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Research Article

Why Down-managing Backlog Forensic DNA Case Entries Matters

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Abstract

Forensic laboratories face a backlog of case files, affecting service delivery, causing delays. The backlog points to underfunding, poor planning, and inadequate support, hindering deoxyribonucleic acid (DNA) analysis. Resolving casework backlogs may initially seem like a straightforward and attainable measure to improve the arrest of offenders and promote justice. Longer turnaround times impede investigative leads, emphasising the need for efficient strategies and a comprehensive approach to address and prevent backlogs in forensic laboratories. No study has been published on the forensic DNA backlogs in South Africa. The article explicitly addresses one aspect of a Doctor of Philosophy study and aims to ascertain the impact of backlogs in forensic DNA case entries. The study article's research questions included the following: "What cases are considered as backlog?"; "What is the current backlog in forensic DNA case entries in South Africa?" and "What are the main reasons for the backlog of cases involving forensic DNA?" The prompt processing of DNA evidence is vital not only for safeguarding individuals falsely accused of crimes based on circumstantial evidence but also for aiding prosecutors and providing justice for crime victims.

More Information

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Introduction

DNA backlogs have been identified as negatively impacting forensic laboratories' reputation and their service delivery responsibility to their customers [1-5]. Backlogs are unprocessed and non-finalised DNA case entries, files, or exhibit material that have yet to be processed or reported within a specific period, such as a year, week, or month.

Processing and testing evidence from crime scenes or post-coital samples (rape samples) is part of forensic casework. When a crime occurs, crime scene examiners gather evidence at the incident scene or from locations related to the crime, like the victim's residence or from the suspect's clothes or items suspected to have been used by the suspect. Medical professionals take post-coital (rape) samples from victims of sexual assault [6]. After evidence is gathered in the field, it is sent to a forensic laboratory, where forensic analysts determine whether it contains testable DNA. The forensic analyst must assess whether the sample has enough integrity to produce reliable test results if DNA is detected. Testing might be complex when a sample is contaminated or deteriorates. Multiple person samples in the evidence present another difficulty (DNA mixture samples).

Nevertheless, the process of conducting DNA analysis is the initial step. Jurisdictions that solely prioritise testing to fulfil public or legislative obligations fail to recognise the significant benefits of uploading profiles into DNA databases [7]. A positive DNA match can connect a person to a crime scene or the victim, making DNA exhibit material a valuable tool in forensic casework. When die DNA of a person does not match the DNA found at a crime scene, such as in a rape case, it can also serve to rule out suspects in specific circumstances. Many countries require the collection of DNA buccal samples from various persons, including those who have been convicted and those who have been arrested but have not yet been prosecuted. These persons' forensic DNA profiles are uploaded to the forensic DNA database [8,9]. The forensic DNA database is meant to help law enforcement identify possible suspects when more conventional investigative techniques, like eyewitness accounts, are unavailable. The outcome of comparison searches on the forensic DNA database is DNA forensic investigative leads. After Law enforcement receives a forensic investigative lead, they can interrogate the person of interest about the crime and seek clarification as to why or obtain an explanation from the person as to why their DNA matches the forensic DNA profile derived from the crime scene exhibit material.

A growing backlog of DNA buccal samples awaiting processing has resulted from changes to legislation demanding the taking of DNA buccal samples from diverse categories and increasing crimes [5,10]. While forensic laboratories are capable of managing sizeable volumes of buccal samples, many laboratories still require assistance in handling the overall volume of samples received for DNA analysis. Additionally, the DNA backlog affects timely comparison searching on the forensic DNA databases and reporting of forensic investigative leads. As a result, several repeat offenders can persist in their criminal activities and harm innocent victims.

Governments are under pressure to prioritise cost- and resource-cutting measures due to the current state of the world economy. Due to this, forensic service providers are under pressure to improve and broaden their offerings while also cutting expenses and turnaround times. Delivering top-notch forensic services within budgetary constraints is essential. As such, this difficulty has impacted forensic laboratories across the globe. Forensic backlogs continue to exist because they are dynamic and subject to supply and demand [3,5,7,9-11]. The study in this article aims to ascertain the impact of backlogs of forensic DNA case entries. The study's research questions included:

- What is considered a backlog?
- How does the DNA backlog impact the criminal justice system?
- What is the current backlog in forensic DNA case entries in South Africa and other countries?
- What are the main reasons behind the backlog of forensic DNA cases?
- What strategies can be deployed to cut backlogs in forensic DNA case entries efficiently?

Method

This article is based on one aspect of a Doctor of Philosophy study and explores the backlog issue in forensic laboratories within the South African Police Service (SAPS) [5]. Using a qualitative approach, it employed a case-study design and conducted interviews with SAPS detectives, forensic examiners, and international experts. The study focused on the Gauteng Province due to its high crime rates and significant forensic investigative leads that required processing. Non-probability sampling was used, selecting detectives (n = 30), forensic examiners (n = 4), and international forensic experts (n = 4). The research design allowed the researcher to offer recommendations based on in-depth interviews and participant experiences to address the backlog problem in forensic DNA examinations.

Literature study

The backlog of exhibit material (including Sexual Assault Evidence Collection Kits {SAECK}) and buccal samples involves two primary concerns. The initial problem emerges when exhibit material and buccal samples are collected, and they can either be sent for DNA testing or retained in police exhibit storage. This results in a backlog of untested or un-submitted exhibit material (including SAECK) and buccal sample kits. The second problem arises when the evidence collected during a rape investigation, such as SAECK and buccal samples, is not swiftly processed for DNA testing. This leads to a secondary backlog of rape kits that have not been analysed at the forensic laboratory [12,13].

Defining backlogs

Differing views exist on the definition of a forensic DNA case entry backlog. A forensic laboratory may classify a sample as backlogged if it has not been processed within a predetermined period; for example, the case entry is not finalised within ninety days, although other laboratories may wait longer [14]. The National Institute of Justice classifies a DNA exhibit as backlogged one that has not been tested within 30 days after submission [15]. This definition is now the accepted standard for NIJ-funded crime laboratories. Other laboratories define backlogs in their annual operational plan based on case entries exceeding the target finalisation date for each entry category (e.g., priority, routine, non-routine/complex, intelligence cases). Additionally, the South African Police Service ring-fenced and defined case entries older than 1 June 2021 as historical backlog [16]. Other organisations prefer to limit backlogs to cases that meet court dates. This discrepancy in defining backlogs highlights variations in defining and measuring DNA backlogs across different entities [7,14-19].

Demand for forensic DNA analysis

The increasing demand for forensic DNA testing, fuelled by collecting DNA evidence from crime scenes and a broader range of persons, poses challenges for forensic laboratories [5,10,17,18]. The complexity of forensic DNA analysis procedures involves various agencies and role players, including detectives, forensic field workers, analysts, prosecutors, and magistrates. The timely processing of forensic DNA evidence is crucial for justice-seeking prosecutors, crime victims, and innocent individuals facing false accusations. However, escalating backlogs in forensic laboratories limit the efficacy of DNA analysis, with longer wait times diminishing its potential for providing investigative leads and restricting its applications to courtroom support [1,5,20,21].

While DNA technology has proven invaluable, there is a risk of overreliance [20]. The necessity to test all gathered evidence may be unsustainable, and not all samples may have probative value. A balanced approach, considering both police and scientists' knowledge, is essential. A caution has been raised against compromising the overall integrity of the process by rushing analysis to meet court deadlines, which may adversely affect the quality of work [20].

Contributing factors to DNA backlogs

Forensic science faces challenges in integrating into the broader policing framework, requiring improvements in service performance while navigating financial constraints [22,23]. Factors contributing to backlogs include environmental conditions, resource shortages, and budget constraints, encompassing issues such as managing human capital, water and electricity supply, procurement processes, forensic consumables, analyst competency, unfunded legislative mandates, and process changes [5,7]. These shortcomings underscore the challenges victims face and the negative impact on the criminal justice system [3-5,17,24].

Impact of DNA backlogs

The Public Service Commission in South Africa highlights the adverse effects of backlogs on laboratory efficiency, resulting in delays within the criminal justice system and a lack of justice, particularly for vulnerable populations [3]. The accumulation of unprocessed rape kits is that, in many cases, victims are being deprived of their right to receive legal redress [13]. Delays impact scheduled trials, create trauma for families awaiting forensic DNA results, disrupt ongoing legal processes, impede criminal apprehension, and prolong the detention of innocent individuals. The burden extends to families waiting to identify the human remains, and contributors resorting to private laboratories due to public forensic laboratories' delays may incur higher costs. Each day without a lead in the investigation enables a recidivist to inflict harm on further victims [9].

Performing forensic DNA analysis immediately upon case submission may provide investigators with prompt forensic DNA investigative leads, thereby minimising a perpetrator's duration in further criminal activities. Postponing the analysis enables the attacker to evade capture and persist in victimising further individuals. Prompt processing of forensic DNA evidence is essential for justice, public safety, and the efficient functioning of the criminal justice system [5].

Triage of forensic DNA analysis

Triage offers a strategic approach to enhancing forensic laboratory efficiency. Lowering workload, optimising sample influx analysis and reduction, and implementing cost-effective pricing strategies contribute to better functioning [25]. Prioritising tests based on underlying requests aligns with crime scene investigators' identification of forensic evidence without necessarily requiring the development of a case theory. Adopting tiered evaluation approaches and pre-screening evidentiary items can reduce case backlogs, minimise duplicate testing, and set sample and case priorities for efficiency [10,22].

Selective testing procedures were driven by limited funding, heavy workloads, and turnaround time requirements, resulting in a prioritised selection of exhibit material by forensic laboratories using triage methods. In sexual offence casework, triage algorithms typically test one or two, sometimes three, samples from SAECKs. In a study, researchers demonstrated a 47.2% increase in the yield of DNA profiles for the forensic DNA database by gathering samples from the three most probative areas from exhibit material [26]. While evaluating every sample may boost the forensic DNA database's yield, testing only the most critical samples presents a more efficient benefit-to-cost ratio.

Addressing backlogs

Funding for crime laboratories is essential to address backlogs. Providing funds for high-throughput instruments, automated robotic systems, laboratory information management systems, validation of efficient procedures, and additional personnel can expedite case processing and analysis. Outsourcing may be an option, though its practice and permissibility vary among countries based on legislation [13]. Forensic laboratories must adopt better strategic thinking and planning to respond more effectively to backlogs [7].

Results

The DNA backlog of the Forensic Science Laboratory (FSL) in South Africa during the last five years is depicted in Table 1.

The Public Service Commission of South Africa reports that the historical (ring-fenced) DNA backlog of the FSL has been eradicated [3].

The following are examples of responses provided by participants in the study [5]:

The forensic backlog is not assisting our investigations. We cannot close our dockets whilst awaiting forensic results (Detective Participant No.3, Sample A).

The time spent waiting for these forensic reports lengthens, and it becomes more challenging to track down complainants for additional statements (Detective Participant No. 29, Sample A).

Many of the posts are vacant and need to be filled. The ongoing load shedding and water interruptions at our laboratory facilities are problematic, and our production is subsequently low. This contributes to the backlogs and long turnaround time of finalising our forensic casework (Forensic examiner participant No.1, Sample B).

The problems involved in finalising forensic reports are numerous and complicated. Continuous power outages make it difficult for forensic tools to operate appropriately during analysis. A lack of service experts to import spare parts and the

Table 1: DNA Backlog of the FSL.

Financial Year	2018/19	2019/20	2020/21	2021/22	2022/23
Case entries	1 821	49 674	194 067	154 204	55 681

Source: [5,28,29].

absence of approved contracts or purchase orders exacerbate the problem. Additionally, the need for more essential reagents worsens the backlog problem. When there are water disruptions, total output is affected since forensic examiners have limited work hours to guarantee hygiene and occupational well-being (Forensic Examiner Participant No. 2, Sample B).

Investigative lead backlogs and forensic test result delays are caused by significant resource issues, such as a need for qualified and experienced forensic examiners (Forensic Examiner Participant No. 3, Sample B).

Several difficulties are to blame for the lengthy turnaround times for FILS and forensic test findings. Essential forensic instruments cannot function continuously due to frequent power outages and unstable water supplies. The forensic examiners' constrained working hours influence productivity regarding hygiene and workplace safety. Problems with service agreements, technician accessibility, and spare parts availability further complicate instrument maintenance. The need for essential reagents makes finalising results worse (Forensic Examiner Participant No. 4, Sample B).

Backlogged cases, defined by the National Institute of Justice as untested for 30 days, need a precise forensic backlog definition. Dynamic and challenging to quantify, backlogs persist in forensic labs, driven by faster case submissions than report completions. While NIJ funding aims to address this, backlogs persist until forensic capacity aligns with analysis demand. Labs face internal and external hurdles—unfunded mandates, resource shortages, training times, increased submissions from regulatory changes, and technological advancements impacting screening processes. For example, Y-screening accelerates initial procedures, but in more cases, DNA analysis progresses due to improved male DNA identification. Improved communication between labs and clients, such as detectives, is crucial to prioritise and remove cases from analysis when forensic findings are no longer needed (International Forensic Expert Participant No. 4, Sample C).

Discussion

The DNA backlog at the FSL exhibited a significant increase from 1,821 case entries at the end of the 2018/2019 financial year to a peak of 194,067 case entries at the end of the 2019/2020 financial year [3,5]. However, the case entries demonstrated a notable downward trend to 55,681 at the end of the 2022/2023 financial year. While the SAPS FSL has successfully cleared the historical backlog, which refers to case entries before June 2021, many case entries still surpass the intended completion time frame [3,5,27,28]. The detective participants' comments unambiguously demonstrate that DNA backlogs adversely impact their investigations, resulting in delays in administering justice to victims [5]. The forensic laboratory backlogs can be attributed to many variables, such as insufficient budget and resources (both in terms of personnel and specialised forensic equipment), frequent disruptions in the provision of electricity and water, scarcity of essential chemicals and consumables, delay in servicing their instruments and problems with information technology systems [3,5]. Management efforts aligned with ISO 17025 requirements and recent appointments positively impact backlog reduction [3]. Short-term strategies have been implemented, such as additional overtime funding and resolving contract issues [3].

Evidence gathered from people who have reported sexual assault incidents is known as a SAEC. These SAECK come with biological samples that were obtained during a forensic medical examination that the victim selected when reporting the assault and which may contain the perpetrator's DNA. SAECKs are kept in police evidence storage after they are collected. In contrast to other types of backlogs in forensic casework, the untested SAECK backlog is often caused by police agencies' decisions not to send many SAECKs for testing, in addition to the large number of SAECKs and the restricted capacity of the forensic laboratory. This results in SAECKs staying untested in police storage due to concerns about the strength of the evidence for prosecution or early case closure through plea deals. Furthermore, there has been an increase in the number of buccal samples collected from persons, encompassing a broader range of crimes for which these samples are required to load their forensic DNA profiles to the forensic DNA database. The amount of forensic casework has increased due to the implementation of amended legislation and regulations in certain jurisdictions [3,5].

There is yet to be a widely recognised international forensic industry standard for precisely describing a backlogged case. A case is considered backlogged if it has not been processed immediately, within the specific target, defined calendar days, or more [7,14-19]. The distinction is noteworthy: according to one definition, a case is considered backlogged as soon as it is submitted to the laboratory, whereas according to the other definition, the laboratory has a specified target-day period to analyse the case before it is categorised as backlogged. The latter definition suggests that the laboratory has a specific time frame of a certain number of calendar days to complete the case and prevent an increase in backlog [7].

The processing of DNA exhibit material collected from crime scenes is laborious because initial screening is required to detect the presence of biological material and identify its type before DNA testing can commence [10]. Furthermore, specific samples may be degraded, fragmented, or contain DNA from multiple suspects and victims, adding to the complexity of analysis. In many countries, the rate of new cases submitted has increased more rapidly than the capacity to process new and existing workloads, resulting in a backlog [3,5,19]. Crime laboratories have substantially increased their case-processing capacity [3,5,19]. However, the laboratories still need help clearing their backlogs due to ongoing demand outpacing capacity expansions.

Increased demand

The increasing demand for forensic DNA testing and consistent laboratory capacities creates bottlenecks [29]. Factors contributing to this demand include the rise in DNA evidence gathered from crime scenes and the broader collection of DNA samples from arrestees and convicted offenders. The complexity of forensic DNA procedures involves multiple stakeholders, necessitating efficient processing for justice-seeking prosecutors, crime victims, and innocent individuals facing false accusations [24]. Backlogs deprive victims of justice, hinder closure, and impact individual and societal levels [14]. Forensic laboratories miss the benefits of entering DNA profiles into databases when focused solely on legal or public requirements. DNA evidence from one crime scene can also shed light on another seemingly unrelated crime.

Another crucial aspect to consider is the significant number of death penalty cases in countries such as the United States, where convictions have been overturned due to DNA evidence. Backlogs result from inadequate resource allocations, encompassing human capital management, supply chain issues, forensic consumables, analyst competency, legislative mandates, and process changes [30]. Poor risk management, inconclusive cases, suboptimal technical approaches, and inadequately conducted validation studies contribute to extended turnaround times and dissatisfaction among internal and external clients.

Non-technical issues, such as administrative challenges, paperwork, and procurement processes, can lead to prolonged turnaround times, affecting optimal budget management and depleting resources [3,5,6]. Laboratories should consider alternative measures to manage high demand, such as screening DNA exhibits, triaging, and prioritising samples. Clear communication with court officials, including awareness of triage methodologies and the availability of untested samples, is crucial to prevent delays. Harnessing the advantages of the fourth industrial revolution through new technologies and semi-automation can optimise exhibit material processing and reporting. Effective laboratory information management systems, risk management, identification of critical metrics, and continual improvement based on ISO17025 contribute to streamlined processes [5,31,32]. Proactive risk management is essential to address issues before they escalate [5,31,32]. Attention to experimental design in validation studies, determination of uncertainties, and threshold values for decision-making are critical. Technical managers are pivotal in ensuring scientifically valid methods and implementing decision trees based on quantification values [5,32].

Benefit for society with each profile acquired

Backlogs present a significant criminal justice issue affecting individuals and society [1,2,3,5,13,32]. Uploading forensic DNA profiles to a forensic database leads to a positive outcome. Studies demonstrate that uploading a DNA profile is considerably more economical than deploying supplementary law enforcement procedures, leading to a financial benefit for society with each profile acquired [20]. Uploading forensic DNA profiles to a forensic database produces a positive outcome in terms of both societal and judicial system benefits [5,20,33]. In a cost-benefit analysis based on Detroit data, researchers concluded that it is advisable to test all SAECKs in the DNA backlog [6].

In a cost-benefit analysis based on Detroit data, researchers concluded that it is advisable to test all SAECKs in the DNA backlog [6]. This prioritisation should also extend to SAECKs that fall within the legal time limit for prosecution and those lacking an identified suspect, even though these specific cases were not explicitly investigated. The study conducted by researchers showed that performing DNA testing on both stranger and non-stranger sexual assault kits (SAKs) can produce DNA matches in the forensic DNA database, resulting in forensic DNA investigative leads [10].

Customer-centric approach

Forensic laboratories must adopt quality management systems based on ISO standards, prioritise a customer-centric approach, and possess the ability to understand and anticipate their customers' present and future requirements, including investigating officers and court officials [5,32]. They should strive to meet their requests and exceed their expectations. The management of forensic laboratories must identify and distribute the necessary resources to build and maintain the Quality Management System (QMS), consistently improve its efficiency, and guarantee customer satisfaction by meeting their demands [5,32]. Moreover, the management should be transparent and report challenges, forensic DNA backlogs, and cases exceeding target dates regularly. It is essential to ensure that backlogs are continually down-managed and that turn-around time is improved to report forensic DNA findings to the investigating officer and the courts.

System-focused strategies

The central question revolves around ascertaining the ideal quantity of cases that a forensic laboratory, equipped with a specified workforce and verified procedures, can efficiently manage. Knowing a forensic laboratory's capacity enables more accurate evaluation and control of output discrepancies. With this fundamental starting point, organisations can avoid depending on experimentation and guesswork to enhance quality and productivity. This method has yet to be successful [34]. It is asserted that a backlog is more than just a fundamental inefficiency resembling a warehouse filled with boxes [7]. Instead, it results from past deficiencies in resource allocations (such as technology, training, and unfulfilled legislative obligations) and process modifications [7,35,36]. In forensic laboratories, this prolonged condition results in a backlog, indicating that backlogs are enduring [7]. Novel

approaches are required to gauge input, process, output, and feedback methodically to diminish backlogs instead of relying on automatic procedures efficiently.

The utilisation of expeditious, accurate, and highly responsive presumptive screening tests by crime scene examiners enables the identification of exhibit material that necessitates submission to the forensic laboratory for DNA analysis. Effective screening of exhibit material and eliminating unnecessary submission to the forensic laboratory should improve efficiency in achieving higher success rates and turnaround times in forensic laboratories [37]. Moreover, forensic laboratory managers should use process mapping and bioanalytical techniques to assess output metrics at each stage of the DNA process to detect bottlenecks. By employing critical thinking and collaborative efforts, solutions can be adopted to reduce DNA turnaround time, optimise chemistry and forensic instruments, increase the number of samples analysed per analyst, and minimise costs.

Backlogs include unresolved cases, the laboratory's ability to manage its workload (production function), and the rate at which cases are submitted. Unfortunately, due to time restrictions, these laboratories frequently precede casework analysis over tasks like assessment, investigation, verification, and integration of novel technologies [9]. Shifting from event-focused to system-focused strategies is crucial for significant organisational progress. Event-level strategies tackle individual incidents like financial deficits, while systems-level approaches consider broader patterns, structures, and mental frameworks for enduring transformation. Implementing systemic strategies involves practical methods to enhance processes beyond immediate responses, addressing root causes, and challenging existing beliefs for strategic improvement and long-term success in organisational transformation [7]. Monitoring laboratory metrics demonstrates the efficacy of the strategy implemented to decrease the DNA backlog [10]. A forensic laboratory can reduce the backlog of cases awaiting analysis by streamlining its internal procedures.

Despite backlog challenges in many forensic laboratories, specific laboratories have demonstrated the capacity to effectively reduce case entry turnaround time to less than 90 days. Moreover, these laboratories have effectively achieved prompt turnaround times for various exhibit types of analysis [5,9,10,38-45]:

- DNA analysis of buccal samples within less than 14 days.
- Single-source volume crime exhibits material within less than 30 days.
- DNA mixture case entries within less than 60 days.

Conclusion

Although there are no widely accepted criteria for forensic DNA backlogs, it is crucial to emphasise that this metric needs to be clearly and regularly conveyed to the public. It is a basis for measuring the forensic laboratories' capability to consistently process the exhibit material and buccal samples. Persistent backlogs in forensic laboratories will endure until the forensic laboratory's capacity surpasses the demand for new service requests. Economic challenges arise from the overwhelming rate of new analysis requests compared to processing speeds, highlighting budget limitations, facility size, equipment inadequacies, low personnel levels, and procurement challenges. Laboratories prioritise older case entries in backlogs, necessitating efficient resource planning to minimise or prevent escalation. Time series graphs effectively illustrate backlog fluctuations. The consequences of DNA delays and backlogs extend to victims, legal processes, and the justice system, demanding urgent attention and comprehensive strategies for a sustained, efficient, and just forensic DNA process.

Dependence on grant funding or extra working hours (overtime funding) cannot substitute for having an adequately staffed and optimally equipped organisation. The presence of persistent inefficiencies can result in a situation that is difficult to alter, driven by both internal processes and external influences, such as an increase in case submissions. Forensic laboratories should embrace innovative ideas instead of depending on conventional approaches or short-term fixes. An organised and systematic approach is necessary to identify and resolve systemic issues. This approach involves clearly describing the current situation, developing an improvement plan, and promoting effective communication among different areas of expertise. By implementing this approach, backlogs can be effectively addressed, and service delivery can be improved with a focus on customer satisfaction.

Addressing the DNA backlog requires a multi-faceted approach involving management efforts, short-term strategies, proactive risk management, technological advancements, effective communication, and continual improvement based on established standards. The complexities involved in forensic DNA procedures necessitate collaborative efforts among stakeholders to enhance efficiency and meet the growing demand for forensic examinations. Prompt processing of DNA evidence is essential for those falsely accused of crimes based on circumstantial evidence, prosecutors, and crime victims seeking justice. Under ideal circumstances with a fully resourced forensic laboratory and no external uncontrolled influences, it is not unreasonable to expect that buccal sample analysis can be completed within 14 calendar days, single source DNA exhibit case entries within 30 calendar days, and DNA mixtures exhibit material case entries within 60 days.

Ethical clearance, approval and participant consent

Ethical clearance and approval were obtained from the University of South Africa for the Doctor in Philosophy Study

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