caseloads.

While the variable of 'age' was collected as a continuous and numerical variable, for the purposes of analyses, the age group of 0 – 15 years was differentiated, because fingerprints are only collected by the state from individuals who are 16 years and older. The age variable was further categorised following the recommendations in relation to the statistical tables according to the South African

National Department of Health age groupings (Republic of South Africa. National Department of Health: Age Definitions 2012): < 1 year, 1 – 15 years, 16 – 24 years, 25 – 34 years, 35 – 44 years, 45 – 54 years, 55 – 64 years, 65 - 74 years, and 75 above. Age and biological sex at different legal time points were compared and their statistical significances were also established using the Pearson's chi-square test. Furthermore, using the Bonferroni correction test (α adjusted = α/m), the significance level of α was adjusted, where α, the overall significance level and m, the number of comparisons for cases where the age categories/sex were compared at different time points.

Equation 3.1: Bonferroni test (α adjusted = α/m).

Using the Bonferroni correction test to adjust the significance level of α for age and sex category, where α the overall significance level = 0.05 and m = the number of comparisons.

A adjusted = $\frac{\alpha}{m}$; m = 3

α adjusted = $\frac{0.05}{3}$

α adjusted = 0.01667

Therefore, the new α significance level for the age categories and sex, which were compared three (3) times = 0.0167.

To gain insights on fingerprint analyses, the percentage of cases that requested fingerprint analysis was established. From the number of cases that requested fingerprint analysis, the number and percentage of cases with a successful match (i.e., those that had a match record on the searched database) were determined. Those where there was no match established (referred to as 'unsuccessful'), the report was scrutinised for any justification to this end. Where no results report was obtained, these were referred to as 'unknown', and cases were flagged for follow-up by collating a list of all the missing reports and documents and shared with the appropriate staff for action. In addition, the number of fingerprint requests across age groups was determined and the body condition of cases that had an unsuccessful analysis outcome was portrayed. The body condition of cases was classified as decomposed, burnt, skeletonised, mutilated, good body condition and trauma for cases which showed extensive trauma to the face/body. Furthermore, cases that had a higher fingerprint analysis rate depending on the environment (indoor, outdoor or aquatic) the body was recovered were determined using a p-value significance level of 0.05. Different areas of recovery of the decedent's body were further compared to the number of fingerprint analysis requests and to the success rate. Cases recovered from housing and hospitals were grouped as "indoor", those retrieved from roads, railways, open lands and other outdoor areas were grouped as “outdoor” and all cases recovered from water-related environments were grouped as “aquatic”.

The mean turnaround timeline for the fingerprint analysis was reported by calculating the difference in days between the date fingerprint analysis was requested and the date stated on the results report. A timeline was established reflecting the average number of days between the date the body was admitted, the date fingerprints were collected, when analysis was requested, the date fingerprint result was obtained, and when the body was released for burial.

The suitability of fingerprint analysis was determined by comparing the preservation status and location of recovery of the body to the analysis performed. Assessing the suitability of fingerprint analysis helped to determine whether fingerprinting yielded favourable outcomes to identification efforts and whether the allocation of resources towards the method was appropriate given the body condition of the remains. Pearson’s chi-square tests between the condition of the body (decomposed, burnt, mutilated, skeletonised, good body condition, trauma) and the environment of recovery (indoor, outdoor, aquatic/water) were compared with the number/frequency of fingerprint analysis requests and the success rate of the fingerprint analysis. This was done using IBM SPSS Statistics version 29.0.2.0 (IBM Corporation, Armonk, New York City, USA), and a Bonferroni analysis was applied to correct for multiple tests.

2.5 Approvals

Ethical approval was obtained from the UCT Faculty of Health Sciences Human Research Ethics Committee (HREC REF: 131 / 2024) (Appendix D). This study was sub-linked to the larger ongoing study (HREC REF: 136 / 2021) (Appendix D). Approval was also obtained from the Head of the Division of Forensic Medicine and Toxicology for access to the mortuary data (Appendix E).

CHAPTER 3 RESULTS

3.1 Admitted cases at SRM/OFPI during 2021

The total number of cases admitted to SRM/OFPI between 1 January 2021 and 31 December 2021 was 3742. Four cases of non-human remains were excluded, resulting in 3738 cases analysed in this study. Of these cases, 90.1 % (n = 3369 / 3738 of cases) had a suspected identity at admission and 9.9 % (n = 369 / 3738) did not (Appendix B: Table B1). Furthermore, excluding cases with unknown sex (n = 21 / 3738), 76.6 % (n = 2847 / 3717) were males, 23.4 % (n = 870 / 3717) were females (Appendix B: Table B1). The age group of 25 – 34 years had the highest number (26.3 %; n = 976 / 3705) of cases at admissions (Figure 3.1).

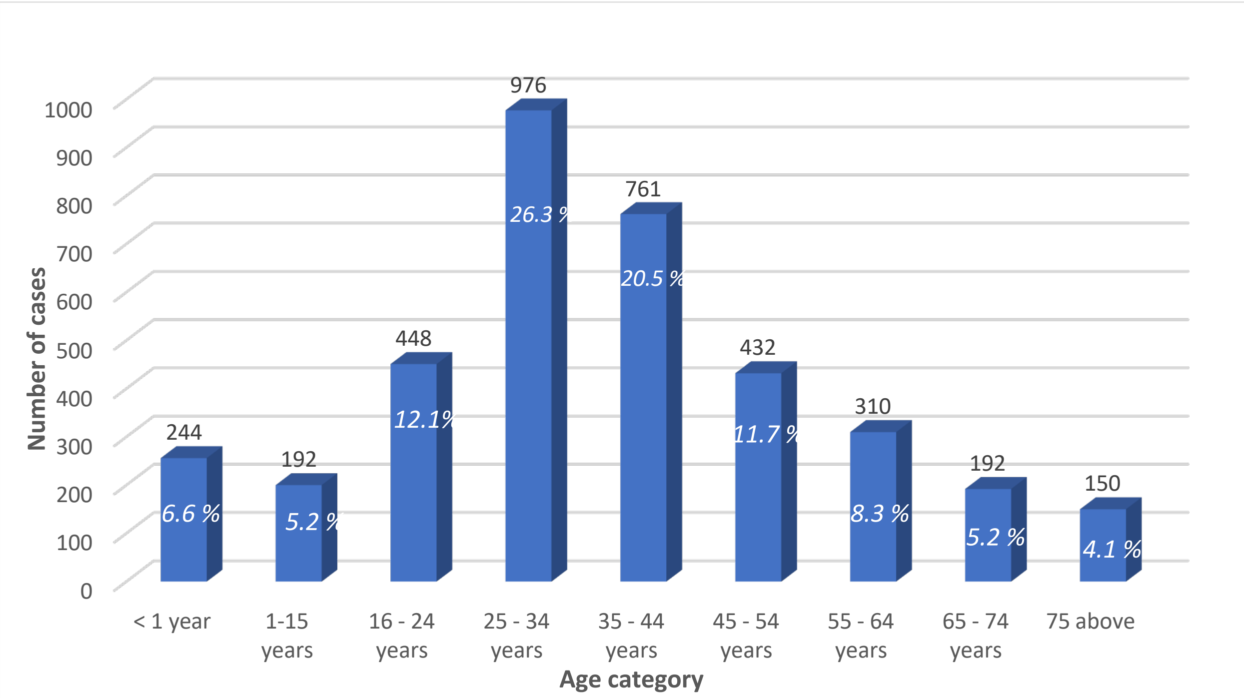

Figure 3.1: Bar-graph showing the age distribution for cases with known ages at admission (3705) admitted to SRM/OFPI in 2021.

From the total of 3738 at admission, 26 non-viable foetuses were excluded, resulting in a total of 3712 cases, of which 3368 cases had a suspected identity and 344 cases had unknown identity (Figure 3.2). Of these cases, 83.9 % (n = 3113 / 3712) were visually identified within seven days of admission, with eight cases being unclaimed and 16.1 % (n = 599 / 3712) remaining unknown at this time point (Figure 3.2). Additionally, a table showing all the total sex and cases identified at different timepoints has been provided in Table 3.1 (Table 3.1.)

Identification status for 2021 admitted cases at SRM/OFPI as of 2nd December 2024.

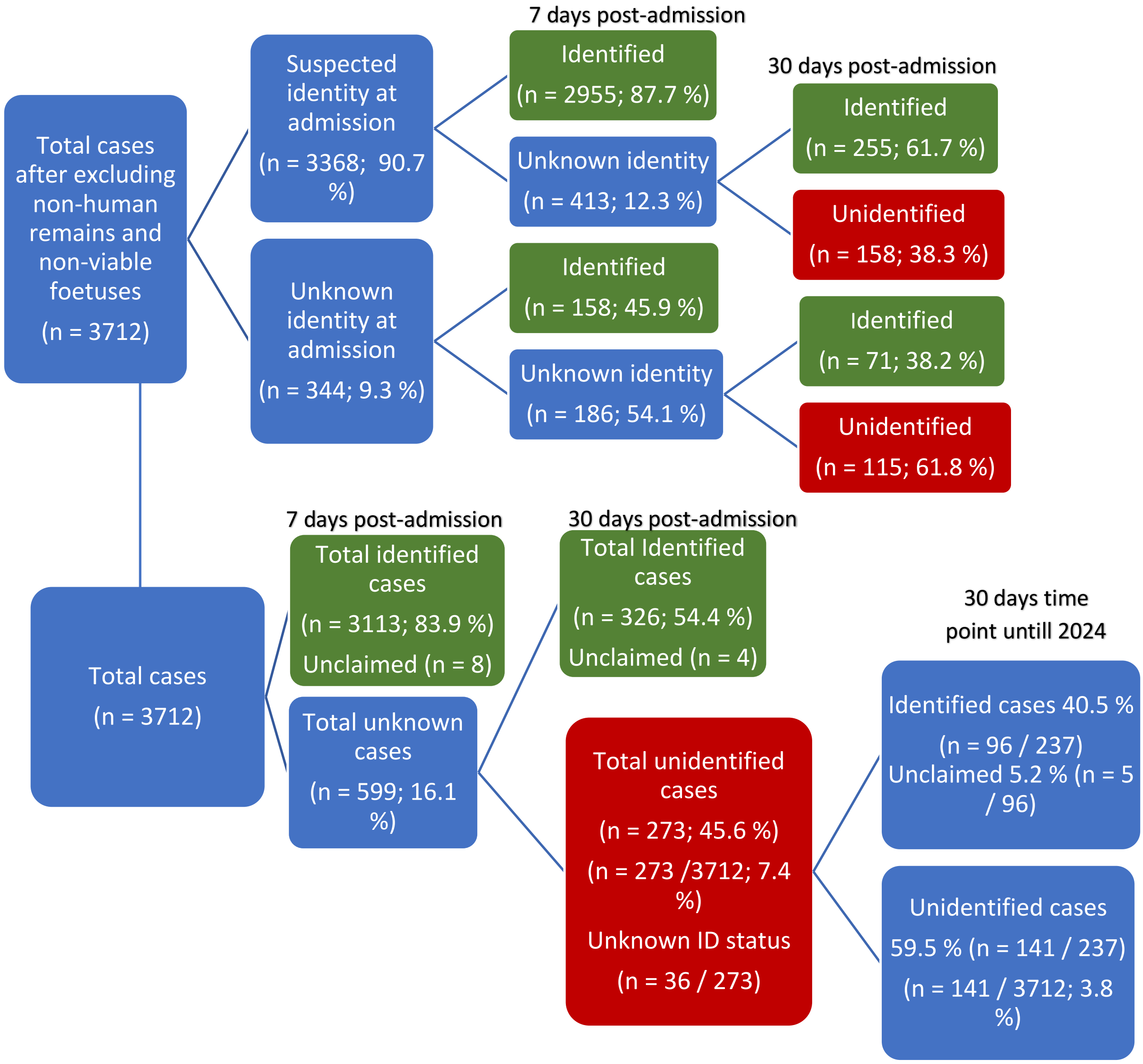

Figure 3.2: Flow chart showing 2021 admitted cases at SRM/OFPI with suspected (3368; 90.7%) and unknown (344; 9.3 %) identity, with their identification status at different time points until 2024.

Table 3.1. Table showing the total numbers of sex, and cases identified, Unclaimed and Unidentified at different time points.Table showing the total numbers of sex, cases identified, Unclaimed and Unidentified at different time points.

Total cases reviewed for 2021 (N = 3742)								
Cases 3742	N	Identity		Sex				
Excluded non-human remains (4)	3738	Suspected (3369)	Unknown (369)	Males (847)	Female (870)	Unknown (21)		
Excluded non-viable foetuses (26) from 3738 cases (N = 3712)								
Cases	**Total**			**Identity**		**Sex**		
3712	N	Claimed	Unclaimed	Suspected	Unknown	Males	Females	Unknown
Identified within 7 days of admission	3 113	3 105	8	2 955	158	2 371	742	0
Unknown at 7 days of admission	599	0	0	413	186	465	124	10
Identified within 30 days of admission	326	322	4	255	71	254	72	0
Unidentified at 30 days of admission	273	0	0	158	115	211	52	10
Casess	**Total**			**Identity**		**Sex**		
273	N	Claimed	Unclaimed	suspected	Unknown	Males	Female	Unknown
Identified after 30 days of admission	96	91	5	59	37	80	16	0
Unidentified	141	0	0	77	64	110	27	4

3.2 Unknown cases population at 7 days and 30 days post-admission

The total number of cases with unknown identity after seven days of admission (Figure 3.2) was 599 cases. Of these, 78.9 % (n = 465 / 589) were males, and 21.1 % (n = 124 / 589) were females (Appendix B: Table B1). The age and sex of these cases differed significantly ($p < 0.005$ for age and $p < 0.001$ for sex) from those for all cases at admission (Figures 3.2 and 3.3). From the 273 unidentified cases after 30 days of admission (Figure 3.2), 80.2 % (211 / 263) were males, 19.8 % (n = 52 / 263) were females (Appendix B: Table B1), with the age group between 35 – 44 years having the highest proportion of cases (n = 63 / 266) of cases (23.7 %) (Appendix B: Table B2). Comparing the age distribution and sex of cases that were unidentified at 7 and 30 days post-admission, there was a statistically significant difference for both demographics ($p < 0.001$ for each) (Appendix B: Tables B2 & B3). A higher proportion (26.4 %; n = 156 / 592) of decedents with no confirmed identity at seven days between the ages of 25 – 34 years was observed compared to cases that remained unidentified till the time point of this study were the age group between 35 – 44 years had the highest proportion (26.2 %; n = 36 / 141) of cases. Additionally, males were more likely to be unidentified at both time points (Figure 3.3, 3.4 & Table 3.1)

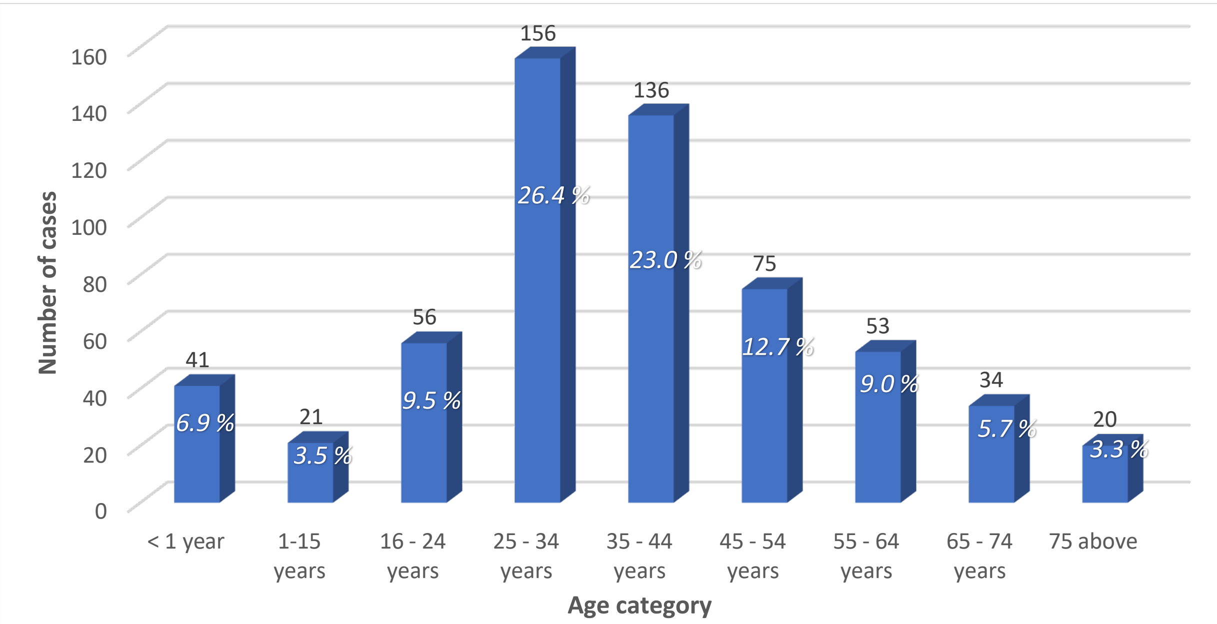

Figure 3.3: Bar-graph showing the age distribution of cases in 2021 with unidentified identity (n = 592, excluding 7 unknown ages) at seven days post-admission.

Of the unidentified cases at 30 days post-admission (n = 273), 86.8 % (n = 237 / 273) were either identified visually and released to their family members/remained unclaimed or remained unidentified with a pauper burial, while the identification status for the remaining cases (n = 36 / 273) was unclear due to missing documents (Appendix B; Table B1). Excluding those cases with missing documents (n = 237), 40.5 % (n = 96 / 237) were visually identified with 5.2 % (n = 5 / 96) of the cases being unclaimed and 59.5 % (n = 141 / 237) remaining unidentified from the 30 days time point until this study in 2024 (Figure 3.2).

3.3 Unidentified population as of 2024

Of the cases that remained unidentified at the time of this study (n = 141 / 237; 59.5 %), sex was known in 97.1 % (n = 137 / 141). Of these, 80.3 % (n = 110 / 137) were males and 19.7 % (n = 27 / 137) were females (Appendix B: Table B1). The age group between 35 – 44 years had the highest frequency of cases (26.2 %) (Figure 3.4). There was a statistically significant difference in age distribution and sex between the unidentified cases at 30 days post-admission and the unidentified population as of 2024 (p-values < 0.001 for each) (Appendix B: Table B5). The contingency tables used for comparing the age categories and sex can be found in Appendix B: Table B2 and B3.

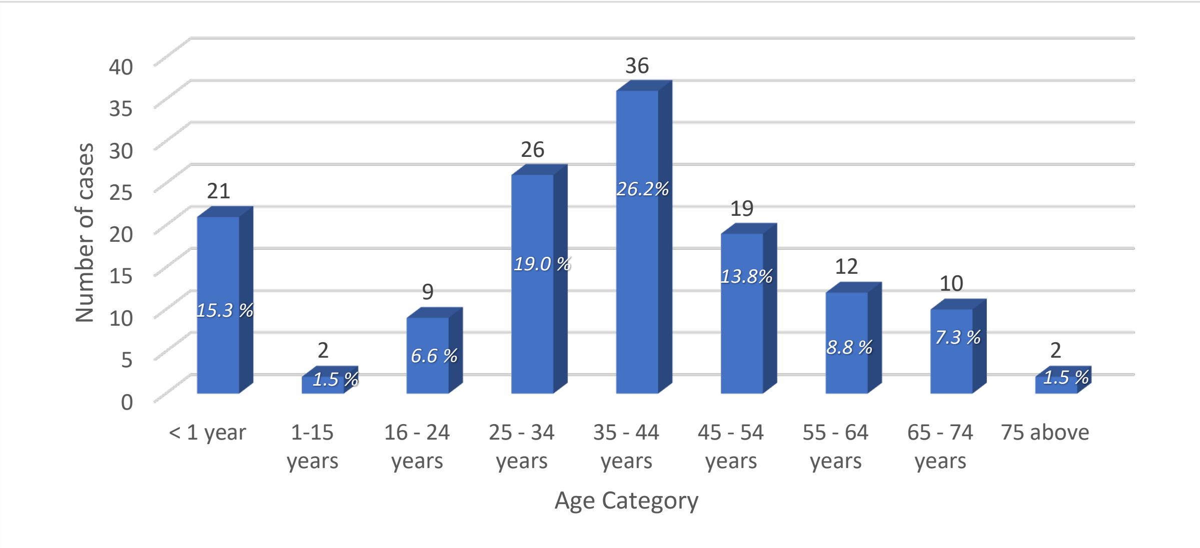

Figure 3.4: Bar-graph showing the age distribution of cases in 2021 that remained unidentified (n = 137, excluding 4 unknown ages) as of 2024, the time point of this study.

In total, for 2021 admitted cases excluding non-human remains and non-viable foetuses at SRM/OFPI, 99.0 % (n = 3676 / 3712) were known to be either identified, unidentified or remained unclaimed (Appendix B: B1). Of these cases, 95.7 % (n = 3518 / 3676) were visually identified, with 0.5 % (n = 17 / 3676) being unclaimed and 3.8 % (n = 141 / 3676) remaining unidentified (Figure 3.5). Additionally, n = 26 / 3738 of the total cases were non-viable foetuses and the identification status of the remaining cases (n = 36 / 3712) was unclear due to missing documents (Appendix B: B1).

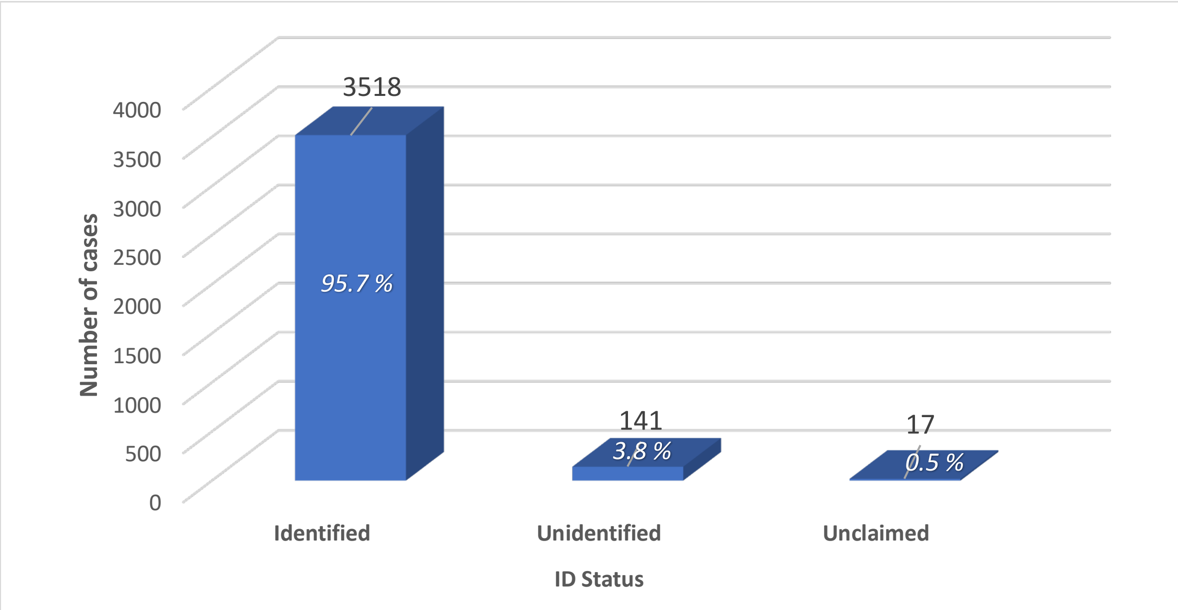

Figure 3.5: Bar-graph showing the total identified, unidentified and unclaimed of the total cases

3.4 Fingerprint analysis request and success rate for 2021 cases at SRM/OFPI

Fingerprint analysis was requested in 143 cases of all admitted cases to SRM/OFPI in 2021, of which 90.2 % (n = 129 / 143) of the analysis request outcomes were known. The majority were successful with an identity being returned (n = 115 / 129; 89.2 %) (Appendix B: Table B4). Where the results outcome was unknown (n = 14 / 143; 9.8 %) this was mostly due to the absence of a report to review (n = 13 / 14; 92.9 %) or an unclear result which was not interpretable in this study (n = 1 / 14; 7.1 %). Two of these cases (n = 2 / 143; 2.8 %) had a confirmed identity within seven days of admission.

Of the cases that had unconfirmed identities at seven days (n = 599), fingerprint analysis was requested in 139 cases, of which 81.3 % (n = 113 / 139) yielded a successful identification. Of these cases (113), 42 cases were subsequently identified and claimed by next-of-kin, 7 were unclaimed and 64 remained unidentified.

Fingerprint analysis was unnecessarily requested in 0.1 % (n = 2 / 3113) of cases identified within 7 days of admission (Appendix B: Table B4). Among cases identified within 30 days of admission (n = 326 / 599; 54.4 %) (Figure 3.2), 4.6 % (n = 15 / 326) had fingerprint analysis requests (Figure 3.6). Of these three cases (n = 3 / 15; 20 %) had no fingerprint analysis report and all 12 cases (n = 12 / 15; 80 %) that were requested had a successful outcome (Appendix B: Table B4).

Unidentified cases at 30 days of admission that were further identified 30 days post-admission (n = 96 / 273) had 43.8 % (n = 42 / 96) fingerprint analysis requests, Of the 38 cases with available reports, 97.4 % (n = 37 / 38) resulted in a successful identifications, while 2.6 % (n = 1 / 38) were unsuccessful. Three cases (n = 3 / 42) had no analysis report and one (n = 1 / 42) analysis report was unclear (Appendix B: Table B6). Additionally, cases that remained unidentified by next of kin at the time of this study (i.e. as of 2024) (n = 141), had 58.2 % (n = 82 / 141) fingerprint analysis requests, which 77 of the cases (n = 77 / 82) resulted in a successful match in 83.1 % (n = 64 / 77), no fingerprint match in 16.9 % (n = 13 / 77), and the remainder of cases (n = 5 / 82) had no analysis report (Appendix B: Table B6).

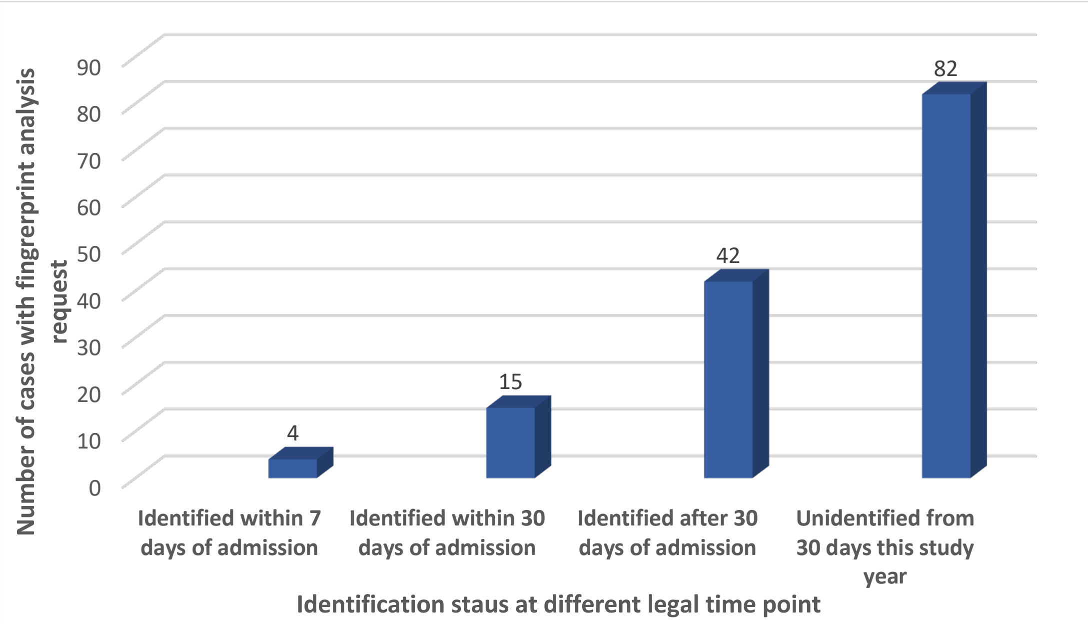

Figure 3.6: Bar-graph showing the total fingerprint analysis requests (143) for identified/unidentified cases at different legal time points at SRM/OFPI in 2021.

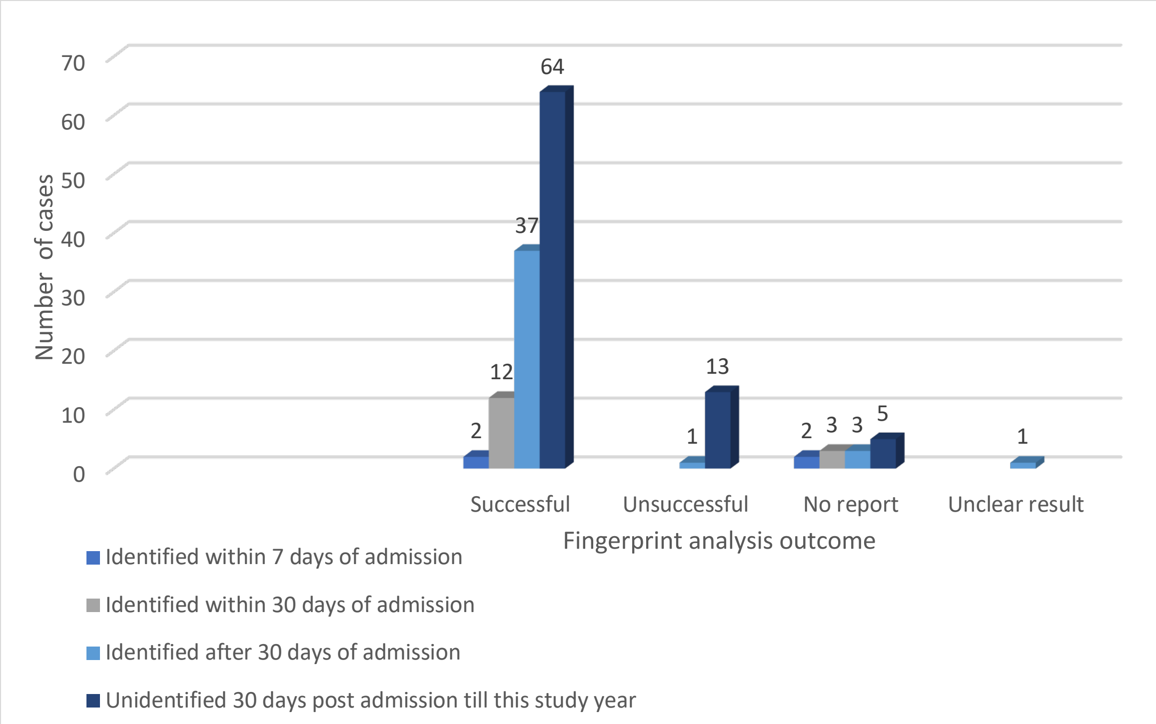

Figure 3.7: Bar-graph showing the success rate of cases of fingerprint analysis requests (143) for identified/unidentified cases at different legal time points for 2021 cases at SRM/OFPI with a successful/unsuccessful identification match, including cases which had no fingerprint analysis report, with one case whose report was unclear.

Fingerprints were only requested in cases where the deceased was above 16 years old, with the highest analysis request in ages between 35 – 44 years (n = 49 / 142; 34.5 %) (Appendix B: Table B7). In addition, one case of unknown age also requested fingerprint analysis. Therefore, fingerprint analysis was requested in 3.9 % (n = 143 / 3712) of the total caseload (n = 3712) of the analysed cases and it successfully aided identification in 3.1 % (n = 115 / 3712) of the caseload. (Figure 3.7). Of the unidentified cases after 30 days time point untill this study (n = 141), 41.8 % (n = 59 / 141) had no fingerprint analysis request and 58.2 % (n = 82 / 141) had an analysis request of which 9.2 % (n = 13 / 82) of these requests were all unsuccessful (Figure 3.7). Of the unsuccessful cases, (n = 13), 61.5 % (n = 8 / 13) body conditions were good, 15.4 % (n = 2 / 13) were decomposed, 7.7 % (n = 1 / 13) were burnt, 7.7 % (n =1 / 13) mutilated and 7.7 % (n = 1 / 13) had extensive trauma to the body (Appendix B: Table B8). Additionally, for the total fingerprint analysis request, bodies that were in good condition had more requests compared to the decomposed bodies (Appendix B: Table B9).

Of the 141 cases that remained unidentified at the time of this study, 59 did not have fingerprint requests submitted. This was due to being under the age of 16 years (n = 23 / 59; 39.0 %), decomposed (n = 7 / 59; 11.9 %), burnt (n = 7 / 59; 11.9 %) and skeletonised (n = 3 / 59; 5.1 %). A reason for the absence of fingerprint analysis request was not determined in 19 cases (Appendix B: Table B10).

3.5 Physical condition of the body and environment of recovery

Using Pearson's chi-square test, cases recovered outdoors had significantly more fingerprint requests of 64.3 % (n = 92 / 143). Of these, 82.6 % (n = 76 / 92) were successful, making up 66.1 % (n = 76 / 115) of the total successful outcomes of the 143 requests (Appendix B: Table B11). Comparing the cases recovered indoors (n = 49 / 143; 34.3 % request) (n = 37 / 49; 75.5 % success) to with other environment, indoor cases contributed about 32.2 % (n = 37 / 115) of the total success outcome of the (143) fingerprint analysis requests ($p < 0.001$ for each) (Table 3.2). Two cases of bodies recovered from aquatic environments had fingerprint analysis requests (n = 2 / 143; 1.4 %), which were successful (Appendix B: Table B11).

Table 3.2 Table showing chi-square values for fingerprint analysis request/outcome in cases recovered Indoor, outdoor and water body conditions at SRM/OFPI in 2021.

Variable 1	**Variable 2**	**Variable 3**	**Pearson's Chi-square P-value** α = 0.05
Fingerprint analysis requests for the bodies recovered Indoors (n = 49)	Fingerprint analysis requests bodies recovered outdoors (n = 92)	Fingerprint analysis requests for the bodies recovered in water (n = 2)	<0.001
Fingerprint analysis outcome for the bodies recovered Indoors Successful cases (n = 37), Unsuccessful (n = 5)	Fingerprint analysis outcome for the bodies recovered outdoors Successful cases (n = 76), Unsuccessful (n = 9)	Fingerprint analysis outcome for the bodies recovered in water Successful cases (n = 2)	<0.001

3.6 Timeline from admission to release for admitted cases

Overall, it took an average 5 days (Std. dev = 81 days) from the date of admission to the body release of the decedent. Autopsies were usually performed within 3 days on average (Std. dev = 9 days) and fingerprints were collected within the mean of 21 days (Std. dev = 66 days) following admission (Figure 3.8). It took a median of 7 days from the time the fingerprint was collected to when the fingerprint request analysis was officially requested in the total population. The time between receiving the fingerprint analysis report for the total analysed cases and the release of a body varied greatly (range: 1 – 1175) (Appendix B: Table B12), with a median of 61 days (Appendix B: Table B12). The processing time of analyses did not appear to be affected by whether the case was admitted with a suspected or unknown identity, with both averaging at a median of 30 days (Std. dev = 120 days). From the admission of cases, the result showed that fingerprints were collected earlier in cases without a suspected identity at admission compared to cases that had a suspected identity (Figure 3.9, 3.10). However, when cases were admitted without a suspected identity, the time body being released for burial took longer (Figure 3.9, 3.10).

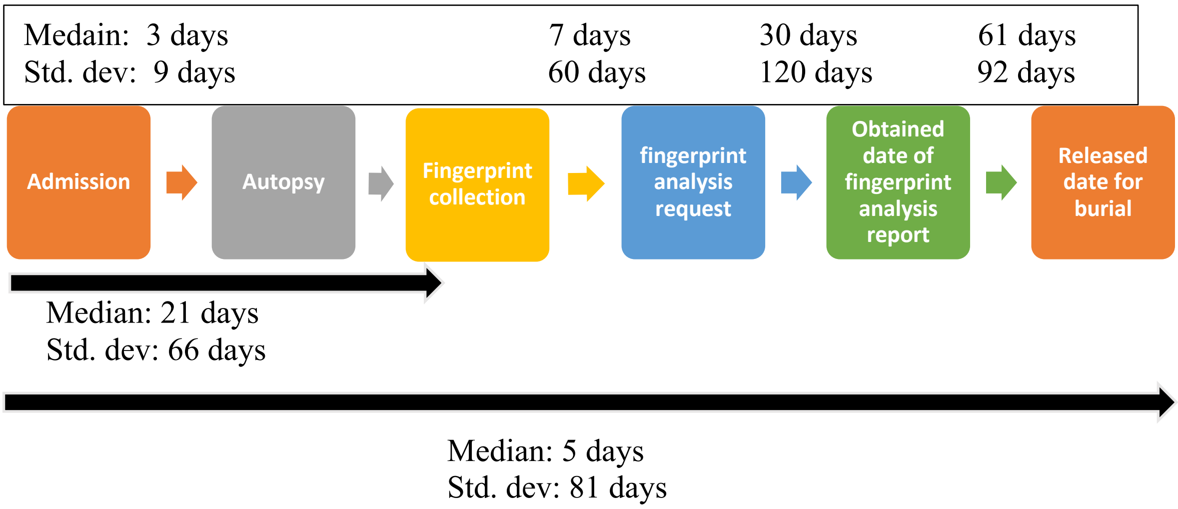

Figure 3.8: A Flow chart showing the timeline from admission of a decedent to the body release for the total analysed (3712) cases admitted to SRM/OFPI in 2021.

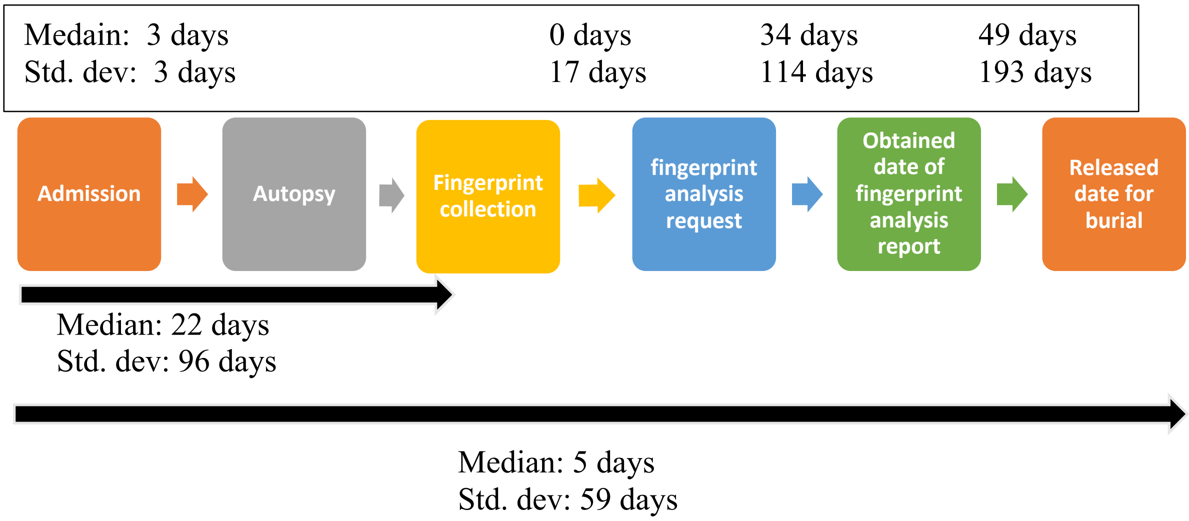

Figure 3.9: A flow chart showing the timeline from admission of a decedent to the body release for cases with suspected identity.

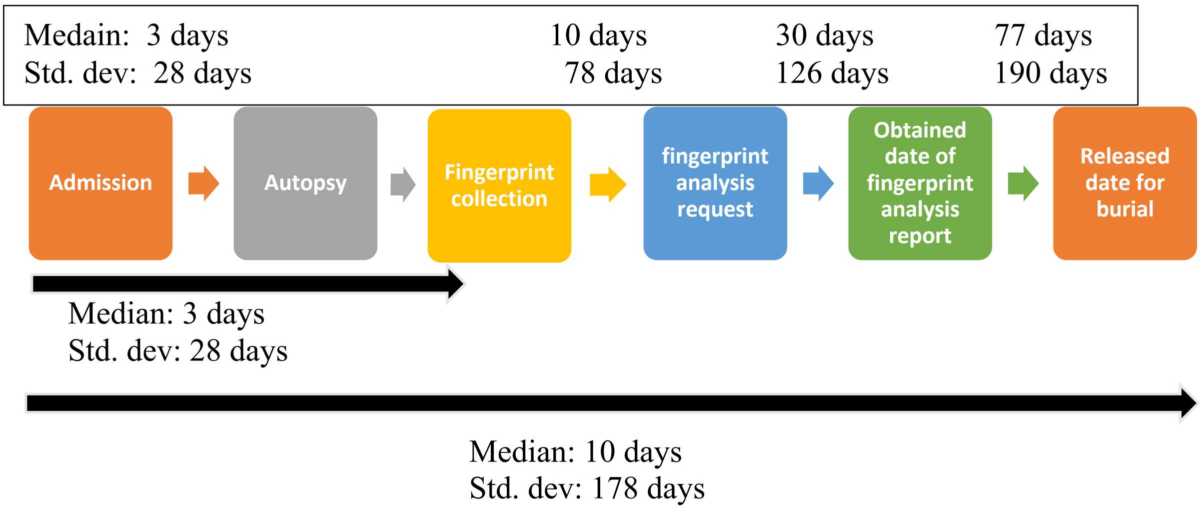

Figure 3.10: Flow chart showing the timeline from the admission of a decedent to the body release for cases with an unknown identity at admission.

CHAPTER 4 : DISCUSSION

4.1 Caseloads

This study has provided imperative insight regarding the population of unidentified decedents and the use of fingerprints at SRM/OFPI in 2021. The first objective was to describe the unidentified population at SRM/OFPI in 2021. Of the admitted cases at SRM/OFPI in 2021, 7.4 % (n = 273 / 3712) (Figure 3.2) were unidentified 30 days post-admission, with 3.8 % (n = 141 / 3712) remaining unidentified at the time of this study (Figure 3.2). This result (3.8 %) was comparable with rates in developed countries, such as to Cattaneo et al. (2010), who reported unidentified decedent numbers at the Institute of Legal Medicine in Milan, Italy, over 14 years to be 3.1 % (n = 454 /14607) (Cattaneo et al., 2010). Furthermore, a study by Hanzlick and Smith (2006) reported the unidentified decedent in Fulton County, United States of America (USA), to be 4.4 % (n = 44 / 1000) per year (Hanzlick & Smith, 2006).

Comparing the 3.8 % (n = 141 / 3712) of unidentified decedents at SRM/OFPI with the rates of unidentified bodies in developing countries, at SRM/OFPI, in the last retrospective study, a decrease was seen in the percentage (and number) of bodies that remained unidentified: from 9.2% to 3.8 % (Reid, Martin & Heathfield, 2020). This decrease in number compared to the earlier retrospective study is likely due to the method of data sourcing and advancement in identification procedures at SRM/OFPI, and restrictions due to COVID-19 in 2021, thereby reducing the total admitted caseloads to the facility for that year. A major difference lies in the method of document review for decedents, in which this study utilised all the actual (original) post-mortem documents of decedents, which were not limited to the identification document alone. This method of document review helped to sort cases that were either identified/unidentified beyond 30 days post-admission. In contrast, the previous study utilised the office autopsy database, which recorded the identification status of decedents at autopsy. However, the database was rarely updated to reflect subsequent identifications, thereby introducing limitations to the use of secondary data (Reid, Martin & Heathfield, 2020). Additionally, the previous study reviewed cases from 2010 – 2017 while this study focused on cases admitted in 2021, in which COVID-19 pandemic restriction could have affected various activities, thereby reducing movements, in turn reducing the rate of death and the number of caseloads admitted to SRM/OFPI facility for that year (Reid, Martin & Heathfield, 2020; Esposito et al., 2022).

There was a lower percentage of unidentified bodies observed in this study compared to other related studies (Paulozzi et al., 2008; Kumar et al., 2009; Evert, 2011). Similarly, there was a lower percentage of unidentified cases observed in this study compared to other forensic facilities across South Africa. Keyes et al., (2022), reported unidentified decedents reaching 8.1 % of the total number of annual admitted cases at Johannesburg Mortuary over 31 months (Keyes, Mahon & Gilbert, 2022). This percentage (8.1 %) was possibly due to the higher number of immigrant workers residing in Johannesburg, who were undocumented (Keyes, Mahon & Gilbert, 2022). Although, fingerprint method of identification is one of the most successful methods of identification by the WITS ID unit, for undocumented migrants, match records are not always found on the national databases, thereby contributing to the high rate of unidentified cases (Keyes, Mahon & Gilbert, 2022).

Indeed, undocumented migrants residing in a country may contribute to the number of unidentified cases, because if an individual is undocumented in a country the databases for forensic identification of that country would not have a match record on their system (Keyes, Mahon & Gilbert, 2022). Internationally, strict measures are placed across borders to filter undocumented people crossing the borders, and the use of specialized means of identification at borders has helped to later identify migrants, and ultimately reduce the unidentified population (Anderson, 2008).

For bodies that remained unidentified, the majority of decedents were males and within the age group of 25 – 44 years. Reid et al. (2020) study reported a similar percentage for unidentified males (78.7 %), with most of the individuals being between twenty to thirty-nine (20 – 39 years) (Reid, Martin & Heathfield, 2020). Cattaneo et al. (2010) study in Italy reported 60 % of unidentified cases in the age group between 21 – 40 years (Cattaneo et al., 2010). This aligns with findings from Paulozzi et al. (2008) in the USA, which identified the highest frequencies of unidentified cases among females aged 18 - 27 years and males aged 28 – 37 years (Paulozzi et al., 2008). When compared to the Keyes et al., (2022) findings, the number of males was reported to be 91.7 % which was a bit higher than the findings of this study (Keyes, Mahon & Gilbert, 2022). The high proportion of unidentified males observed in this study, in combination with the age distribution could be attributed to the risk-taking nature of men, which can be social carrer-wise, involvement in crimes and riskier lifestyle among the youthful age groups (Loomis, Bena & Bailer, 2003; Paulozzi et al., 2008). The majority of men are more likely to relocate to bigger cities in search of better opportunities to sustain their family and eventually, when identification is needed, some family members may not be able to travel to identify them (Paulozzi et al., 2008).

4.2 Fingerprint success rate and turnaround times

This study specifically investigated the success rate and turnaround times of fingerprint analyses at SRM/OFPI in 2021. The overall fingerprint request rate for total admitted cases was 3.9 % (n = 143/3 712), and of the total number of requests, cases with analysis reports (129) had a 89.2 % (n = 115/ 129) successful outcome. Comparing this success outcome (89.2 %) to Blau and Rowbotham (2022) in Australia, where fingerprint aided identification in 31 % of 78 cases that requested an analysis, the success rate of this study is seen to be higher (Blau & Rowbotham, 2022). Fingerprint success rate reported by Keyes et al., (2022), (98.9 %) was quite higher than the success rate of this study. This was despite Johannesburg experiencing a greater percentage of international migration than Cape Town (Keyes, Mahon & Gilbert, 2022). Efforts made by the ID unit, like modifying and refining the most successful identification processes, like fingerprinting and constantly reviewing the standard operating procedures (SOP) annually, may have contributed to the higher rate of identification at the unit. Additionally, collaborations between the unit and entities like SAPS, FPS, the University and humanitarian organisations may have greatly impacted identification rates (Keyes, Mahon & Gilbert, 2022). Other studies, such as Evert (2011), highlighted fingerprint collection requests but did not report on the success rate of the analysis (Evert, 2011).

Where fingerprint analysis was unsuccessful (10.9 %), this was largely as a result of no existing ante-mortem fingerprint record or template on the searched databases (Figure 3.11). For example, only a minority of the population may have their fingerprint on a SAPS database, and undocumented migrants or citizens will not have a record on the HANIS database (Breckenridge, 2005; McKinley, 2018; Van der Straaten, 2019). This suggests that a transnational approach should be used, where fingerprints from decedents at SRM/OFPI could be searched against fingerprint databases from other countries (e.g., neighbouring countries) to expand the potential for identification.

A transnational approach of identification like the creation of a unified database across borders which has been emphasised by the International Committee of the Red Cross (ICRC) would help in the collection and analysing of information on missing or unidentified persons to avoid misidentification and underreporting of missing cases (International Committee of the Red Cross (ICRC), 2022). Adherence to forensic standardised procedures for the identification of deceased individuals across states and countries, including forensic data sharing, would assist in criminal investigation and the identification of unidentified decedents and missing people. Most importantly the creation of a joint transnational forensic network to support and facilitate cases involving countries should be established (International Committee of the Red Cross (ICRC), 2022). The establishment of a transnational fingerprint database in South Africa can be achieved using a similar approach adopted by the INTERPOL and Europol Information System (EIS) DNA databases which involved the use of a hit/no-hit model where DNA from a country was searched in another country's database and if a match was found, then it moved to a stage where demographic data or other information was shared. The use of the INTERPOL I -24 / 7 network has helped ensure that the forensic data shared is not modified or misused during transmission by INTERPOL (Amankwaa, 2020).

A holistic approach should be used, where there is no reliance on fingerprints as an identification tool. A recent study conducted in the USA compared post-mortem data of unidentified decedents with ante-mortem records of missing people with the help of a database that allowed the combination of missing people and unidentified decedents' data (Soler et al., 2024). The study led to the identification of over 80 long-term unidentified cases (Soler et al., 2024). The same approach can be employed in SA to increase the chance of identification, but it would start with the creation of such a database. This can be done by enhancing the available databases in a way that missing people databases or other existing databases, other than the one utilised would allow a cross search with unidentified cases, utilising available ante-mortem records of missing decedents.

It is acknowledged that fingerprint analyses may be limited in certain cases with poor body condition or where decedents are less than 16 years of age. Whilst fingerprints were only collected from decedents aged 16 years and older, it was noted that some unidentified decedents above 16 years, with intact fingers, had no fingerprint analysis request (n = 19). This highlights an area for improvement where fingerprint analyses should be adequately utilised in all appropriate cases.

In this study, fingerprint analysis requests and outcomes were significantly higher for bodies of good condition than those who were decomposed. This was expected since decomposition is known to have affected the quality of fingerprints obtained, which may impede the ability to match fingerprints to a database (Alonso-Fernandez et al., 2007). The effect of different body conditions on fingerprint recovery can be very challenging in decomposed, burnt or mummified cases (Marks, Love & Dadour, 2009; Chen et al., 2017; Verdon & Hamilton, 2019). Evert (2011), showed how factors like decomposition, skeletonisation, burning and age (children) also affected the collection of fingerprints and analysis requests (Evert, 2011). Sauerwein et al., (2017) described fingerprints as one of the most lasting biometrics, but they were dependent on temperature, decomposition, scavengers and insects, which affected fingerprint quality and in cases of skin slippage, made fingerprints unobtainable

(Sauerwein et al., 2017). Bolme et al., (2016) study showed how decomposition impacted fingerprint scoring using a fingerprint-matching system by reducing fingerprint detectability and it was also suggested that collecting multiple fingerprint samples or images would increase the chance of the fingerprint-matching system detecting such prints.

The recovery environment was also shown to be statistically significantly associated with fingerprint analysis requests as well as success rate ($p<0.001$ for each), with bodies recovered outdoors having significantly more analysis requests (n = 96) with more successful analysis outcomes (n = 76) compared to those from indoor environments and in water. The reason for the higher success rate in outdoor cases compared to those recovered indoors and in water could be the preservation status of the body based on the effect of environmental factors on the body, as it can either inhibit or facilitate decomposition. Only two decedents recovered from water environments had fingerprint analyses requested. Studies have shown that water can be an inhibiting factor to fingerprint analysis and success rate, as water can facilitate decomposition and degradation (Caruso, 2016; Sauerwein et al., 2017; Gülekçi, 2021). A study that investigated the environmental effect on fingerprints showed that fingerprints obtained from dried surfaces were more identifiable than those obtained from a wet environment (Gülekçi, 2021). The effect of these environmental factors and the preservation status of the body may have played a role in why only a few cases recovered from the water had an analysis request. Irrespective of the environment of recovery, effort should be made for fingerprint collection if obtainable prints are available in unidentified cases.

It is recommended by SA legislation for fingerprints to be collected for bodies that are not identified within 7 days of admission (South African National Health Act, Regulation Regarding the Rendering of Forensic Pathology Service 2005). The result of this study showed that 16.1 % (n = 599 / 3712) were unknown after 7 days of admission and the median days taken from admission to fingerprint collection was 21 days (Figure 3.13). Adherence to the legislation for fingerprint collection would help reduce the time frame for collection, which would be helpful for cases that are already decomposing, because the more time it takes to collect fingerprints, the more the degradation of soft tissues. Additionally, a delay in fingerprint collection would slow down the identification process, thereby increasing the cost of storage and maintenance of the bodies. This gap between the practice at SRM/OFPI and what the SA legislation recommends should be addressed to further facilitate the identification process at the facility. The findings of this study showed that it took 61 days (median) to process the fingerprint analysis results. Due to the decomposition effect in fingerprints, it would be advisable for fingerprints to be collected on admission for cases in poor body condition.

Cadd et al., (2015) showed that collected fingerprints over time undergo degradation or aging, which is dependent on various factors (Cadd et al., 2015). These factors can be intrinsic (water, or lipids/amino-acids from the fingers), environmental factors like storage conditions, light, air, contamination, dust), or collection and transfer processes which can play a role in the degradation process (Jones et al., 2001; Cadd et al., 2015). Therefore, minimising the time between collection and searching against a database should be specialised.

4.3 Propose recommendations for a standardised procedure relating to the use of fingerprints at SRM/OFPI

The rate of unidentified cases internationally and across South Africa shows that more effort and measures are needed to reduce the burden, and this could be achieved by creating a database that would allow data upload of missing persons and unidentified human remains. This would help increase the chances of identification by pairing a missing person's fingerprint with unidentified bodies. Fingerprints should be collected for all unidentified cases above the age of 16 years where possible. Fingerprint collection should follow the legislation guidelines, with the analysis requested at 7 days of admission, as it will help preserve the integrity of such fingerprints and prevent further aging with time. In cases where body condition is poor, it will be best if collected at admission.

Through the findings of this study, it is recommended that the South African legislation be amended to accommodate the sharing of fingerprint data outside South Africa. Furthermore, the SAPS and HANIS databases should be upgraded to accommodate international searches while adopting the hybrid model of search used by INTERPOL and EIS (Amankwaa, 2020). The use of this transnational approach should align with the South African Criminal Procedure Act and the Protection of Personal Information Act (POPIA) (Republic of South Africa, Criminal Law (Forensic Procedures Amendment Act 6 of 2010). Additionally, SAPS and the Department of Home Affairs should establish a committee to manage this biometric exchange on the database following SOPs and guidelines.

It will be beneficial if SAPS facilitates the process of fingerprint analysis by training more fingerprint experts at SAPS to help facilitate and assist with the analysis process. However, this may be unrealistic given their large caseloads and thus collaborating with Universities (as demonstrated by the WITS ID unit) may be a better solution. Regarding the turnaround for fingerprint analysis, it is unknown if the collected fingerprint starts the analysis process immediately at SAPS or if it takes a longer period for the analysis to begin. Collected fingerprints should be well preserved to avoid dust, foreign particles, water, overlight exposure and heat during collection, transportation and storage as environmental and other factors can affect them (De Alcaraz-Fossoul et al., 2019). It is recommended that the surface of the prints be covered or protected. Therefore, a practice for fingerprint collection at 7 days of unknown cases should be adopted and for cases recovered from a water-related environment or in a decomposition state, fingerprints should be collected at admission. Created with follow-ups to obtain the analysis report until the individual is eventually identified or buried.

In cases where body conditions are poor due to decomposition or skin slippage, specialised techniques like degloving (removal of the epidermal layer of the fingers to print) to enhance the quality of the obtained fingerprints should be employed, as they could vary depending on the body condition. It was not evident if these advanced methods were being employed in 2021 at SRM/OFPI. In addition, an immediate collection and analysis request is recommended, with future research focusing on the techniques of fingerprint collection and the quality of prints obtained at SRM/OFPI, as this may impact the success rate of fingerprint analysis.

4.4 Limitations of the study

The major limitation of this study during data collection was missing documents, which resulted in some difficulty in knowing if a body was identified, unclaimed or unidentified.

4.5 Conclusion

This study has shown that the unidentified decedent population in 2021 comprised 3.1 % of the total cases admitted to SRM/OFPI. Fingerprint analyses were successfully used in the identification of 89.2 % of total cases that had an analysis request at SRM/OFPI in 2021. Due to this successful outcome, 42 cases that were unidentified at 7 days of admission were visually identified and claimed by their next of kin. This study has provided fingerprint analysis information for SRM/OFPI to help improve the use of fingerprints in forensic human identification in this mortuary setting. Procedures currently followed would benefit from some improvements, including the standardisataon of collecting fingerprints from all unidentified decedents over the age of 16 years old, as well as implementing degloving methods in decomposed cases. Additionally, analysis requests should be made immediately. However, not all cases will benefit from fingerprint analyses when only South African databases are used, which suggests a transnational (international) approach may need to be explored. Additionally, fingerprints should be used in combination with other identification methods holistically to improve the potential for successful identification outcomes.

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APPENDIX A: Variable coding table

Table A 1: The variable coding table shows the variable types and capture methods used during the data collection.

Variable categories/ where obtained from	Type	Coding (Method of Capture)
Age (years) (ID document)	Numerical continuous	(as specified in the report) years
Sex (Male/Female/Unknown) (scene script)	Categorical nominal	Male/Female/Unknown
Fingerprint analyses requested: (Yes/No) (Fingerprint documents)	Categorical binary	Yes/No
Date the fingerprints were collected: (yyyy/mm/dd)	Numerical discrete	yyyy/mm/dd
Forensic facilities that performed the analysis/Where requested (SAPS/SAPS VIC/SAPS LCRC/B1663)(fingerprint documents)	Categorical nominal	SAPS/SAPS VIC/SAPS LCRC/B1663
Date the result was obtained yyyy/mm/dd (Fingerprint documents)	Numerical discrete	yyyy/mm/dd
Report details/Nature of result (Favourable/Unfavourable) (fingerprint documents)	Categorical binary	Favourable/Unfavourable
Database searched. (AFIS/HANIS) (fingerprint documents)	Categorical nominal	AFIS/HANIS
Environment of recovery (Road/housing/waters/hospital/railway/open land/others) (Incident log/Scene script)	Categorical binary	Waters/Hospital/Railway/Open land/Road/Housing/Other
Date of death (yyyy/mm/dd) (Scene script)	Numerical discrete	- yyyy/mm/dd
Date of death recovery yyyy/mm/dd) (Scene script)	Numerical discrete	- yyyy/mm/dd
Nature of release/burial; (Private release/Pauper burial/State held/unknown) (acknowledgement of receipt/notice of claim receipt)	Categorical nominal	Private release/Pauper burial/State held/Unknown
Fingerprint sample collected (fingerprint document)	Categorical nominal	(As specified on fingerprint report)
Date of autopsy (yyyy/mm/dd) (Post-mortem report)	Numerical discrete	- yyyy/mm/dd
Date(s) of identification request(s) and report(s) (yyyy/mm/dd)(ID documents)	Numerical discrete	- yyyy/mm/dd
Date of release (yyyy/mm/dd) (acknowledgement of receipt document)	Numerical discrete	- yyyy/mm/dd
Physical inhibitors of visual identification: (Decomposition/Scavenging/Mutilation/Burnt) (PM report)	Categorical nominal	Decomposition/Trauma/Burnt/Skeletonised Good condition
Identity at admission (scene script)	Categorical nominal	Suspected/Unknown

APPENDIX B: Contingency tables

Table B 1: Table showing the proportion of males, females and unknown cases of the unidentified population.

Cases	N	Males	Females	Unknown	N (male/Female)
Total analysed	3 738 Suspected 90.1 % (n = 3369), Unknown 9.9 %(n = 369)	2 847 (76.6 %)	870 (23. 4%)	21	3717
Total (3 738) Non-viable foetuses = 26 (excluded)	3 712 [Identified/Unidentified (n = 3 676/ 3 712; 99.0 %) Missing documents (n = 36/ 3 172)]	2 836 (76.6 %)	866 (23.4 %)	10	3 702
Unknown cases 7 days post admission	599	465 (78.9 %)	124 (21.1 %)	10	589
Unidentified after 30 days of admission	273	211 (80.2 %)	52 (19.8 %)	10	263
Unidentified 30 days post admisdsion untill 2024 0f this study	141	110 (80.3 %)	27 (19.7 %)	4	137

Table B 2: Table showing the age distribution of the total cases/unknown/unidentified populations at various legal time points and the contingencies for Pearson's chi-square test.

Age category	N	< 1 year	1-15 years	16 - 24 years	25 - 34 years	35 - 44 years	45 - 54 years	55 - 64 years	65 - 74 years	75 above	Unknown
Total at admission	3 738	261	197	451	976	761	432	310	192	150	8
Total analysed at admission	3 712	244	192	448	976	761	432	310	192	150	7
Unknown 7 days post admission	599	41	21	56	156	136	75	53	34	20	7
Unidentified untill 2024 0f this study	141	21	2	9	26	36	19	12	10	2	4
Unidentified untill 2024 0f this study	141	21	2	9	26	36	19	12	10	2	4

Age category (Pearson's Chi-square test)	N	< 1 year	1-15 years	16 - 24 years	25 - 34 years	35 - 44 years	45 - 54 years	55 - 64 years	65 - 74 years	75 above
Total analysed cases	3 705	244	192	448	976	761	432	310	192	150
Unknown cases 7 days post admission	592	41	21	56	156	136	75	53	34	20
Unknown cases 7 days post-admission	592	41	21	56	156	136	75	53	34	20
Unidentified cases 30 days post-admission	266	33 (12.4%)	3 (1.1 %)	23 (8.7 %)	53 (19.9 %)	63 (23.7)	40 (15.1%)	24 (9.0%)	20 (7.5%)	7 (2.6 %)
Unidentified cases 30 days post-admission	266	33	3	23	53	63	40	24	20	7
Unidentified 30 days post-admission untill 2024 of this study	137	21	2	9	26	36	19	12	10	2

Table B 3: Table showing the known sex of the total cases/unknown/unidentified populations at various legal time points and the contingencies for Pearson's chi-square test.

Sex (Pearson's Chi-square test)	Cases (N)	Males	Female
Total analysed at admission	3 702	2 836 (76.6 %)	866 (23.4 %)
Unknown at 7 days of admission	589	465 (78.9 %)	124 (21.1 %)
Unknown at 7 days of admission	589	465	124
Unidentified cases 30 days post-admission	263	211	52
Unidentified 30 days post-admission	263	211	52
Unidentified 30 days post-admission untill 2024 of this study	137	110	27

Table B 4: Table showing the total number of fingerprint analysis requests for identified and unknown/unidentified cases at different legal time points for 2021 cases at SRM/OFPI.

Fingerprint analysis request	Total (no of cases)	Yes	No	unknown
Total cases after exclusion	3 712	143 (3.9 %)	3 547 (96.1%)	22
Identified before 7days of admission	3 113 (n = 4/3 113; 0.1 % request)	4 (0.1 %)	3 104 (99.9 %)	5
Identified before 30days of admission	326 (n = 15/326; 4.6 % request)	15 (4.6 %)	311 (95.4 %)	0
Identified post 30days of admission	96 (n = 42/96; 43.8 % request)	42 (43.8 %)	54 (56.2%)	0
Unidentified untill 2024 0f this study	141 (n = 82/141; 58.1% request)	82 (58.2 %)	59 (41. 8 %)	0

Table B 5: Table showing chi-square values for age categories/sex and fingerprint analysis request/outcome in with good and decomposed body condition at SRM/OFPI in 2021.

Variable 1	Variable 2	Pearson's Chi-Square p-value α = 0.0167
Total age at admission (3 730)	Age categories for Unknown cases at 7 days post-admission (592)	<0.005
Age categories for Unknown cases at 7 days post-admission (592)	Age categories for unidentified cases at 30 days post-admission (266)	<0.001
Age categories for unidentified cases at 30 days post-admission (266)	Age categories for Unidentified cases as of 2024 (137)	<0.001
Total sex at admission (3 717)	Sex for unknown cases at 7 days post-admission (589)	<0.001
Sex for unknown cases at 7 days post-admission (589)	Sex for unknown cases at 30 days post-admission (263)	<0.001
Sex for unidentified cases at 30 days post-admission (266)	Sex for unidentified cases as of 2024 (137)	<0.001
Variable 1	**Variable 2**	**Pearson's Chi-Square p-value** **α = 0.05**
Fingerprint analysis requests for bodies in good condition Yes (n = 115), No (n = 3 198)	Fingerprint analysis requests for decomposed bodies Yes (n = 9), N (n = 51)	<0.001
Fingerprint analysis request outcome for bodies in good condition Successful cases (n = 94), Unsuccessful (n = 9)	Fingerprint analysis request outcome for decomposed bodies Successful cases (n = 6), Unsuccessful (n = 2)	<0.001

Table B 6: Table showing the total cases of requested fingerprint analysis outcome for identified and unknown/unidentified cases at different legal time points for 2021 cases at SRM/OFPI.

Fingerprint analysis request Outcome	Cases	Successful	Unsuccessful	No report	Unclear result	Number of successful and unsuccessful cases (N)
Total fingerprint analysis request	143	115 (89.2 %)	14 (10.9 %)	13	1	129 (n = 129 / 143; 90.2 %)
Identified 7 days post admission	4	2 (100%)	0	2	0	2
Identified within 30 days post admission	15	12 (100 %)	0	3	0	12
Identified 30 days post admission	42	37 (97.4 %)	1 (2.6 %)	3	1	38
Unidentified untill 2024 0f this study	82	64 (83.1 %)	13 (16.9 %)	5	0	77

Table B 7: The contingency table showing the age category of cases above 16 years with total fingerprint analysis requests and for 2021 cases at SRM/OFPI.

Age category	Fingerprint requests

16 - 24 years	8 (5.6 %)
25 - 34 years	29 (20.4 %)
35 - 44 years	49 (34.5 %)
45 - 54 years	26 (18.3 %)
55 - 64 years	19 (13.4 %)
65 -74 years	10 (7.0 %)
75 above	1 (0.7 %)
Total	142

Table B 8: Table showing cases with unsuccessful analysis outcome (14) and their physical body for total analysed cases (3712) in 2021 at SRM/OFPI.

Total Unsuccessful	Identified after 30 days of admission	Unidentified untill 2024 of this study
N (cases)	13	1
Good	8 (61.5 %)	1 (100 %)
Decomposed	2 (15.4 %)	0
Burnt	1 (7.7 %)	0
Trauma	1 (7.7 %)	0
Multilated	1 (7.7 %)	0

Table B 9: Table showing the proportion of cases with and without fingerprint analysis request/outcome in cases with good and decomposed body condition for 2021 cases at SRM/OFPI.

Fingerprints analysis requests			
Physical condition of body	No	Yes	Total

Decomposed	51	9 (7.3 %)	60
Bodies in good condition	3198	115 (92.7 %)	3313
Total	3249	124	
Fingerprint analysis outcome	**Body physical condition**		Total
	Bodies in good condition	**Decomposed**	
Successful	94	6	100
Unsuccessful	9	2	11

Table B 10: Table showing the proportion of cases that remained unidentified (141) and were above 16 years with fingers, and no fingerprint analysis was requested.

		N	Cases with no request	
Unidentified till 2024 0f this study		141	59 (41.8 %)	
Cases with no fingerprint request			<16 years	16 years above
		59	23 (38.9 %)	36 (61.0%)
16 years above (Cases with fingers)			Yes	No
		36	19	17
Body condition (16 years above cases with fingers) (N = 19)		**Cases with no analysis requests (59), under the age of 16 years (n = 23/59)**		
Good	13 (68.4 %)	Undetermined why analysis was not requested		19
Decomposed	2 (10.5 %)	Decomposed		7
Burnt	1 (5.3 %)	Burnt		7
Trauma	3 (15.8 %)	Skeletonised		3

Table B 11: Contingency table showing the proportion of fingerprint analysis requests/outcomes and the environment of recovery in 2021 at SRM/OFPI. Contingency table showing the proportion of fingerprint analysis requests/outcomes and the environment of recovery.

Environment of recovery

Fingerprints request	Indoor	Outdoor	Aquatic	Total
Yes	49 (34.3 %)	92 (64.3 %)	2 (1.4 %)	143
Total	49	92	2	
Analysis Outcome	**Total**	**Indoor**	**Outdoor**	**Aquatic**
Successful	115	37 (32.2 %)	76 (66.1 %)	2 (1.7 %)
Unsuccessful	14	5	9	0
Total		42	85	2

Table B 12: Table showing the turnaround time (median days difference) from the admission of a decedent to the autopsy, finger analysis performance and the release of the body for total analysed cases (3 712), cases with (3 369) and without (unknown)(369) *suspected identity at admission for 2021 cases at SRM/OFPI.*

Total analysed cases (Days)	Admission - Fingerprint collection	Admission - Autopsy	Fingeprint collection –	Fringerprint request - Result	Result outcome obtained	Admission – Body release

			Analysis request	outcome obtained	– Body release	
Mean	34.7241	3.9189	20.8654	67.4031	145.5328	20.8113
Median	20.5	3	7	30	61	5
Mode	15	2	0	0	8	3
Std. Deviation	65.84746	9.06581	60.59639	119.9864	192.2989	81.04445
Range	498	369	434	629	1174	1226
	Suspected identities					
Mean	45.5769	3.6799	10.7273	68.0938	121.3279	13.6622
Median	21.5	3	0	34	49	5
Mode	15	2	0	0	1.00a	3
Std. Deviation	95.76353	3.25689	17.17191	114.9246	193.4267	59.21633
Range	496	95	57	629	1174	1266
	Unknown identities					
Mean	6.2653	25.9063	28.3	66.7231	169.7377	92.6246
Median	3	19	9.5	30	77	10
Mode	2	15	0	0	277	4
Std. Deviation	27.94757	19.94243	78.15906	125.6632	189.6546	178.1515
Range	369	92	434	576	804	1077

APPENDIX C: DATA MANAGEMENT PLAN FOR THIS STUDY

1. General guidelines

PURPOSE OF THIS TEMPLATE - The purpose of the Outline DMP is to indicate your initial plans for how your data will be collected, shared, and stored, and to give you a chance to think about these data-focused aspects of the research process. As you begin doing your research, your data process may change, and it is perfectly acceptable to change your data management plan to accommodate the changes in your research process. Indicate below that you understand the purpose of completing this Outline DMP template.

- I understand the Outline DMP template is a projection of my anticipated data management planning requirements and should be updated as my project develops.

2. Authors and supervisors

PROJECT NAME - Replicate the title of your project, dissertation, or thesis exactly as it appears in your proposal document.

Utilisation of fingerprint analysis for human identification at SRM/OFPI

PERSONAL DETAILS - Indicate the name(s) and student number(s) of the student(s) who will be involved in this project, dissertation, or thesis.

Rachael Eromosele KYDRAC001

SUPERVISOR(S) DETAILS - Indicate who will supervise this project, dissertation, or thesis. If you do not yet have a supervisor, leave this section blank.

Mrs. Kate Reid and A/Prof. Laura Heathfield

3. Data Collection/Generation

COLLECTION OF ORIGINAL DATA - Indicate whether or not you intend to gather/produce original data for your study and provide a brief description of the kind of data you think you will collect. If you are unsure at this time, indicate what you think you are most likely to collect. If you are not intending to gather or collect your own data, declare that here.

- I do not intend to collect original data.

This study is a retrospective study, therefore already existing data will be collected. The Data will be collected from Salt River Mortuary's medico-legal autopsy records. The data will be collected using Microsoft Excel. It is anticipated that approximately 3500 medico-legal reports will be reviewed. I anticipate the data to be less than 1GB.

USE OF EXISTING DATA - Indicate if you intend to re-use existing data, either from online searches or from datasets provided by your supervisor, lab, or funder. If you are not intending to re-use existing data, declare that here.

- I intend to reuse existing data in my study (described below).

Ethical approval will be obtained from the University of Cape Town, Faculty of Health Sciences Research Ethics Committee for the research to be conducted. Permission will be obtained from the head of the division, Division of Forensic Medicine, and Toxicology & the director of Forensic Pathology Service: WCGH for reuse and access to the mortuary data. The pilot study conducted by Kate Reid has obtained ethical clearance for the umbrella of study: HREC REF: 136/2021. Preliminary data will be obtained from the office autopsy database (R036/2014). Thereafter the online repository of electronic copies of medicolegal document (Livelink) will be reviewed which provides long-term access to data. I intend to collect a mix of qualitative and quantitative data which include demographic information (age, biological sex), case details (manner of death, area of recovery, date of death/recovery and autopsy date) and fingerprint related variables (date fingerprints was obtained, facility performing the analysis, date the result was returned, details of the analysis, database searched). The collected data will be transferred directly to MS Excel.Data collection will be between (March 2024 - July 2024). The collected data will be shared with the principal investigator of this study (Mrs Kate Reid). I anticipate my data will be between 200MB-2G. I anticipate these will be tabulated and analysed using MS Excel 365. i am not certain about how large my dataset will be until I start the collection. Already existing data from Salt River Mortuary (SRM) medico-legal autopsy records will be collected, this will include case details, demographic information, and various date points. Permission to collect the data will be obtained from SRM before the study commences. The data will be collected to provide context on the identification methods used at Salt River Mortuary and to establish a timeline from death to release. The data will be collected using Microsoft Excel. It is anticipated that approximately 3500 medico-legal reports will be reviewed. I anticipate the data to be less than 1GB. The data will be stored in a secured excel based database and backed up in an accessed controlled online storage cloud and USB.

DATA SHARING - Indicate whether or not you are intending to publish your research data. If you are, indicate where you are intending to publish your data and under what licensing conditions, such as Creative Commons. If you are not intending to publish your data, provide reasons and reference the appropriate ethical considerations, commercial applications/patenting ambition, or data re-use agreements that prevent you from publishing your data.

- I intend to share my data (details below).

This study might be published individually or as part of the larger study that is on-going.

4. Data Storage

ANTICIPATED DATASET SIZE - Indicate the estimated size of your completed dataset and indicate whether or not you will need to access additional data storage facilities. If such storage is not provided by your unit or department, you may need to factor in the cost of purchasing additional storage space.

- 20GB or less

The anticipated that the data that will be collected will not exceed 20 GB, this data will be stored in Microsoft Excel spreadsheets. Therefore, the data and data analysis files are anticipated to be less than 1 GB. The data will be also stored and backed up on a password protected USB that will be stored at a Secure location. This data will only be accessible to a limited individuals who are involved in this project.

DATA BACKUPS - Indicate how you plan to ensure your data is secure and retrievable in case of errors or hardware failure. Describe what procedures you will put in place to back-up copies of your data and where they will be stored.

- I intend to backup my data using a service provided by UCT (UCT GoogleDrive, UCT OneDrive, Netstorage, ZivaHub etc.). I will perform weekly backups to my UCT One drive account and my Google Drive account during the period of data collection. My final draft will also be backed up before final submission. The data will also be stored on a removable hard drive that is password-protected and stored in a secure location within the Division of Forensic Medicine and Toxicology. I intend to backup my work in different storage/backup mediums to ensure the security and retrievability of the data. The data will primarily be stored on my personal laptop. The backup data will be stored on a password protected extenal hard drive (USB), and the UCT cloud (UCT google drive and/OneDrive). This data will be regularly backed up at the end of every week and will only be accessed by limited number of people. Data sharing with supervisors will be through OneDrive or Google drive.

5. Data Centre(s)/Repositories

DATA CENTRES/REPOSITORIES - Once your project, dissertation or thesis is complete, it is advisable to curate and archive your completed dataset with an established data centre or repository. Note that you should archive your data even if you are not intending to publish it. Check with your supervisor or funder if you are required to deposit your data in a specific repository or declare that you will deposit the data in ZivaHub (see the Guidance section).

- At the end of my study, I will deposit my data on a subject or disciplinary repository (details below).

AT the end of my research project, all the raw data will be returned to the main supervisor in accordance with the UCT data management policy.

METADATA - Metadata is descriptive information that others will need to make sense of your dataset. Metadata includes things like study descriptions or abstracts, study instruments (sample collection schedules, codebooks for variables, survey instruments, etc.), subject codes, and keywords. Indicate what metadata will accompany your curated dataset.

The completed dataset will be accompanied by keywords: Human identification, unidentified remains, and fingerprint analysis.

6. Budget

BUDGET - Indicate any costs specifically relating to the management and curation of your data, such as purchasing additional storage space, digitisation of physical media, data storage or curation charges, and data audits. Most student research will be able to make use of free options provided by UCT and will not have to budget for data costs.

- I do not anticipate any data costs as my data is less than 10GB, and I will be using a storage system provided by UCT (UCT GoogleDrive, UCT OneDrive, Netstorage, ZivaHub, etc.) to curate my data I do not anticipate any costs as my data is less than 1GB, and I will be using a storage system provided by (UCTGoogleDrive, UCT OneDrive, etc.) to manage my data.

APPENDIX D: ETHICAL APPROVAL LETTER

UNIVERSITY OF CAPE TOWN
Faculty of Health Sciences
Human Research Ethics Committee

Room 45 E-52-E-Floor- Old Main Building
Groote Schuur Hospital
Observatory 7925
Telephone [021] 406 6492
Email: hrec-enquiries@uct.ac.za
Website: https://health.uct.ac.za/home/human-research-ethics

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27 February 2024

HREC REF: 131/2024

A/Prof L Heathfield
Division of Forensic Medicine and Toxicology
Department of Pathology
Email: Laura.heathfield@uct.ac.za
Student: Kydrac001@myuct.ac.za

Dear A/Prof Heathfield

PROJECT TITLE : UTILISATION OF FINGERPRINT ANALYSIS FOR HUMAN IDENTIFICATION AT SRM/OFPI-SUB-STUDY LINKED TO 136/2021-
(MPHIL CANDIDATE-MRS RACHAEL EROMOSELE)

Thank you for submitting your study to the Faculty of Health Sciences Human Research Ethics Committee (HREC) for review.

It is a pleasure to inform you that the HREC has **formally approved** the above-mentioned study.

Approval is granted for one year until the 28 February 2025.

You are required to submit a progress report form, using the standardised Annual Report Form (FHS016) or (FHS017) if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.
(Forms can be found on our website: www.health.uct.ac.za/fhs/research/humanethics/forms)

The HREC acknowledge that the student: Mrs Rachael Eromosele will also be involved in this study.

Please quote HREC REF 131/2024 in all your correspondence.

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Please note that for all studies anoroved by the HREC, the principal investigator **must** obtain appropriate institutional approval, where ɑɛUe sɜtɩry. before the research may occur.

Yours sincerely

PROFESSOR M BLOCKMANS TICCNMLC
CHAIRPERSON, FACUEC RAL MNGN SCIENCES HUMAN RESEARCH ETHICS COMMITTEE

Federal Wide Assurance Number: FWA00001637. Institutional Review Board (IRB) number: IRB00001938 NHREC-registration number: REC-210208-007

HREC REF 131/2024

APPENDIX E: SRM/OFPI APPROVAL LETTER

Western Cape Government
FOR YOU
Health

DIRECTORATE: Forensic Pathology Service
ENQUIRIES: Professor LJ Martin MB BCh *Wits* Dip For Med *SA* M Med Path (Foren) *UCT* F C For Path *SA*
Email: lornaj.martin@uct.ac.za

To whom it may concern,

I, Lorna J. Martin, **do** / ~~**do not**~~ hereby grant final permission for the following researchers to have access as specified for the research project as stipulated:

Principal Investigator: A/Prof Laura Heathfield
Staff number: 01426764

Researcher: Kate Reid
Student number: RDXKAT001

Researcher: Rachael Eromosele
Student number: KYDRAC001

Project Title: Utilisation of fingerprint analysis for human identification at SRM/OFPI.

Access to:

✓	*Please tick all that apply*
	The autopsy allocations
✓	The Office Autopsy Database and related records
	Forensic Pathology Services Laboratory, Observatory Forensic Pathology Institute for observation and collection of data
	Forensic Pathology Services Laboratory, Observatory Forensic Pathology Institute for the collection of tissue samples
	Forensic Pathology Services Laboratory, Observatory Forensic Pathology Institute for conducting Interviews
	Forensic Pathology Services Laboratory, Observatory Forensic Pathology Institute for obtaining informed consent

For the data collection period of 01/04/2024 to 31/12/2024.

~~Approved~~ Not required

Prorco (signature)
Head of Division
Division of Forensic Medicine and Toxicology

17/04/2024
Date *(dd/mm/yyyy)*

Ms V Thompson *(signature)*
Director
Forensic Pathology Service: WCGHW

Date *(dd/mm/yyyy)*

Division of Forensic Medicine & Toxicology
Faculty of Health Sciences, UCT
Anzio Road, Observatory, 7925
P O Box 13914, Mowbray, 7705
Tel: +27 21 406 6412
Fax: +27 21 448 1249
www.forensicmedicine.uct.ac.za

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