Diagnostic Radiographers' knowledge about the management of Non-accidental Injury

by

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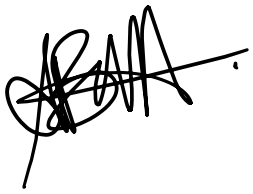
DECLARATION:

I, Aneeqa Basardien, declare that the contents of this dissertation are my own work, and have not been previously submitted for examination towards another academic qualification. It is furthermore a representation of my own work and does not necessarily reflect the views of the Cape Peninsula University of Technology.



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ABSTRACT

Introduction

The World Health Organisation (WHO) describes non-accidental injury (NAI) as a form of child abuse where an injury is inflicted in a minor due to intentional physical force that would likely result in developmental impairment or the possibility of death to the victim. Child abuse includes sub-categories such as assault or physical abuse, sexual abuse, bullying, exploitative labour practice and or exposure to any activity that may cause psychological or physical harm. Furthermore, child abuse may result in impairment in the victims' cognitive, physical, and emotional ability or growth. Diagnosing NAI victims requires a thorough patient history and a clinical examination which is often supported by radiological investigations. Signs and symptoms of child abuse are often similar to other injuries or diseases. Diagnostic imaging is often used to establish a diagnosis based on injuries characteristic of physical child abuse. Furthermore, diagnostic imaging is essential for accurately diagnosing a victim of suspected NAI. Therefore, the role of a radiographer in this process is deemed crucial as the diagnosis of NAI is enhanced by the application of standard radiological protocols and the quality of images produced. There is limited published research focusing on diagnostic radiographers' understanding of the management of NAI in children.

Methods

This study incorporated a descriptive cross-sectional study design, by means of an electronic survey conducted amongst diagnostic radiographers at three tertiary academic hospitals. The data was collected with the use of a questionnaire, created using Microsoft® Forms. Participants voluntarily took part, and anonymity was ensured by not recording any personal identifying information. Data analysis was conducted using Microsoft® Excel and GraphPad Prism (v10.2.1) respectively. Statistical measures of central tendency (e.g. mean, median, mode) and dispersion (range, standard deviation, interquartile range) were calculated based on the type and distribution of the data (parametric or non-parametric). Results were analysed based on job ranks and qualifications obtained to draw comparisons amongst the three samples.

Results

A total of 72/149 diagnostic radiographers participated in the study, which yielded a response rate of 48% of the total number of participants invited. Overall, 96% of participants (n=69/72)

identified the meaning of the NAI abbreviation, while 97.2% (n=70/72) selected physical abuse and neglect as the description for NAI. Radiographers' knowledge regarding signs and symptoms of NAI was variable, with only 37.5% (n=27/72) of participants scoring in the highest category. Chief radiographers (61.5%) (n=16/26) outperformed the other job ranks in this domain. Despite this, image-based NAI diagnoses scores showed no significant differences across education levels or job ranks, with most of the participants (over 55%) (n=40/72) scoring in the middle range. Regarding the awareness of radiographic imaging protocols, 71% (n=51/72) of respondents reported familiarity with the recommended protocols for suspected NAI and 60% (n=43/72) confirmed having knowledge of the hospital reporting procedures. Familiarity of NAI radiographic protocol was highest among chief radiographers (73%) (n=19/26). Radiographers based at Hospital two demonstrated better overall knowledge with a mean score of 57.3% (n=5.73/10) compared to Hospital one (42.9%) (n=11.58/27). Radiographers at Hospital three showed greater variability in scores with a mean of 49.7% (n=17.39/35).

Discussion

The study showed that the majority of respondents 71% (n=51/72) were familiar with NAI radiographic imaging protocols. While most respondents were familiar with the identification of suspected NAI, gaps remained in the recognition of signs and symptoms, which could potentially affect the early recognition of NAI victims. The notable gaps in radiographers' practical and theoretical knowledge of NAI, particularly concerning reporting imaging protocols and imaging criteria. This variation in overall response rates underscores the need for ongoing education and training across all job ranks at the research sites to ensure that all radiographers are equally equipped to handle NAI cases. There is a need within the profession to enhance the capabilities of radiographers in identifying and managing NAI cases effectively. The overall findings highlight the baseline awareness amongst respondents as well as critical gaps which requires structured education and training in order to enhance radiographers' role in the identification and imaging of suspected NAI.

Conclusion

The findings showed that the majority of radiographers exhibited foundational knowledge of NAI and showed substantial differences in the depth and consistency with regard to radiological signs of NAI and hospital reporting procedures. The observed disparity across the job ranks and hospitals suggests a variability in training and protocol implementation. These findings

underscore a critical need for structured, continuous professional development and standardisation of radiographic imaging as well as reporting protocols to ensure that radiographers are adequately prepared to contribute to the multi-disciplinary management of suspected NAI cases.

Addressing these knowledge gaps will enhance the overall effectiveness of the healthcare system's response to NAI and contribute to the safety and well-being of at-risk children. The findings of this study provide a reliable snapshot of the current knowledge and practices of radiographers regarding NAI at the three tertiary hospitals sampled.

Key Words

Non-accidental injury, radiographers' knowledge, diagnostic imaging, child abuse, imaging protocols.

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DEDICATION:

- I dedicate this dissertation to my siblings and parents. Thank you for all your endless support and encouragement.
- To my four siblings: Uthmaan, Zainab, Taulha and Raabiah; anything that you set your sights on is within your grasp, all you need is hard work, encouragement and love. You can achieve anything and everything that you strive for.
- This is what you have all given to me.

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LIST OF ABBREVIATIONS

AAP	American Academy of Pediatrics
ACR	American College of Radiology
ACR-SPR	American College of Radiology-Society of Pediatric Radiology
AD	Assistant-Director
AHI	Abusive head injury
AHT	Abusive head trauma
ALARA	As low as reasonably achievable
BSc	Bachelor of Science
BTech	Baccalaureus Technologiae (Bachelor of Technology)
CAS	Child abuse syndrome
COVID-19	Coronavirus Disease of 2019
C-Spine	Cervical spine
CT	Computed Tomography
HIV/AIDS	Human Immunodeficiency Virus/ Acquired Immunodeficiency Syndrome
HPCSA	Health Professions Council of South Africa
MBS	Mongolian Blue Spots
MRI	Magnetic Resonance Imaging
MS	Mongolian Spots
NAI	Non-accidental injury
ND	National Diploma
OI	Osteogenesis Imperfecta
POPIA	Protection of Personal Information Act
Q	Question/s

RCPCH	Royal College of Paediatrics and Child Health
RCR	Royal College of Radiologists
REC	Research Ethics Committee
SA	South Africa
SAPS	South African Police Services
SBS	Shaken Baby Syndrome
SCoR	Society and College of Radiographers
SD	Standard deviation
SIDS	Sudden Infant Death Syndrome
SOP	Standard Operating Procedure
UK	United Kingdom
USA	United States of America
WHO	World Health Organisation
WMA	World Medical Association

CHAPTER ONE

INTRODUCTION

1.1. Chapter Introduction

Child abuse remains a major social and medical issue globally, including in South Africa (SA) (Fouché & Le Roux, 2018:22). Child abuse-related injuries remain one of the leading causes of childhood morbidity and mortality in the developing world (Peters et al., 2020:1218). Research demonstrates that perpetrators of child abuse can emerge from any level of care and social standing as abuse may be inflicted on a child by any adult perpetrator who occupy positions of guardianship or authority over the child (Peters et al., 2020:1218).

Reports of violence against children within SA have followed an upward trajectory, a trend also observed globally (Mgele, 2010:290). Non-accidental injury (NAI)[1] manifests in a variety of ways and accounts for over 50 000 deaths annually in children globally (Mgele, 2010:290). Usually, the most severe cases of NAI occur in children under the age of three. Violence against children comprises various forms of physical and emotional abuse, which includes negligence, neglect and sexual abuse (Van As, 2016:1075; World Health Organisation {WHO}, 2022).

Considering that the majority of children subjected to child abuse, will require professional and medical assistance, it is incumbent on all categories of health professionals to report child abuse. Therefore, all health professionals should be able to recognise, accurately document and report all findings related to child abuse (Van As, 2016:1075).

The reporting of child abuse has been overlooked and is under reported in SA as well as internationally (Hendricks, 2014:550). Many factors contribute to the lack of reporting of suspected child abuse cases, which includes a lack of knowledge on how to report such cases, previous negative experiences, a lack of general knowledge related to child abuse and the inability to identify suspected victims (Hendricks, 2014:551; Peters et al., 2020:1223). As defined in the Children's Act (No. 38) of 2005 (South Africa, 2006), it is the legal obligation of all healthcare professionals who suspect NAI to report suspected abuse to the relevant authorities. The Children's Act (No. 38) of 2005 requires the Department of Social Development to record the child's name, perpetrator's name and type(s) of abuse committed in the National Child Protection Register (South Africa, 2006; Joyner, 2016:1159).

[1] It is acknowledged that Suspected Physical Abuse is now the preferred term for NAI (RCR, 2018). However, at the time of collecting data, this term was still widely used in SA and hence the continued use of this term throughout this thesis.

Consequently, healthcare practitioners including diagnostic radiographers need to know how to deal with and identify child abuse or suspected NAI cases under their care.

1.2. Background

Globally, it is estimated that approximately 95 million children experience abuse annually, with the highest prevalence observed within the WHO African Region (Cluver et al, 2016:567). Factors such as the Human Immunodeficiency Virus/ Acquired Immunodeficiency Syndrome (HIV/AIDS), caregivers' mental health, and poverty significantly contribute to the physical, emotional, and sexual abuse of minors in SA (Cluver et al., 2016:2).

In a seminal study conducted by Hillis et al. (2016:4), comprehensive data from 96 countries were meticulously analysed to ascertain the prevalence of violence against children. The findings revealed baseline estimates indicating that at least 50% of children in Asia, Africa, and Northern America were subjected to violence in 2015. Moreover, the study illuminated a staggering global reality, demonstrating that over half of the world's children (which amounts to an astonishing one billion individuals between the ages of 2 and 17) had encountered violence (Hillis et al., 2016:2).

Within low-to-middle income countries such as SA, domestic safety protocols and guidelines are not clear, which adds to the risk factors of children within densely populated areas (Peters et al., 2020:1218). This is compounded by poor living conditions, social and financial stressors, such as unemployment and mental health issues, that may have arisen during the global Coronavirus Disease of 2019 (COVID-19) pandemic that started at the beginning of 2020 (Katz et al., 2022:2; Rengasamy et al., 2022:2).

Saayman (2001:43) describes NAI as part of a broader syndrome known as Child Abuse Syndrome (CAS). CAS encompasses a range of symptoms manifesting emotionally, physically, nutritionally, and through neglect (Brown & Henwoodt, 1997:201). An assessment conducted by Halstead (2019:309) pertaining to the revised directives issued by the Royal College of Radiologists (RCR) revealed that conventional projection radiography (previously known as plain film imaging) emerged as the preferred modality for the diagnosis of suspected instances of abuse. In view of this, diagnostic radiographers deal with child abuse victims frequently as the radiographic skeletal survey, encompassing comprehensive imaging of the entire skeleton, is widely used as the primary diagnostic modality in the clinical diagnosis of NAI (Mussmann et al., 2021:425).

After bruises, skeletal fractures, represent the second most prevalent injury type observed in children subjected to physical abuse. Fractures have been documented in up to 55% of such cases, with 18% of affected children experiencing multiple fractures (Kemp et al., 2006:723; Paddock et al., 2023:740). Brown and Henwoodt (1997:202) stated that even though 90% of child abuse perpetrators are often parents, radiographers should not automatically assume the parents or guardians accompanying the child to the X-ray department are the perpetrators. Expert opinion suggests that the demeanour of the parents or guardians should not be misconstrued as that of guilt by the radiographers. Furthermore, professionalism must always be maintained in order to protect the dignity of the child (Brown & Henwoodt, 1997:202).

The Children's Act (No 38) of 2005 (South Africa, 2006) identifies abused children as vulnerable individuals in need of care and protection, highlighting the imperative for structured intervention to ensure their safety and developmental well-being. Chapter seven of this Act states that all medical or healthcare personnel who suspects or concludes that a child is a victim of abuse in SA must report it to the relevant child protection agency, namely the Department of Social Development or the South African Police Services (SAPS) (South Africa, 2006).

Radiographers commonly occupy a leading role in identifying instances of abuse, given their direct exposure to radiographic evidence during image review, as emphasised by (Strouse 2018:446). Consequently, radiographers must possess a thorough awareness of clinical indicators, radiographic imaging patterns and institutional protocols when managing suspected cases of child abuse. This knowledge is essential for effective identification and timely response to potential instances of NAI. In the researcher's perspective, a critical aspect of child protection lies in the early recognition of the signs and symptoms of child abuse. The identification of abuse by healthcare professionals across all levels of care, underscore the need for comprehensive awareness and vigilance within the healthcare system (South Africa, 2006). It is therefore important that diagnostic radiographers are well aware of the signs and radiographic appearance that may indicate abuse (Ebrahim, 2008:5). Subsequently the reporting of suspected NAI is vital to safeguard the victims.

1.3. Research Question

Do diagnostic radiographers know the signs and symptoms of NAI and are they knowledgeable of the protocols to follow when imaging children suspected of NAI?

1.4. Research Aim

To determine the knowledge base of diagnostic radiographers with regard to the clinical signs and symptoms, the radiographic appearance and management of NAI cases.

1.5. Research Objectives

The research objectives for this study were to:

- determine diagnostic radiographers' knowledge of the clinical signs and symptoms of NAI among paediatric patients.
- determine diagnostic radiographers' ability to identify NAI victims.
- the radiographic appearance of NAI amongst paediatric populations.
- explore their knowledge of the protocol/s to follow when suspecting NAI.

1.6. Research Design and Methods

A quantitative, descriptive cross-sectional study design was employed, using a structured electronic questionnaire distributed amongst diagnostic radiographers. The sampling frame comprised diagnostic radiographers working at three tertiary academic hospitals. Prior to data collection, site permission was obtained from the Assistant-Directors (ADs) of Radiography at each hospital. A pilot study was conducted to assess the questionnaire for clarity, allowing for the identifications of errors and ambiguity before the actual data collection commenced. A detailed description of the research design and methods used for this research study is presented in Chapter 3.

1.7. Significance of research study

Management of NAI is a complicated and a difficult task and diagnostic imaging of such children is vital in deriving at a correct diagnosis (Paddock et al., 2017:196). Failure to identify NAI and instigate subsequent child protection measures may result in the child or their siblings being further subjected to abuse if the child is allowed to return to the abusive environment (Doyle & Vuong, 2019:1). The insights gained by conducting this study will indicate the current knowledge on radiographers' awareness of the clinical signs and symptoms, the radiographic imaging appearances of NAI, possible victims of NAI as well the management thereof in public hospitals in SA. There are limited publications particularly related to radiographer's knowledge regarding the above stated objectives. Through this,

the study will add to the body of knowledge on this topic. This thesis will further describe whether any discrepancies or shortcomings existed amongst diagnostic radiographers and whether there is a need for continuous professional development in any of the areas to be investigated. To the author's knowledge, this is the first study of this nature to be conducted amongst diagnostic radiographers in SA. This study therefore aimed to fill this gap and provide baseline data on the current status of radiographer's knowledge related to this topic.

1.8. Thesis Outline:

1.8.1 Chapter one: Introduction

Chapter one provides an overview of the study and sets the stage for the research study that was conducted. The chapter provides a brief background regarding the role radiographers play in the management and imaging of NAI within radiology departments. Furthermore, it provides a clear description of the research question, aim, research objectives and the significance of the study.

1.8.2 Chapter two: Literature Review

Chapter two presents a comprehensive review of the literature pertaining to NAI. The chapter explores several key areas such as the epidemiology of NAI, clinical signs and symptoms thereof, medical imaging protocols and radiographic signs as well as the role of the radiographer in managing this disease entity. The review underscores the importance of accurate reporting cases of child abuse and gives an overview of the appropriate use of radiographic imaging when abuse is suspected. The chapter ends with a discussion on diseases that may mimic NAI.

1.8.3 Chapter three: Research Methodology

Chapter three explains the research design and methods employed for this study. Topics of discussion include the study population enrolled as determined by the inclusion and exclusion criteria, the data collection instrument used, how internal validity and reliability of the study was ensured, the data analysis performed as well as the ethical considerations taken into account for the data collection.

1.8.4 Chapter four: Results

In chapter four the results of the study are described. Here the correlation between the research question, objectives and results is drawn. This chapter describes the statistical analysis performed and serves as a precursor to the discussion of the results. This chapter discusses the demographics of respondents, radiographers' knowledge of NAI, protocols

and reporting procedures as well as radiographers' ability to diagnose NAI based on imaging findings. Furthermore, the results chapter presents the findings and provides a comprehensive statistical analysis thereof.

1.8.5 Chapter five: Discussion and Conclusion

Chapter five provides an interpretation and explanation of the findings presented in the results chapter. This chapter further provides an in-depth analysis of the results, compare findings to similar studies, draw conclusions based on the findings and discusses the implications thereof for clinical practice. This chapter concludes with a brief discussion of the study's strengths and limitations.

CHAPTER TWO

LITERATURE REVIEW

2.1. Chapter Introduction

The South African Children's Act (No 38) of 2005 outlines child abuse as any deliberate act of harm or ill-treatment inflicted upon a child (South Africa, 2006). It involves acts of violence perpetrated against a child by a parent, caregiver, or guardian (South Africa, 2006). Child maltreatment, as defined by the WHO, encompasses a range of abusive behaviours and neglect experienced by individuals under 18 years old, including physical and emotional maltreatment, sexual abuse, neglect, negligence, and exploitation (WHO, 2022). Throughout this thesis, the terms "child abuse" and "NAI" will be used interchangeably as these two clinical entities are closely related. This chapter provides the context for the research problem and presents current literature related to NAI. It critically evaluates existing studies on NAI and discusses the current state of knowledge in this area. The aim of this study was to investigate radiographers' knowledge of the clinical signs and symptoms, the identification of NAI victims as well as the radiographic appearance of NAI as well as the protocols to follow when imaging children suspected of having sustained physical abuse.

A focused literature search was conducted using electronic databases such as PubMed, ScienceDirect and Scopus in order to identify relevant studies on NAI, radiographers' knowledge and associated imaging practices. The keywords as mentioned previously were as follows: *"Non-accidental injury, radiographers' knowledge, diagnostic imaging, child abuse and imaging protocols"*. Boolean operators were applied to refine the search and reference lists of selected articles were screened for additional references. Studies unrelated to diagnostic imaging or radiographer involvement were excluded to ensure alignment with the aims of this study.

2.2. Epidemiology of child abuse

NAI remains a global problem, for example within the United Kingdom (UK), over 50 000 children have been added to the child protection register (Van Rijn et al., 2009:147; Patel et al., 2017:202). It is estimated that globally, around one billion children are victims of childhood abuse of some form, whether emotionally or physically (Rengasamy et al., 2022:2). Biswas and Shroff (2021:876) highlight the significant challenges in accurately

estimating the global burden of child abuse. One major issue is the paucity of literature and the lack of awareness about child abuse in many regions of the world. Additionally, concepts such as Shaken Baby Syndrome (SBS) and Abusive Head Trauma (AHT) are often poorly understood or entirely absent in many cultures, resulting in underreporting or a complete lack of reporting. This prevalent lack of awareness and understanding, further complicates the collection of reliable data. Moreover, global estimates are often skewed due to cultural differences that affect the recognition and reporting of child abuse cases, leading to substantial discrepancies in reported incidences (Biswas & Shroff, 2021:876).

Studies solely focusing on the epidemiology of child abuse in SA is limited (Speelman, 2025)[2]. Child abuse is a worldwide problem as well as in SA, particularly in Cape Town and continually increases (Mohamed & Naidoo 2014:250; Meinck et al., 2015:183). Child abuse rates in SA are substantially higher than those of other countries globally (Meinck et al., 2015:183). The rate of child homicide by abuse estimated in a study performed by Mathews et al., (2013:563) in SA was 5.5 per 100 000 children under the age of 18. Nearly 44% of all homicides in children were related to NAI. This high rate of fatal child abuse suggests that NAI is endemic within SA (Mathews et al., 2013:564). However, these numbers only represent the confirmed abuse cases that had been reported. A potentially large number of child abuse cases go unreported and therefore unrecognised in statistics. These children remain in abusive homes and may continue to be victims of abuse (Mussmann et al., 2021:425).

Martin et al. (2022:151) states that according to The Crime Survey for England and Wales, 20% of adults aged 18 to 74 years old may have in some way experienced childhood abuse, especially before the age of 16, whether physical, emotional, sexual or even the witnessing of domestic violence or abuse. In contrast, literature reports that physical abuse is most prevalent in younger children especially those who are non-ambulant as 25-56% of fractures found in children under one year old could be attributed to abuse (Martin et al., 2022:152).

Approximately a 1% incidence of confirmed NAI cases were seen at the Red Cross War Memorial Children's Hospital (RXH) over a 14-year period (Van As et al., 2007:102). The study found a fracture incidence of 11.7%, which the researchers noted was consistent with

[2] Speelman, A. 2025, Personal communication, Cape Peninsula University of Technology, Bellville, Cape Town, South Africa.
Kindly note that according to institutional referencing guidelines, personal communication is referenced in-text but not in the reference list.

findings from other studies in literature. The average age for abuse victims was nearly four years old.

A national survey conducted in Nigeria found that about 50% of children were subjected to some form of abuse throughout their childhood, of which only five percent received assistance. The low rate of assistance may be due to the under reporting of abuse cases (Ibrahim et al. 2020:2). However, a study in England demonstrated an increase in the incidence of child abuse reports, which was attributed to an increase in abuse awareness and the ability of healthcare providers to detect abuse (Patel et al., 2017:202).

Child abuse can occur in various settings, including the family home, community, or institutions such as schools or hospitals. Neglect and NAI are not limited to specific environments but may manifest within familial, communal or institutional contexts (Van Rijn et al., 2009:147; Dessena & Mullan, 2018:60; Doyle & Vuong, 2019:1).

2.3. Causes of child abuse

There are various domestic, family and community related factors that contribute toward the causes of child abuse. Family factors may include drug or alcohol abuse, mental health issues, financial problems and violence within the family. Whereas community factors may include unstable households, unemployment or poverty. These socio-cultural factors may have an impact on a parent's ability to adequately provide a safe and nurturing upbringing for the child (Rengasamy et al., 2022:4). Moreover, numerous instances of child abuse remain undisclosed to relevant authorities due to the enduring stigma and fear surrounding such reports (Madu & Peltzer, 2000:259).

Consequently, the cycle of abuse persists, with perpetrators evading accountability (Madu & Peltzer, 2000:259). In SA, emotional instability and violence within the family home or parental separation has been identified as a significant risk factor. Children from impoverished households, where parents are compelled to work away from home, often find themselves vulnerable to abuse when left unsupervised with other adults or family members. Vulnerable groups include stepchildren, children of adolescent parents who entrust childcare to others while attending school, and abandoned children left to fend for themselves. Such circumstances render them susceptible to abuse, as they lack the presence of a stable, responsible adult to safeguard their well-being (Madu & Peltzer, 2000:260).

In Cape Town, the prevalence of reported child abuse cases was initially lower than anticipated. This may be attributed to the fact that children are not always brought to medical facilities unless they have sustained severe injuries or head trauma. Additionally, the high incidence of violence related trauma in South Africa, likely contributes to this trend of undisclosed abuse cases (Van As et al., 2007:103).

During the COVID-19 pandemic, concerns arose regarding the accurate reporting and diagnosis of child abuse, primarily due to restricted access to emergency services and public protection offices enforced by global lockdown measures. Consequently, there was a notable increase in reports to child abuse helplines in the UK, as observed by Rengasamy et al. (2022:4). It can be argued that the prolonged time spent with perpetrators during lockdowns likely contributed to heightened reports of child abuse and domestic violence.

Some studies underscored the correlation between pandemic-induced stressors and the heightened risk of child abuse and domestic violence (Martins-Filho et al., 2020:1980;Katz et al., 2021:7; Rengasamy et al., 2022:2). While Rengasamy et al. (2022:4) reported an increase in abuse cases during the pandemic, De Boer et al. (2022:728) noted a decrease in reported cases, possibly due to barriers to accessing healthcare services and identifying abuse amid pandemic-related restrictions.

In SA, where stringent lockdown measures were implemented, children from disadvantaged backgrounds faced significant challenges, as highlighted by Fouche et al. (2020:2). Childline reports during the initial lockdown period revealed a surge in child abuse calls, indicating the heightened vulnerability of children during this time. Despite constitutional protections, disruptions to essential services during the pandemic compromised the safety of children, exacerbating their susceptibility to abuse and neglect (De Boer et al., 2022:730).

Martins-Filho et al. (2020:1980) suggest that the surge in child abuse may have been associated with increased financial restraints and burdens caused by school closures during the COVID-19 pandemic. It can therefore be deduced that that the features, appearance or presentation of an abused child is a product of social and environmental factors (Martins-Filho et al., 2020:1980).

2.4. Consequences of child abuse in live individuals

Violence in children may have devastating consequences for each victim’s development. Early exposure to violence may cause catastrophic damage to multiple levels of body systems, such as the nervous system, endocrine and in some cases may affects the immune

system as well. Thus, child abuse becomes a public health, human rights, and social problem (Hillis et al., 2016:2).

Meinck et al. (2015:183) asserts that extensive childhood exposure to abuse can have enduring consequences on both the mental and physical development of the child. While research specifically within SA is limited; global studies, particularly in more developed nations, have identified various risk factors associated with increased incidence of abuse. These factors encompass domestic and community violence, parental, physical and mental health challenges, elevated parenting stress, difficulties in parenting, substance and alcohol misuse, as well as socioeconomic factors such as poverty and substance abuse involving drugs or alcohol (Meinck et al., 2015:183-184).

Adverse childhood experiences such as NAI and domestic violence may have long-term effects on the victims. Exposure to violence is a major risk factor that may affect long-term child development (Madu & Peltzer, 2000:259; Rengasamy et al., 2022:2). One study showed that 50% of young South Africans indicated that they are exposed to violence from family members in a fit of rage or lost tempers. Harmful experiences or stress throughout childhood may cause permanent damage or developmental impairment in children (Pieterse, 2015:877) or in some severe cases, even death (Wessels & Moodley, 2022:1).

2.5. Child abuse resulting in fatalities

The impact of abuse can extend throughout the lives of childhood victims. In SA, homicide stands as the foremost cause of mortality among males aged 15 to 29. As per Mathews et al., (2013:564), the incidence of homicides among teenage boys surpasses that of girls by a notable margin. Fatalities stemming from violence and injury predominantly involve males. The enduring effects of childhood violence may persist into adulthood. Factors such as unstable family environments, neglect and abuse contribute to the development of violent behaviours, particularly among males (Mathews et al., 2013:564).

Research conducted by Klevens and Leeb (2010:264) showed between the years 2003-2006 there were 1374 child deaths under the age of five in the United States of America (USA). Among these, a total of 132 deaths were related to child maltreatment. In this category, there were blunt trauma, neglect, SBS and AHT. In addition, the total number of children found to have died related to abuse was 600. In this same study, 52% were deaths of children under the age of one year. Alarmingly, only 44% of these cases were reported to relevant authorities. A study by Wessels and Moodley (2022:1) reported similar findings, indicating that injuries in younger children, particularly those under two years, tended to be

more severe. These findings highlight the increased vulnerability of infants and toddlers, whose developmental stage and age make them more susceptible to fatal outcomes.

2.6. Consequences of misdiagnosis

Failing to correctly diagnose a case of abuse may leave the victim at risk for more abuse. But at the same time, incorrectly diagnosing abuse where abuse is not present will put the family through unnecessary emotional stress and the child possibly being removed from the care of his or her parents (Eysenbach et al., 2022:1). The non-reporting as well as the misdiagnosis of NAI increases the victim's risk of further injury. If a misdiagnosis or non-reporting occurs, there is a 20% likelihood of additional injury to the victim. This places the child at greater risk of sustaining permanent damage and increases the likelihood of death by 24% (Martin et al., 2022:151).

Mathews and Martin (2016:1160) states that approximately 13% of all injury related deaths in children under the age of 15 years may be linked to abuse and neglect, but studies suggest that fatal child abuse is often underreported by child protection services and police, which results in a significant underestimation of abuse statistics (Mathews & Martin, 2016:1160).

The dangers of false negatives are highlighted by Mathews and Martin (2016:1160), wherein deaths due to abuse are incorrectly misdiagnosed and recorded as natural causes, unintentional injuries or Sudden Infant Death Syndrome (SIDS). SIDS which has shown to comprise of 10% of infanticide cases. These misclassifications obscure the extent of child maltreatment statistics, which compromises reliable data collection, and results in lost opportunities to protect the remaining siblings, which in some cases allows subsequent abuse and fatalities within the same family (Mathews & Martin 2016:1160).

In contrast, Christian and States (2017:982) highlight the dangers of false positives, where diseases such as those pertaining to bleeding or bone disorders that may mimic abuse are misdiagnosed as NAI. When this occurs, children who require medical treatment for such diseases may be indirectly denied the appropriate medical care needed. Both Mathews and Martin (2016:1160); and Christian and States (2017:982) emphasise the importance of appropriate diagnoses in children presenting for medical care. As a failure to do so may either lead to the inability to safeguard children and siblings from further abuse (Mathews & Martin, 2016:1161), or that unsubstantiated accusations of abuse may cause unjust emotional and psychological harm to families (Christian & States, 2017:984).

2.7. Clinical signs and symptoms of child abuse

Physical abuse may present with a variety of manifestations, such as bruises, rib and spiral fractures, skeletal fractures especially femur fractures in non-ambulant children, burns, spinal fractures as well as head injuries which includes subdural haematomas, retinal haemorrhages and skull fractures (Mohamed & Naidoo, 2014:253; Quigley & Stafrace, 2014:83,84). The attending physician is usually the first to suspect abuse based on the clinical examination and history provided, or lack thereof, from the parent or guardian. When a child presents to the emergency department or family physician, children in infancy are accompanied by an adult. In cases of child abuse caregivers often present illogical or false information (Laskey et al., 2013:86). Information provided by parents or caregivers often lacks a proper description of the mechanism of injury, which is necessary to explain the child's presentation. In some cases, parents or caregivers may refuse to provide details of events that led up to the injury (Doyle & Vuong, 2020:1). Features such as guardians altering clinical history or events that lead to the injury, refusal to provide a history of trauma, and conflicting history are often suspicious (Laskey et al., 2013:86; Doyle & Vuong, 2019:1; Eysenbach et al., 2022:2). The latter usually occurs when a parent or carer holds fear of prosecution or discrimination, or fear of the child being taken out of their custody. These factors usually raise suspicion of abuse. Other signs of child abuse are poor childcare and delays in seeking medical care (Laskey et al., 2013:86; Doyle & Vuong, 2019:1; Eysenbach et al., 2022:2).

It's important to note that delays in seeking medical treatment may not always be indicative of abuse. In ambulant children where an injury or for example, a scalp laceration may not be visibly noticed or identified by a parent, guardian or caregiver could result in a delay to seek medical attention. The absence of visible bruising or immediate swelling may also be a contributing factor in seeking medical attention (Laskey et al., 2013:86).

One of the more common types of injuries inflicted on abuse victims are burns. Burns may either be accidental or purposefully inflicted (Kreston, 2008:42). As with all burn injuries, the severity of the burn is dependent on the time spent exposed to the heated object or fire. As with all cases of abuse versus accidental injury, the mechanism of injury would usually explain the severity of the injuries sustained. The history or explanation of events by the parent or caretaker, is as always vital in the distinction thereof (Kreston, 2008:42).

In a study conducted by Pawlik et al. (2016:54), it was found that 40.9% of children presenting with burns were likely victims of child abuse. These children exhibited typical indicators of abuse, such as a history of burns and previous assaults, an absent or

inadequate explanation of the injury mechanism, and excessive or irrelevant information provided about the injury (Pawlik et al., 2016:54).

Wessels and Moodley (2022:3) found that the most frequently found injury sites to children were the chest, the cranium and long bones, with fractures to the rib cage being the most common. Determining the age of fractures is complex, an area of specialisation that falls outside the scope of this literature review. In their study examining postmortem fracture patterns in NAI cases, Wessels and Moodley (2022:3) found that the majority of the fractures were acute, potentially signalling the intensity of the trauma experienced by these individuals at the time of death. Additionally, there were subjects who exhibited fractures at various stages of recovery, suggesting recurrent maltreatment and a failure to report suspected abuse (Wessels & Moodley, 2022:6).

2.8. Shaken Baby Syndrome: A historical context

SBS is an older term no longer in use. SBS refers to the clinical condition of a child who has been severely abused, characterised by injuries spread across various body parts. These injuries can result in severe, lifelong consequences and in some cases, fatality (Kreston, 2008:39). SBS is suspected when there is a discrepancy between the history provided by the caregiver and the likely mechanism of injury. Nearly 50% of SBS cases present with rib [and skeletal] fractures, and retinal haemorrhaging occurs in almost 80% of these cases. Victims are typically very young, most commonly under the age of one year (Kreston, 2008:39; Ibrahim et al., 2020:3).

SBS is a prominent type of Battered Child Syndrome (Kreston, 2008:38). Typically, a child is shaken rapidly for up to twenty seconds, and in some cases, may be slammed against a wall or thrown. This repetitive motion causes internal injuries, often not visible externally. Fatal cases usually occur when brain damage results in diffuse axonal injury, which disrupts the brain's communication pathways, leading to unconsciousness and death. (Kreston, 2008:39; Daniel et al., 2022:1). The violent shaking can cause excessive extension and flexion of the head and cervical spine. Injuries to the thoracic and lumbar regions suggest extremely exaggerated hyperflexion of the spine, involving significant movement or bending of the upper and lower back, not just the cervical spine and head (Twomey et al., 2004:667). This repetitive motion severely impacts intracranial contents, causing significant neurological deficits, visual impairments, physical disabilities, and in severe cases, death.

Caregivers often attribute such trauma to episodes of inconsolable crying, irritability or refusal to eat, amongst other factors (Daniel et al., 2022:1).

2.9. Abusive head injuries

Various terms such as non-accidental head injury, inflicted traumatic brain injury, and traumatic head injury resulting from child maltreatment are used to describe instances of inflicted injury to the head as a consequence of child abuse (Biswas & Shroff, 2021:876). According to (Kim et al., 2017:1827), head trauma resulting from maltreatment is the predominant cause of brain damage that leads to fatalities. AHT, a subset of NAI, involves cranial trauma and contributes to an estimated 474 000 emergency department visits annually in the USA among children aged 0 to 14 years. In infants, head injuries carry a greater risk for injury and death when compared to that of older children, largely due to an increased occurrence of AHT in infants (Davison et al., 2022:e223). A hallmark injury, termed the “triad” (Davison et al., 2022:e223) , includes retinal haemorrhaging, subdural haematomas and encephalopathy, which usually occurs without any obvious external trauma (Davison et al., 2022:e223).

2.10. Management of NAI

For the safeguarding and protection of children, all healthcare personnel need to be able to identify any inflicted injury and need to be updated on hospital protocols and training related to management of child abuse. All clinicians and healthcare workers need to always remain alert and perceptive in all situations especially when dealing with suspected NAI cases (Van As et al., 2007:104). Kreston, (2008:43) asserts that when a child's injuries are explained as accidental, the circumstances should be thoroughly investigated. The explanation provided by the parent or caregiver must correspond with the mechanism of injury, the number of injuries and the findings from medical imaging. Laskey et al. (2013:86) supports this, noting that in cases of abusive head trauma in pre-verbal children, caregivers may offer false accounts of minor head injuries.

It is the responsibility of all healthcare professionals, public officials and educators to ensure that when NAI is suspected, a timely referral is made to The Department of Social Services (Hendricks, 2014:551). All radiological findings must be documented in the report submitted to social services. Both the attending clinician or paediatrician and the radiologist may be required to submit formal reports for use in police investigations or legal proceedings (RCR & Royal College of Paediatrics and Child Health (RCPCH), 2008). Hulson et al. (2014:1557)

identifies paediatric NAI as a critical health concern. The RCR and the RCPCH have established consensus on the imaging protocols for NAI.

The necessity for a standardised approach to imaging in cases of suspected abuse, significantly reduce the margin of error in identifying injuries or fractures, thereby decreasing the likelihood of missed diagnoses and subsequent exposure of the child to further harm (Hulson et al., 2014:1561). Implementing a standard operating procedure for the appropriate imaging of abuse victims should be integrated into the training and education of radiographers responsible for conducting imaging examinations and radiologists tasked with interpreting these images (Doyle & Vuong, 2019:1).

2.10.1. Compulsory reporting of child abuse

Since child abuse is a generally under reported phenomenon, it is highly likely that statistics on the prevalence of abuse may be skewed. Reporting the suspicion of abuse or sexual abuse is mandatory in SA (Fouché & Le Roux, 2018:23). After an abuse claim is made, an investigation will ensue. This includes taking statements from the child [if verbal], the reporter and the alleged perpetrator. All these parties are expected to testify. Child victims are protected regarding their identity so that they may testify against their sexual perpetrators without fear of further victimisation (Fouché & Le Roux, 2018:23).

2.10.2. The role of the radiographer

The recognition or identification of potential abuse victims falls under the responsibility of all healthcare professionals (Van As, 2016:1075). Due to them performing the radiographic imaging examination, and the subsequent assessment thereof, radiographers are often the first healthcare professionals to observe radiographic evidence of abuse. This places radiographers in the position to communicate their observations immediately and directly with the treating physician or radiologist. The swift actions by radiographers will ultimately influence patient care (Woznitza, 2014:66).

As with all patients, radiographers are required to maintain professional dispositions, particularly when dealing with paediatric cases and the imaging of suspected victims of abuse (Brown & Henwoodt, 1997:207). At the point of diagnostic imaging, radiographers should be mindful that abuse is still under investigation and not proven as yet (Doyle & Vuong, 2019:5). Primarily, radiographers should perform examinations of high diagnostic quality and perform such examinations set forth by departmental protocols or relevant standard operating procedure (SOP) (Halstead et al., 2019:309).

Medical imaging is vital in determining whether or not a child presenting to the emergency department is a victim of abuse (Doyle & Vuong, 2019:5). As with all radiographic examinations an explanation of the positioning, duration and any immobilisation that will be used during the examination should be given to the parent or accompanying guardian (Doyle & Vuong, 2019:5). With any kind of medical imaging there is always the risk of exposure to ionising radiation, therefore clinical indications and physical examinations should support the choice for the type of imaging required. Imaging guidelines serve as the basis for these decisions. The radiographer is responsible for maintaining radiation safety ensuring that the patient and parents or carers present are protected (Doyle & Vuong, 2019:5).

X-ray examination requests may not always indicate the clinical history as suspected abuse; even so, radiographers should always remain cautious and perceptive when possibly identifying such X-ray requests. Best practice guidelines suggest that suspected NAI imaging examinations should only take place when radiographers with paediatric experience are available (Doyle & Vuong, 2019:5; Halstead et al., 2019:310).

2.10.3. Role of medical imaging

Diagnostic imaging plays an important role in the detection of injuries typically related to NAI (Van Rijn et al., 2009:148). Diagnostic imaging is often required as documentation of physical injury is usually the first type of investigation that is requested by the referring physician, when NAI is suspected. Over 80% of child abuse cases are diagnosed through diagnostic imaging. Therefore, medical imaging plays a vital role in the early detection of abuse (Wootton-Gorges et al., 2017:s341; Doyle & Vuong, 2019:5). Additionally, diagnostic images that are produced during the abuse investigative process are used as legal documentation for the representation of abuse as evidence in a court of law (Doyle & Vuong, 2019:6).

Fractures that occur as a result of abuse are seen in 11- 55% of cases. Abuse fracture patterns may be easily missed. While abuse related fractures are widely documented, in practice it may appear as a variety of bony injuries throughout the body, more often to the long bones or extremities (Van As et al., 2007:102). In contrast, Mitchell et al. (2021:6) assert that while skeletal injuries can be indicative of abuse, their occurrence is also influenced by the child's developmental stage.

In a study conducted by Van As et al. (2007:103) 40% of victims had skull fractures associated with violent injury by a weapon or object. Approximately a quarter of these victims also sustained multiple skeletal fractures, not just isolated to the skull.

Rib fractures and metaphyseal lesions have been found to be difficult to identify, and imaging relies on the expertise of trained radiographers and radiologists, specifically in cases where children are not compliant during imaging. Even with advanced equipment, diagnosis may be compromised when imaging is not adequately performed (Arthurs et al., 2021:631). Resulting from a twisting force applied near the growth plate, classic metaphyseal lesions or bucket handle fractures, is highly indicative of NAI. These fractures run horizontally across the metaphysis and when acute can be easily missed radiographically, therefore follow-up imaging is imperative in suspected NAI cases (Quigley & Stafrace, 2014:88).

Due to the flexibility of bones in children, rib fractures occurring in the absence of abuse is improbable. Rib fractures are amongst the most common fractures found in cases of abuse. Because of its high specificity in abuse, imaging of rib fractures, particularly oblique views were added to the American College of Radiology (ACR) guidelines for imaging child abuse using skeletal surveys (Wootton-Gorges et al., 2017:s341; Karmazyn et al., 2022:2). Ross and Juarez (2016:846) concurs, emphasising that rib fractures are "strongly suggestive" of child abuse, particularly when imaging reveals multiple fractures at various stages of healing. But if no fractures are found, and the suspicion of abuse remains strong clinically, further imaging is indicated (Slovis et al., 2015:965).

Pomeranz et al. (2022:103) further supports this, noting that rib fractures are the most commonly detected evidence of NAI when comparing the detectability of plain film imaging in skeletal surveys to that of Computed Tomography (CT) scans. CT imaging has been showed to be useful for rib fracture detection. A study by Pomeranz et al. (2022:105) showed that it is likely that occult rib fractures would be missed if there is no callus formation or evidence of healing that may make it more visible. The CT component of their study discovered that approximately 17% of rib fractures were missed during the initial skeletal survey, where all types of rib fractures regardless of their location were detected on CT (Pomeranz et al., 2022:105).

The estimated percentage of spinal fractures seen in abuse cases is less than one percent and may go undiagnosed unless there are other injuries present that require examination. Injury to the spinal cord is generally quite rare, fractures sustained to the spine often affect the vertebral body and are isolated hereto. In SBS cases the spinal processes may be affected (Twomey et al., 2004:665).

2.10.4. Role of Skeletal Surveys

A skeletal survey which includes images of the entire skeleton, is usually used as the initial imaging modality in the case of suspected physical abuse (Quigley & Stafrace, 2014:82). Here the imaging is used to identify or diagnose fractures or fracture patterns that are highly indicative of NAI (The ACR-SPR, 2021;Wootton-Gorges et al., 2017:s341). Skeletal surveys are the gold standard for imaging suspected cases of abuse and is practiced nationally and internationally (see imaging protocol recommended by The Royal College of Radiologists & Society and College of Radiographers (RCR-SCoR) in Addendum A1 (The RCR-SCoR, 2018). Expert opinion suggest that the use of skeletal surveys is essential in the diagnosis of occult fractures and pre-existing genetic diseases of the skeleton and joints, and to distinguish between the two (Quigley & Stafrace 2014:82; Wootton-Gorges et al. 2017:s345; Doyle & Vuong 2019:1). The radiographic findings of a skeletal survey are also used to identify the age of fractures. This is vital for identifying whether fractures are acute or have callous formation which suggest a healing fracture. Fracture dating can be done based on healing times (Mussmann et al., 2021:426).

When the child is younger than two years of age, a skeletal survey should be performed to diagnose or rule out NAI (Wootton-Gorges et al., 2017:s345; The ACR-SPR, 2021). There are cases where an exception may be made. This is in the case of a child presenting with an isolated head injury. Here the child should be assessed and the discretion of whether or not the child should undergo a full skeletal survey should be weighed against risk of exposure to ionising radiation versus the possibility of missing fractures or fracture patterns that may be indicative of abuse (Laskey et al., 2013:86). The study by Laskey et al. (2013:86), which reviewed children under the age of 18 months who presented to a tertiary hospital with an apparent isolated head injury, set out to determine if these children require skeletal surveys for identification of occult fractures to the body. The study revealed that 6% of the study participants had occult fractures identified on the skeletal survey.

While skeletal surveys are generally accepted as the main diagnostic tool for the investigation and diagnosis of NAI (Quigley & Stafrace, 2014:83,91; Halstead et al., 2019:310), other imaging modalities such as CT, Magnetic Resonance imaging (MRI) and bone scintigraphy that are more specialised examinations may also be used (Nguyen & Hart, 2018:126).

The radiation dose to patients undergoing skeletal surveys, varies dependant on the age or size of the child as well as the number of images taken. According to Slovis et al. (2015:965), and the ACR-SPR guidelines, there are 21 standard images taken per skeletal survey.

Skeletal surveys are the most commonly used imaging tool for diagnosing fractures in suspected child abuse cases. It is the least invasive and is considered the most sensitive for the diagnosis of long bone fractures.

According to The ACR-SPR, (2021) the images should be taken as follows to obtain diagnostic accuracy: Each extremity should be X-rayed in anteroposterior (AP) view and lateral views for the elbow, knee and ankle joints. The axial skeleton should be obtained in two projections: AP and lateral, AP view of the pelvis as well as oblique views of the ribs for rib fractures, the latter being highly indicative of abuse. Additional views as needed should be obtained to fully document suspected abnormalities over areas of concern.

Research has shown that one single X-ray taken of the baby's body called a babygram, used to be a standard practice, is no longer adequate as it does not contribute adequately to the diagnosis of NAI, as the image quality is considered poor especially when it comes to the evaluation of injuries to joints and metaphyseal growth plates (Doyle & Vuong, 2019:3; Sprigg, 2008:557).

2.10.5. Follow-up Imaging for suspected or confirmed cases

If no occult fractures are seen, the recommendation is that a repeat skeletal survey be taken 14 to 21 days and in some cases up to 28 days after the initial presentation of abuse suspicion (Slovis et al., 2015:966; The RCR-SCoR, 2018). In a study by Anilkumar et al. (2006:217), the acquisition of a second radiographic image enhances the diagnostic confidence in both the detection and chronological assessment of fractures. Additionally, the benefit of repeat imaging reveals previously unidentified fractures, thereby contributing to a more comprehensive evaluation of the injury. During the repeat skeletal survey, particular attention should be given to high-risk anatomical regions of the appendicular and axial skeleton that are commonly associated with abuse, such as the chest and ribs, where injuries may be more indicative of NAI (The RCR-SCoR, 2018). Past medical history as well as clinical examination, not only those related to fractures of the appendicular skeleton, are crucial factors that will aid the physician in deciding whether or not further investigation for abuse is warranted (Slovis et al., 2015:966; Wootton-Gorges et al., 2017:s345).

Follow-up skeletal imaging may show an increase in the number of fractures seen on the initial skeletal survey. The healing of fractures showing callus formation or periosteal reaction may also contribute to or assist in the dating of fractures. Also recommended is a follow-up MRI scan if any injuries were present on the initial CT scan, at 2 to 5 days (Martin et al., 2022:154). Follow-up imaging with the exclusion of projections of the pelvis, spine and

skull may increase the cumulative radiation dose to the child by approximately 40% (Mussmann et al., 2021:428).

2.10.6. Supplementary Imaging

Specialised imaging modalities for investigating suspected NAI include MRI, CT, Ultrasound and Nuclear Medicine imaging. According to the RCRCH and ACR-SPR, CT can accurately diagnose injuries to the chest with suspected intra-thoracic organ damage and now assist in the diagnosis of rib fractures (Kraft, 2011:111; Doyle & Vuong, 2019:4).

Pomeranz et al. (2022:106) affirms that supplementary imaging modalities may be used as adjuncts to support or refute a negative skeletal survey. CT for example is highly sensitive to confirm whether or not rib fractures are present in a negative skeletal survey. The detection of rib fractures on a CT scan would drastically change the outcome of an NAI investigation. It would also change the management of the child in terms of whether or not the child would require any further treatment or investigations (Pomeranz et al., 2022:106).

CT of the chest, abdomen, and pelvis is advisable in severely abused children to detect occult fractures to the spine, which may be poorly depicted on plain film imaging, possibly even completely missed. CT is not always clinically justified as it results in a substantial increase in radiation dose to the child (Wootton-Gorges et al., 2017:s342-s343; Halstead et al., 2019:310). Therefore, it should be considered as an aide in difficult cases or where more than just rib fractures are suspected (Halstead et al., 2019:310).

CT is indicated in high-risk head injuries, for the detection of traumatic brain injury. Performed for suspected victims over the age of one year who have visible facial injuries; exhibit neurological symptoms such as focal deficits, seizures or symptoms which may include vomiting, headaches, drowsiness, irritability, memory loss or a history of altering consciousness, which would be indicative of skull fractures. Furthermore, the suspicion of skull fractures justifies the need for a CT scan of the brain (Wootton-Gorges et al., 2017:s344; Doyle & Vuong, 2019:4). Martin et al. (2022:158) advocates for a follow-up MRI examination within two to five days if the initial CT scan reveals any injuries.

According to Van As et al. (2007:104) CT examinations are preferred for the diagnosis of brain, spinal, chest and abdominal injuries [due to the greater sensitivity and specificity of this imaging modality]. Nuclear medicine bone scintigraphy may be used as an adjunct to the skeletal survey in the investigation of suspected NAI cases [especially for skeletal injuries] (Kraft, 2011:111; Bainbridge et al., 2015:e84), but should not replace skeletal

surveys (Wootton-Gorges et al., 2017:s341). Kemp et al. (2006:724) highlights that neither bone scintigraphy nor the skeletal survey alone has the superior ability to detect all fractures.

2.10.7. Standardisation of imaging protocols

Imaging of NAI has been a debated topic regarding the workup of a suspected NAI victim. The RCR and RCPCH, published the Standards for Radiological Investigations in Suspected Non-Accidental Injury (The RCR & RCPCH, 2008). These guidelines have since become the standard operating procedure in the UK and elsewhere. The type and extent of radiographs taken in a suspected NAI victim is dependent on the age of the child, clinical presentation and whether or not the child has been previously abused or has a sibling who has already been diagnosed as a victim of NAI. Moreover, these guidelines recommend follow up X-rays as they may contribute to diagnosis and increase the imaging sensitivity of rib and metaphyseal fractures by up to 27% (Hulson et al., 2014:1561; Wootton-Gorges et al., 2017:s341,s346; Doyle & Vuong, 2019:4).

In New Zealand, a national protocol was developed to reduce inconsistencies and improve quality of skeletal imaging, aimed at improving the diagnostic sensitivity and accuracy when investigating NAI (Doyle & Vuong, 2019:2). Implementing standardised imaging guidelines across institutions ensures a uniform approach, thereby reducing the likelihood of missing occult fractures and decreasing the risk of further abuse (Hulson et al., 2014:1562). Standardised guidelines would also assist training of student radiographers and graduate radiographers on imaging to perform for suspected NAI victims (Hulson et al., 2014:1561).

All [diagnostic] radiographers should ideally have had training and experience in performing X-ray examinations on infants and children (Davis & Reeves, 2006:166). In particular, Wootton-Gorges et al. (2017:s341) states that these examinations should be collimated to the area of interest for each of the body parts, with separate views of each body part. Each joint and limb should thus be X-rayed separately improving the diagnostic accuracy (Brown & Henwoodt, 1997:206). Research conducted by Offiah et al. (2014:1338) previously identified inconsistencies in image quality and radiographic projections related to suspected child abuse cases. These discrepancies included uncertainties regarding the appropriate timing of imaging, the specific images required and the responsibility for interpreting and reporting the findings (Hulson et al., 2014:1561).

2.10.8. Dose optimisation when imaging children

The principle of as low as reasonably achievable (ALARA) should be applied to all X-ray examinations (Sodhi et al., 2015:1755). The use of ionising radiation should be optimised and all radiographers who perform imaging examinations on patients of all ages, but especially on children need to understand the radiation dose metrics as well as the effects of ionising radiation. Minimising unnecessary radiation exposure is crucial in paediatric healthcare, and all departmental standard operating procedures should adhere to the ALARA principle (Laskey et al., 2013:89). This is a fundamental principle taught in all undergraduate studies related to medical imaging (Slovis et al. 2015:963).

Children are more susceptive to the damages that may be caused by ionising radiation, radiographers should therefore be mindful of the cumulative radiation dose when performing examinations (Mussmann et al., 2021:426). The use of ionising radiation should be optimised in accordance with the ALARA principle and protective lead shielding provided to those assisting with patient immobilisation, as well as applied to patients in situations where it would not obscure the field of interest (Doyle & Vuong, 2019:5). Lead shielding should be provided to protect the child, covering parts of the body not being examined, and to the parent or guardian assisting in the procedure, such as holding the child for immobilisation purposes (Doyle & Vuong, 2019:5).

Although the ALARA principle must always be applied, radiographers should also understand that reducing the radiation dose to children should not affect the diagnostic quality and accuracy of the radiographs. Since diagnostic images are used to detect occult fractures, these may be missed if the diagnostic quality is diminished. This is especially crucial as occult fractures may have similar pattern appearances to certain pathological conditions that may be pre-existing (Doyle & Vuong, 2019:6).

2.11. Abnormal variants that may mimic NAI

Ross and Juarez (2016:852) emphasise that an understanding of skeletal bone disease, living conditions and cultural perceptions of child abuse is crucial, as misinterpretation of anatomical variants can lead to misdiagnosis. Periosteal reactions and metaphyseal variations may mimic radiological indicators of trauma which leads to potential misdiagnosis of NAI (Quigley & Stafrace, 2014:87,88). Proper differentiation between these normal variants and actual injuries is essential to avoid erroneous conclusions of child abuse (Ross & Juarez, 2016:845; Wootton-Gorges et al., 2017:s341). The next sections describe some of these variants that may be misinterpreted for physical abuse.

2.11.1. Occipital Synchondrosis

Van As et al. (2007:102) states that as with any trauma, the area of injury is often determined by the mechanism of injury. Skull fractures need to be distinguished from abnormal variants. One such example would be the occipital synchondrosis. This occurs between two portions of the occipital bone namely the exoccipital segments and supraoccipital portions. These bones start to fuse from birth up until the age of four. It should not be misinterpreted as a fracture (Quigley & Stafrace, 2014:83).

2.11.2. Spinal Variants

As stated by Quigley and Stafrace (2014:85-87) and Khanna and El-Khoury (2007:477), there have been reported cases of spinal injury in NAI cases. Therefore, when spinal abnormalities are detected, abuse need to be ruled out. Some of the variants for the cervical spine (C-Spine) are odontoid ossification between the ages of three and five years old, and anterior wedging of the vertebral body, usually around the level of the C-Spine vertebra number three. There may be physiological laxity of the C-spine in children that may mislead the interpreter as a sign of subluxation caused by excessive extension and flexion. Pseudo-subluxation in children is seen most commonly from C-Spine vertebra numbers two to four.

2.11.3. Nutrient vessel

As with the spinal variants, there are variants that are found within the extremities. For instance, the nutrient vessels or nutrient artery, which supplies a long bone enters the cortex at the nutrient foramen which is at an oblique angle and may be mistaken for an oblique fracture (Quigley & Stafrace, 2014:91).

2.11.4. Periosteal reaction

Physiological periosteal reaction is also a common variant that may be found in the extremities or long bones of infants under four months of age. Most commonly found on the long bones, its appearance is usually a two-millimetre layer of bone along the edge of the long bone usually only affecting one aspect of the bone. This normal variant should also be distinguished from the periosteal reaction in response to trauma like NAI as the latter would be greater than two-millimetre (Quigley & Stafrace, 2014:87). A variety of medical conditions can mimic signs of abuse, including osteosarcomas, metabolic bone disease, Caffey's disease and osteopenia. It is important to exclude these types of conditions when evaluating

fractures in children and diagnosing NAI (Lee et al., 2021:2). In-depth discussion of these conditions falls outside the scope of this literature review.

2.11.5. Mongolian spots

These congenital dermal conditions arise from the migration of neural crest-derived melanocytes to the skin during embryonic development. The incidence of Mongolian spots (MS) varies slightly across different populations (Kettner et al., 2020:1144). Although MS are often easily recognisable, they can sometimes be mistaken for bruises. Bruising in early infancy is a significant red flag for inflicted injury. (Prasad & Tully, 2017:909).

Morphologically, MS manifest as hyperpigmented maculae of diverse sizes and shapes, ranging from small, round spots approximately one centimetre in diameter to extensive areas of discoloration, primarily located on the lower back and buttocks. Due to their pigmentation, which can vary with skin type, MS may resemble hematomas, thus presenting a diagnostic challenge for physicians when examining children in cases of suspected child abuse (Kettner et al., 2020:1144).

The distinct features of MS aid clinicians in differentiating them from bruises that might indicate physical abuse. Histologically, MS are characterised by the presence of spindle-shaped melanocytes within the dermis (Prasad & Tully, 2017:909).

2.12. Pathologies that may mimic NAI

Pathological variants, including developmental, metabolic and genetic conditions, can also present as imaging features that resemble those seen in cases of abuse. Hildebrandt et al. (2022:2) highlight that in suspected child abuse cases, medical evaluations must carefully consider underlying genetic conditions that could account for observed fractures. Research studies indicates that seven percent of children with fractures or suspected abuse may have an undiagnosed pathology that mimics NAI (Light et al., 2022:2). Distinguishing between skeletal disorders and inflicted trauma is critical to ensuring accurate diagnosis and prevention of wrongful accusations of NAI (Ross & Juarez, 2016:844; Wootton-Gorges et al., 2017:s341).

2.12.1. Osteogenesis Imperfecta

One of the most common types of normal variants described by Kreston (2008:46) is Osteogenesis Imperfecta (OI). The author comments that while it is a common type of

variant in abuse cases, its incidence is rare with an estimation of 1 in every 15 000 to 60 000 births.

Hildebrandt et al. (2022:2) describes OI as a group of genetic conditions that lead to abnormal bone formation and bone fragility. This disorder affects bones, sclerae, ears, joints, ligaments, skin, and teeth, leading to brittle bones and a predisposition to multiple fractures in children. While severe cases of OI can be easily identified during clinical examinations, OI exhibits a wide range of severity; milder forms may be misdiagnosed as child abuse, particularly when rib fractures are present. Therefore, it is crucial to consider OI in the differential diagnosis when evaluating suspected NAI given their similar clinical manifestations as stated above (Kreston, 2008:46-47; Hildebrandt et al., 2022:5; Light et al., 2022:2).

2.12.2. Metabolic bone diseases

Children born with Metabolic Bone Disease, prevalent in developing countries, are prone to rib fractures (Light et al., 2022:2). Other examples of pathologies that may cause fractures are osteopenia of prematurity, osteopetrosis, osteomyelitis, Caffey disease and Menkes disease, which predisposes patients to fractures and bleeding (Hildebrandt et al., 2022:1). Among these genetic disorders OI presents the greatest predisposition to fractures (Light et al., 2022:3).

2.20. Chapter Conclusion

NAI in children is a significant concern in paediatric radiography, requiring healthcare professionals' keen awareness and expertise. Radiographers are crucial in detecting and documenting NAI due to their unique position in the imaging process. Alzahrani et al. (2022:839) highlighted substantial gaps in healthcare professionals' knowledge and training regarding NAI. Knowledge on reporting procedures and protocols for imaging suspected NAI is essential for accurate diagnosis and reporting. It is therefore essential that specialised training and ongoing education for radiographers is offered to handle NAI cases effectively. Addressing these knowledge gaps and adhering to best practices are vital for early identification and intervention in child abuse, ultimately protecting vulnerable children. The next chapter describes the research design and methodology employed for this study.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1. Chapter Introduction

This chapter provides a comprehensive overview of the research strategies and methodologies employed in this study. It encompasses the research design, target population, sampling method, inclusion and exclusion criteria applied, data collection methods, data analysis employed, and the ethical considerations upheld. Additionally, this chapter elucidates the efforts to achieve the research objectives, which included radiographers' ability to identify the physical signs and symptoms of NAI in paediatric patients, assessing their proficiency in recognising NAI victims, as well as evaluating their knowledge of the radiographic imaging characteristics, and the protocols to follow in suspected NAI amongst paediatric patients.

3.2. Research design

This study utilised a quantitative, descriptive cross-sectional research design. Cross-sectional research is well-established in medical research and involves collection and analysing data from a population at a single point in time (Slater & Hasson, 2024:657). The research study was guided by well-defined research objectives and employed an electronic survey using a questionnaire distributed among diagnostic radiographers. The sampling frame comprised radiographers from three tertiary academic hospitals henceforth named Hospital One, Hospital Two and Hospital.

3.3. Research methods

Prior to data collection, a formal letter outlining the details of the study and requesting site permission was sent to the ADs Radiography of the three participating hospitals (see Addendum A2, A3 and A4). This letter served to request permission to conduct the study amongst diagnostic radiographers. In order to uphold confidentially and anonymity, the hospitals will henceforth be labelled Hospital One, Two and Three. At Hospital One, an ethics application was submitted to the Research Committee of the Department of Allied Medicine, which subsequently granted permission for all three hospitals (refer to Addendum A5).

To comply with the Protection of Personal Information Act (POPIA) and to safeguard participants' contact information, it was agreed, in consultation with the ADs, that the questionnaire and participant information letter (refer to Addendum A6) would be distributed via email by the ADs to radiographers. The self-developed electronic questionnaire (Addendum A7) was created using the Microsoft® Forms (2022) tool and disseminated electronically. Accompanying the questionnaire was a cover letter, detailing the purpose and nature of the survey, confidentiality and anonymity, voluntary participation and the estimated time required to complete the questionnaire (refer to Addendum A7).

3.4. Pilot study

A pilot study was performed allowing an opportunity to evaluate the questionnaire for ambiguity and clarity of the questions and before embarking on extensive data collection. A sample of five diagnostic radiographers employed at one of the study sites, participated in the pilot study. The five pilot participants comprised of the three levels of staff/seniority levels as defined by the organogram of the department at the hospital, namely junior, senior as well as chief radiographers. Each participant completed the pilot study questionnaire with ease and had minor commentary on suggested alterations that needed to be made to the questionnaire. These suggested changes were incorporated in the final questionnaire. Pilot study participants did not partake in the main study, and their responses were excluded from the results of the main study.

3.5. Research Population and Sample

The study population consisted of diagnostic radiographers working within the diagnostic radiography departments at three tertiary academic hospitals. A total of 149 radiographers across the three hospitals were invited to take part in the study, thus forming the study population. A sampling of convenience method was employed for the study where every radiographer available and willing to participate at the three research sites, were enrolled.

3.5.1. Inclusion criteria

- Qualified diagnostic radiographers employed at the selected public hospitals who volunteered to participate in the study.
- Job ranks included community service, junior, as well as senior/ chief radiographers, and ADs.
- Radiographers of all genders.

- Each participant had to have current registration with the Health Professions Council of South Africa (HPCSA).

3.5.2. Exclusion criteria

- Qualified radiographers who worked in other Radiography disciplines namely Nuclear Medicine Technology, Ultrasonography and Radiotherapy were excluded from the study.
- Locum diagnostic radiographers were excluded. This exclusion was due to the possible lack of familiarity of locum radiographers with protocols in a particular hospital.
- Radiography students in training (undergraduate program) were excluded from this study due to their incomplete training, which could bias the observed measures towards a lack of knowledge for the variables being evaluated.

3.6. Data Collection

Data was collected using questionnaires. The questionnaire comprised a series of closed-ended questions, each accompanied by unique identifiers and corresponding scoring metrics. Utilising Microsoft (MS) Forms®, the questionnaires were administered electronically, with a hyperlink distributed to participants for access via their work email accounts. Microsoft Forms® facilitated the automated transfer of responses into a Microsoft Excel® spreadsheet.

Questionnaires were assigned to each hospital by labelling them from Hospital One to Hospital three before being emailed to the ADs. In order to maintain anonymity of participants, no contact details were obtained by the researcher, and the questionnaire was distributed to the radiographers by the ADs. This process allowed for the identification of responses collected from each hospital, without any identifiable participant information. Subsequently, the individual Excel® sheets for each hospital were merged into a single dataset, facilitating the systematic organisation, analysis and interpretation of the combined data.

Questionnaire development was based on existing research and established guidelines on recommended radiographic views for suspected NAI, specifically drawing from the protocol jointly issued by the RCR and SCoR to ensure clinical relevance and alignment with accepted standards. See Addendum A1.

Data collection occurred between February 2022 and October 2022. In compliance with POPIA, the researcher ensured that all data and responses remained anonymised as the questionnaire did not include the collection of personal information. The responses were stored on a password protected computer and only the researcher had access to the password. In order to ensure the data was backed up, the data was synchronised with a OneDrive cloud, which was exclusively accessible by the researcher. No recruitment process followed; after obtaining ethics permission, questionnaire was disseminated by the ADs, and it was each radiographers' prerogative whether or not they wanted to participate.

3.7. Internal validity and Reliability

As part of ensuring internal validity and reliability in the study design and conceptualisation, several critical aspects were taken into account.

3.7.1. Internal validity

Slater and Hasson (2024:657) states that internal validity of a study is essential in assessing the quality and pertinence of the findings in relation to the study's objectives. Internal validity therefore pertains to the extent to which the individual scores generated by an instrument are accurate and relevant, which enables the researcher to draw well-founded conclusions from the sample population (Mohamad et al., 2015:165).

The questionnaire was meticulously designed to include questions that addressed all research objectives, ensuring its validity by clearly defining what the study intends to measure. To achieve this, open-ended responses were deliberately excluded, and considerable effort was invested in providing a comprehensive selection of multiple-choice responses. For instance, respondents were given a selection of answers to choose from when responding to each question. The questionnaire was thus structured to elicit precise answers that fully address the research objectives, thereby ensuring that the study measures what it was intended to measure from its inception, hence ensuring internal validity.

3.7.2. Reliability

Reliability pertains to the dependability and uniformity of a measurement tool over time. It guarantees that the instrument yields consistent outcomes when applied under identical conditions. Assessing the reliability involves evaluating the methods used to determine its stability and consistency (Mohamad et al., 2015:165). Essentially, reliability signifies an

instruments capacity to generate reproducible results in comparable situations (Bull et al., 2019:1024).

A pilot study was conducted to ascertain the reliability of the data collection tool. For this purpose, the questionnaire was distributed to five diagnostic radiographers of varying job ranks. The reported experiences and feedback from participants lead to the removal or reformulation of ambiguous and unclear questions. Only minor amendments were made based on feedback from the pilot participants. These steps were essential in enhancing the reliability of the final questionnaire, ensuring that it consistently and accurately measured the constructs of interest.

3.8. Data Analysis

Data analysis for this study was done with the support of a statistician. Microsoft® Excel and GraphPad Prism version 10.2.1, (GraphPad Software, Boston, Massachusetts, USA) was used for data analysis. The measures of central tendency (such as the mode, median or mean) and dispersion (range, standard deviation or interquartile range) were analysed based on the type (categorical or numerical) and distribution (parametric or non-parametric) of data (variables) being analysed. Responses in the form of numerical data were summarized using means and standard deviations for normally distributed variables or medians and interquartile ranges for non-parametric data. The data analysis involved comparing the results of all respondents across a number of independent variables including level of qualification, job rank and were stratified across the three hospitals included in the study. The most appropriate graphical displays were selected for each question to portray the responses in a clear and objective manner. Percentages were used in the analysis of many of the responses to ensure numerical standardisation for the samples across different groups and hospitals being compared.

These statistical methods were applied to provide an objective and systematic interpretation of the results, which helped to identify knowledge gaps and patterns in radiographers' understanding of NAI. This approach supports evidence-based recommendations for education, training, and clinical practice improvements.

Inherent response bias represented a methodological limitation of this study and was considered during the interpretation of the results. With a lower response rate and a relatively low sample size there is an increased risk that the responses may differ slightly from non-respondents in the sample. This may reduce the representativeness and

generalisability of the findings to the wider target population. The results of the study will be presented in Chapter 4.

3.9. Ethical Considerations

The ethical considerations applied for this study conformed with the Declaration of Helsinki, established by the World Medical Association (WMA) (WMA, 2013). The Helsinki Declaration provides comprehensive ethical guidelines for health science researchers conducting studies involving human subjects. It mandates that researchers prioritise the well-being, health, privacy and dignity of participants. Adhering to these principles ensures that the research not only complies with ethical standards but also fosters trust and respect between researchers and participants (WMA, 2013).

Prior to the commencement of this study, ethical approval was sought from the Research Ethics Committee (REC) of the Faculty of Health and Wellness Sciences at the Cape Peninsula University of Technology (approval number: CPUT/HW-REC 2021/H39, see Addendum A9) as well as from Research Committee of the Department of Allied Medicine Western Cape (see Addendum A5). This approval process required that the study complied with institutional and international ethical standards.

According to Gillon (1994:184), there are four main ethical tenets that must be observed in research studies namely beneficence, non-maleficence, respect for autonomy, and justice. These principles ensure that the research is conducted in a manner that maximises benefits, minimises harm, respects individual autonomy, and promotes fairness. Adherence to these principles is critical for maintaining the integrity of the research process and protecting the rights of participants (Gillon, 1994:187).

In order to protect the identity of participants and the research sites, participants names and that of the research sites would not be revealed when publishing the results of the study nor within any publication stemming from the findings of this study.

3.9.1. Beneficence and non-maleficence

The principle of beneficence underscores the imperative for researchers to prioritise the welfare of participants above any personal interests throughout the study. Furthermore, beneficence ensures that the benefits of the research significantly outweigh the risks, emphasising the positive impact of the study on the participants' well-being (HPCSA, 2016, Gillon, 1994:187). Adhering to the principle of non-maleficence, researchers are obliged to

minimise any risks to participants to the greatest extent possible (Gillon, 1994:185). As the study was conducted via an online questionnaire, no personal identifiable information was collected, thereby protecting participants identity and thus ensuring anonymity. Participants were fully informed about the study's purpose, their voluntary participation and their right to withdraw at any time as outlined in the participant information sheet (Addendum A6). To the author's knowledge, no participants were exposed to any harm (whether physical or emotional) during the data collection.

3.9.2. Respect for Autonomy

The principle of autonomy ensures that all participants have the right to self-determination, empowering them to make informed decisions regarding their involvement in the study (WMA, 2013). In this research study, participants' autonomy was rigorously upheld and protected. The participant information letter emphasised that participation was entirely voluntary and completing the questionnaire was at the sole discretion of the participants. Participants' rights to decline participation without providing reasons was fully respected and no participant was coerced into partaking in this research. Moreover, all participants had the right to withdraw from the study at any time. However, due to the anonymity of the questionnaire responses, withdrawal post-submission was not feasible.

3.9.3. Justice

According to the HPCSA (2016); justice in medical research enforces an ethical obligation so that research should treat each participant fairly. The participant should never be left worse off after the research. The questions asked should never be exploitative in nature; and the selection of inclusion and exclusion criteria should never be biased towards participants, with regards to their religious beliefs, ethnicity, language, age and sex or sexual orientation. No bias was shown towards any participant as all of them were treated in the same way. The same criteria applied across the three hospitals.

In order to protect the identity of participants and the research sites, participant's personal identifiers such as their names or identity numbers were not collected. The identity of the research sites will not be revealed when publishing the research findings. Each research site was given a unique number for identification: Hospital One, Two and Three. Consent to participate in the study was implied after each participant fully read the explanation and clicked on a link to complete and submit the questionnaire. The study was designed to minimise any disruptions to radiographers' workload or patient management ensuring that no harm or disruption of health services were caused by executing this study. Participants

were asks to complete the questionnaire after hours or during their free time. Additionally, no consumables were used at the research sites, and the institutions did not incur any additional expenses related to the study. Furthermore, all recorded data was securely stored and will be destroyed five years after completion of the study in accordance with ethical guidelines. Participants will be informed of the study's outcomes through dissemination of the results via the Radiography ADs and publications ensuring accessibility of results.

3.10. Chapter Conclusion

This chapter contains a detailed explanation of the research design and methodology used to undertake this research study. This includes an explanation of the pilot study, efforts to uphold reliability and internal validity of the research instrument, the data collection methods employed, the data analysis conducted as well as a discussion of the important ethical principles upheld during the data collection. The next chapter will discuss the results of the study.

CHAPTER FOUR

RESULTS

4.1. Chapter Introduction

This chapter presents the study's findings with regards to evaluating radiographers' knowledge and practices in identifying and reporting NAI. The analysis aligns with the study's objectives, providing insight into radiographers' knowledge regarding the signs and symptoms of NAI, their understanding of potential victims, the radiographic appearance of NAI and the protocols to follow when suspecting NAI. This chapter further explores several key themes, including the demographic and occupational characteristics of the respondents.

A composite scoring system was implemented for questions that allowed multiple correct responses or where successive questions warranted a combined evaluation. This approach, known as partial grading for multiple response questions, awards points for each correct option selected rather than requiring all correct options to be chosen for full credit. This method ensures that respondents receive partial credit based on their knowledge, even if they do not provide the entirely correct answer. The composite scoring system was particularly utilised for questions with more than one correct option. Ultimately, the overall knowledge of the respondents was assessed by summing the scores obtained from each graded question.

4.2. Demographic and occupational characteristics of respondents

Of the 149 eligible participants across the three tertiary academic hospitals, a response rate of 48% (n=72/149) was achieved. The response rate for each research site was as follows: Hospital One: 53% (n=10/19) Hospital Two: 50% (n=35/70) and Hospital Three: 45% (n=27/60).

The majority of respondents (93.1%) (n=67/72) in this study were females while males were significantly fewer (6.9%) (n=5). Good representation across the three job ranks was achieved across the three hospitals, with junior production radiographers accounting for more than half of respondents (52.8%) (n=38/72) compared to 36.1% (n=26/72) and 11.1% (n=8/72) for chief radiographers and community service radiographers respectively.

Respondents completing community service were as follows: Hospital one 14.8% (n=4/27) Hospital two 10% (n=1/10) and Hospital three 8.6% (n=3/35). When assessing qualifications of radiographers, an almost equal split was observed across the full sample with those

reporting having attained a National Diploma (ND) in Diagnostic Radiography 30.6% (n=22/72) Baccaluareas Technologiae or Bachelor of Technology (BTech) Radiography 34.7% (n=25/72) and BSc Radiography 34.7% (n=25/72). A summary of the demographics and occupational characteristics of the participants is presented in Table 4.1.

Table 4.1: Demographical characteristics of respondents.

	Hospital 1 (% participants & n)	**Hospital 2** (% participants & n)	**Hospital 3** (% participants & n)	**Total**
Number of participants across three research sites	37.5% (n=27)	13.9% (n=10)	48.6% (n=35)	100% n=72
Number of males	7.4% (n=2)	0% (n=0)	8.6% (n=3)	6.9% (n=5)
Number of females	92.6% (n=25)	100% (n=10)	91.4% (n=32)	93.1% (n=67)
Rank of participants/respondents				
Number of chief radiographers	29.6% (n=8)	60% (n=6)	34.2% (n=12)	36.1% (n=26)
Number of production radiographers	55.6% (n=15)	30% (n=3)	57.2% (n=20)	52.8% (n=38)
Number of community service radiographers	14.8% (n=4)	10% (n=1)	8.6% (n=3)	11.1% (n=8)
Highest academic qualifications				
National Diploma (ND): Diagnostic Radiography	18.5% (n=5)	40% (n=4)	37.1% (n=13)	30.6% (n=22)
BTech Radiography	44.4% (n=12)	40% (n=4)	25.7% (n=9)	34.7% (n=25)
BSc Radiography	37.1% (n=10)	20% (n=2)	37.1% (n=13)	34.7% (n=25)

n: Number of participants; BSc: Bachelor of Sciences; B Tech: Baccalaureus Technologiae; ND: National Diploma

4.3. Radiographer's knowledge of NAI and associated symptoms

The majority of radiographers (96%) (n=69/72) knew what the NAI acronym stands for (answered Yes), whilst 2.7% (n=2/72) reported not being sure and 1.3% (n=1) not knowing the meaning of NAI (Refer to Figure 4.1).

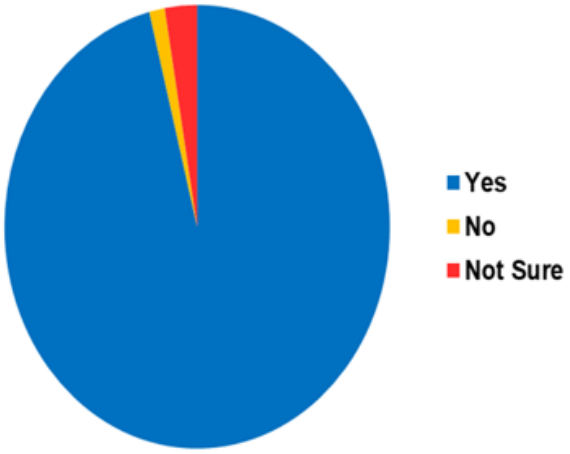

Figure 4.1: Radiographers' knowledge of the NAI acronym.

When asked to select a description of NAI from four options the majority of participants (97.2%) (n=70/72) selected 'Physical Abuse and Neglect', while 1.4% (n=1/72) selected 'Domestic Abuse' and another 1.4% (n=1/72) selected 'Pathology' (Refer to Figure 4.2). No participant selected Emotional abuse.

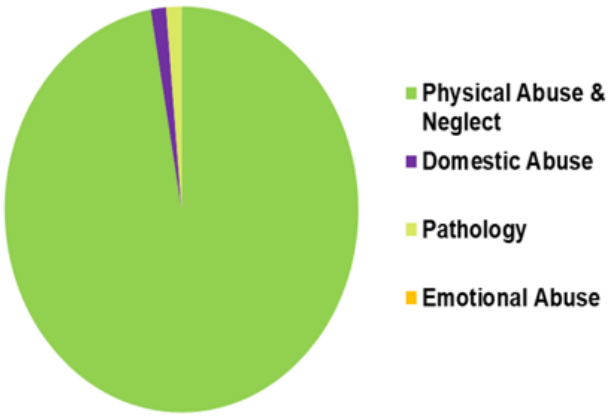

Figure 4.2: Radiographers' selection of what best describes NAI

Radiographers' knowledge regarding the potential signs and symptoms of a child with suspected NAI were evaluated through the provision of 24 choices from which they could choose (see Addendum A7: Question 7). Multiple selections were allowed for this question. For calculation purposes, a three-point criterion referenced style scoring system was used to categorise the overall responses of participants for this question. The scoring system divided the answers into three groups, with 0 being the lowest assigned score implying poor

knowledge, a score of 1 denoted a moderate level of understanding and 2 being the highest score, reflected a good understanding of the signs and symptoms of NAI. Pre-established percentage ranges were assigned to the categories: 0-33% correct answers scored 0 (which for the purposes of this study implied a poor score), 34-66% scored 1 (which for the purposes of this study implied a moderate score) and 67-99% correct answers scored 2 (which for the purposes of this study implied a good score). The highest score of 2 was achieved by 37.5% (n=27/72) of respondents, while 50% (n=36/72) of the respondents scored 1 and 12.5% (n=9/72) scored 0 (portending to poor knowledge). Refer to Figure 4.3 below.

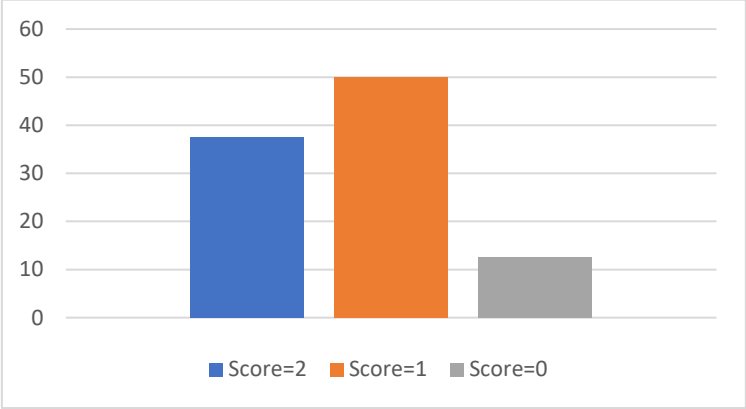

Figure 4.3: Radiographers' knowledge regarding the signs and symptoms of NAI

A breakdown of the scores evaluating the identification of the signs and symptoms of NAI, according to job ranks, revealed that a higher proportion of chief radiographers (50%) scored a maximum of 2 (good score: 67-99% range), when compared to 26% of community service and 31% of production radiographers respectively (Refer to Figure 4.4).

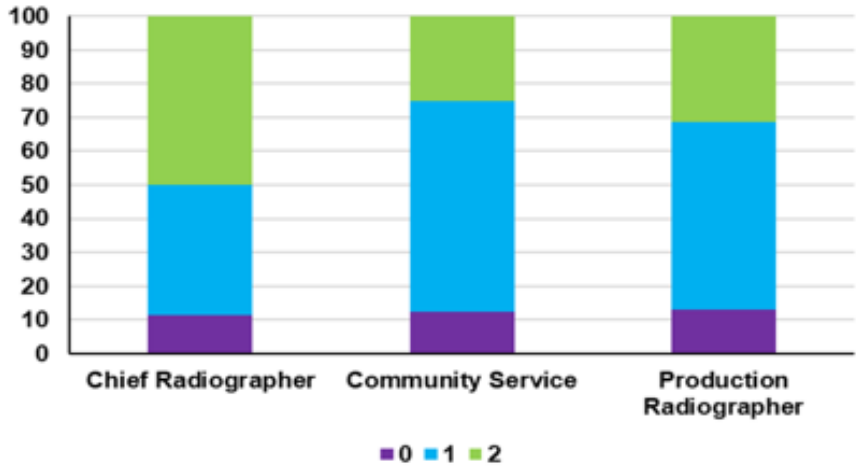

Figure 4.4: Radiographers scores across job ranks

When stratifying radiographer's responses across levels of qualifications attained, 55% of radiographers with a ND scored a maximum of 2 (good score: 67-99% range) followed by 45% of radiographers with a B Tech degree. Only 16% of radiographers with a BSc degree achieved a score of 2 (Refer to Figure 4.5).

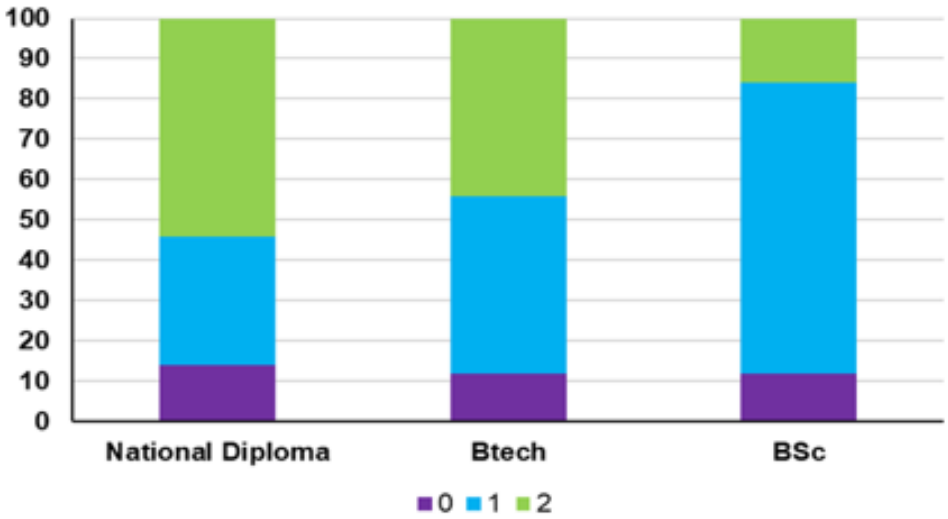

Figure 4.5: Responses scores across qualifications

4.4. Radiographer's ability to diagnose NAI based on imaging appearances

To assess radiographers' knowledge of NAI based on interpretation of diagnostic projection images, a list of 16 imaging outcomes (see Addendum A7 Q:9) were provided and radiographers were asked to choose possible radiographic appearances related to NAI. Like for Section 4.3 above, the same scoring system from 0-2 was used to evaluate respondents' knowledge. As illustrated in Figures 4.6 and 4.7 below, neither job rank nor qualification demonstrated a significant influence on radiographers' knowledge of radiographic imaging features associated with NAI. In terms of job ranks, only 11% of chief radiographers, 12% of Community service radiographers and18% of production radiographers scored a maximum of 2 (suggesting a good score) (i.e. 67-99% range).

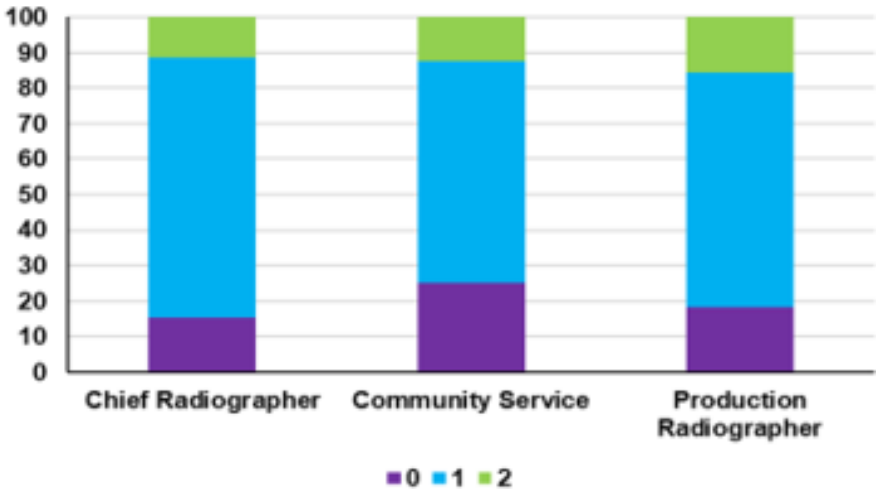

Figure 4.6: Radiographers reported ability to diagnose NAI on imaging scores across job ranks

In terms of qualifications, about 19% of radiographers with a ND, 11% of radiographers with a B-Tech and BSc degree scored a maximum of 2 (suggesting a good score) (i.e. 67-99% range).

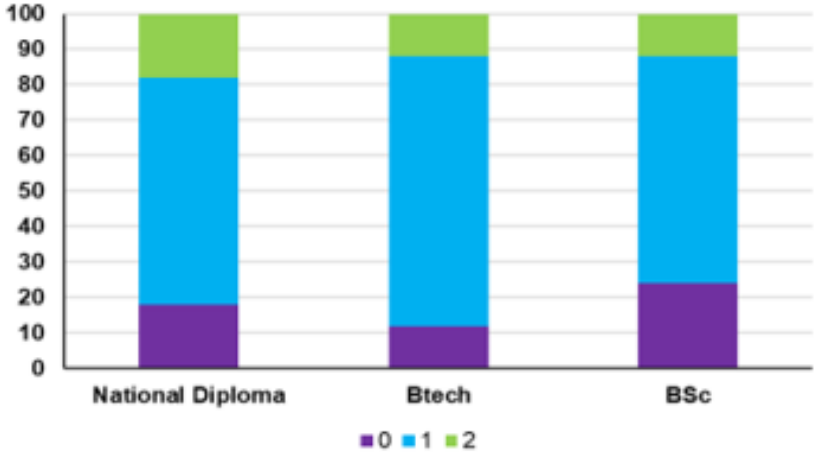

Figure 4.7: Radiographers reported ability to diagnose NAI on imaging scores across academic qualification

4.5. Radiographer's knowledge of potential victims of NAI

To assess radiographers' understanding of a potential NAI victim profile, a question with four potential responses such as "adolescents and children", "adults", "elderly" and "all of the above" was formulated (see Addendum A7: Q10). Sixty percent of respondents selected the right answer, 32% selected "all of the above" and 8% (combined) erroneously believed that

adults and elderly were also included[3]. The full breakdown of responses is portrayed in Figure 4.8 below.

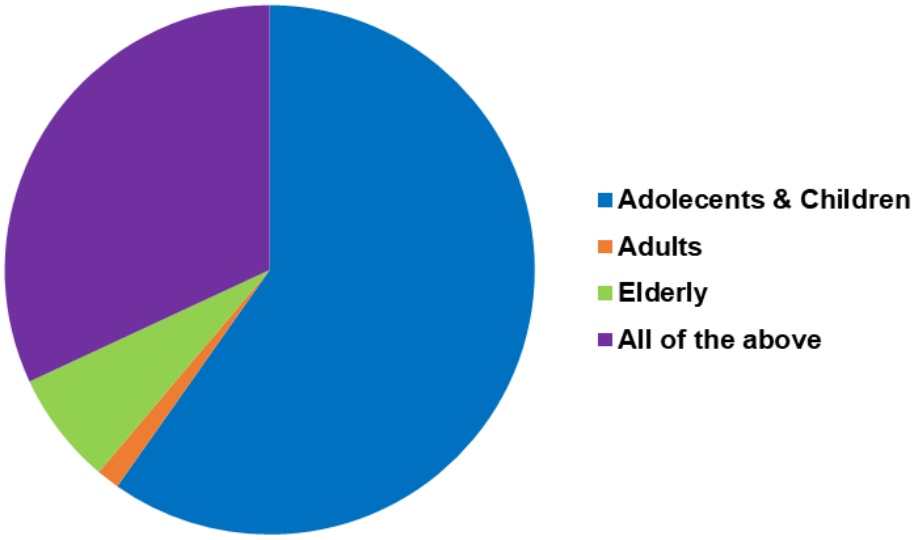

Figure 4.8: Radiographers' knowledge of a potential NAI victim profile.

4.6. Radiographer's knowledge of NAI protocols

The radiographers' knowledge regarding radiographic and hospital protocols used for suspected or confirmed NAI victims was assessed through the administration of three questions (see Addendum A7: Q11-Q13) (i) whether the department had radiographic protocols for suspected NAI, (ii) how to handle suspected cases, and (iii) whether or not a reporting procedure was in place. For the radiographic protocol, 71% (n=51/72) of participants stated being familiar with it, 25% (n=18/72) were unsure and 4% (n=3/72) said that there was no radiographic protocol (Refer to Figure 4.9).

[3] NAI as a clinical description has recently been replaced by Suspected Physical Abuse (SPA) which now include both elderly and children. These results are therefore reported within the context of the researcher using the term NAI within the context of child abuse only.

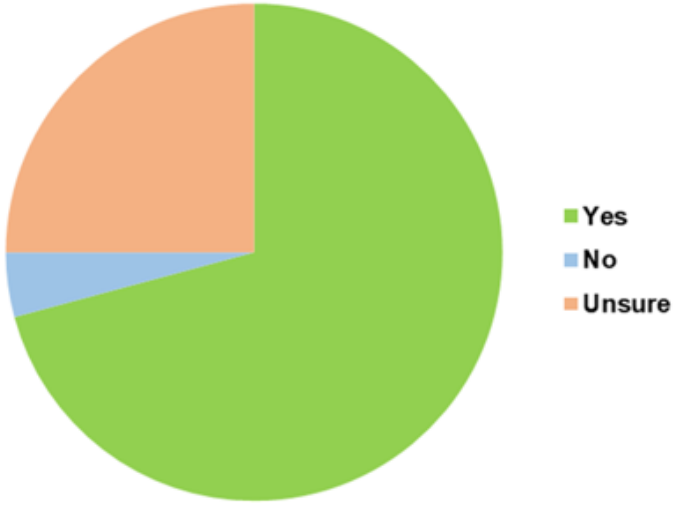

Figure 4.9: Radiographers familiarity with radiographic protocols

Knowledge of the radiographic protocol used was consistent across the various job ranks stratified in this study: Among chief radiographers, 73% (n=19/26) reported awareness of the protocol, compared to 62.5% (n=5/8) of community service radiographers and 71% (n=27/38) of production radiographers (Refer to Figure 4.10).

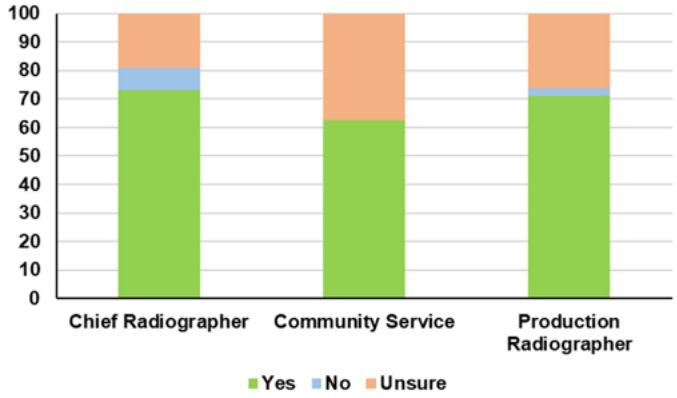

Figure 4.10: Radiographers familiarity with radiographic protocols across job ranks

The evaluation of participants knowledge of hospital protocols for reporting procedures for suspected NAI revealed that 60% of all participants (n=43/72) reported being familiar with these protocols, confirming their knowledge of the hospital's procedure for reporting suspected NAI cases (Refer to Figure 4.11).

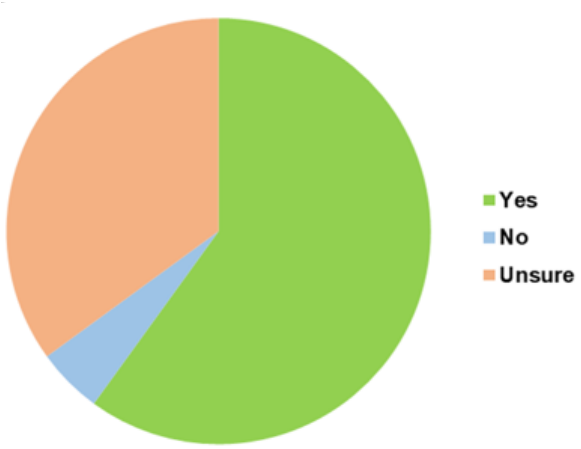

Figure 4.11: Radiographers familiarity with reporting procedure for NAI cases

Knowledge of reporting procedure was not significantly influenced by job rank. Awareness of the reporting procedure was reported by 61.5% (n=16/26) of chief radiographers, 62.5% (n=5/8) of community service radiographers and 59% (n=22/38) of production radiographers (Refer to Figure 4.12).

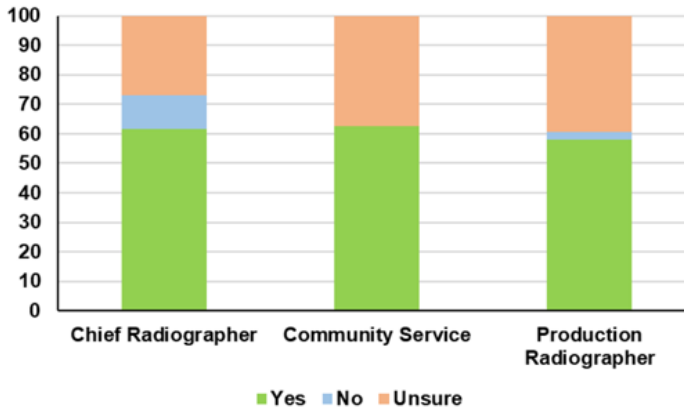

Figure 4.12: Radiographers familiarity with reporting procedure for NAI cases across job ranks.

4.7. Radiographers' knowledge of reporting procedures once NAI confirmed

Radiographers' knowledge about the implementation of reporting procedures was assessed through a question with five possible answers (See Addendum A7: Q14): asking the parents/guardian's about the incident or what they did, informing the radiologist, informing the immediate supervisor, showing other colleagues and inquiring with parents/guardians if the child has any obvious or suspected NAI related injuries. Three of these options were correct within the context of possible reporting procedures to follow. A score of 0 was

allocated for the selection of none or only one of the three correct answers: a score of 1 assigned for the selection of two out of the three correct answers and a top score of 2 awarded for selecting all three correct responses. Reponses to this question revealed a relatively poor knowledge (i.e. a score of 0) amongst chief radiographers on the subject with 57.7% of them scoring 0. This score was more than double of that observed amongst community service (25%) and significantly more than production radiographer groups (29%) (Refer to Figure 4.13).

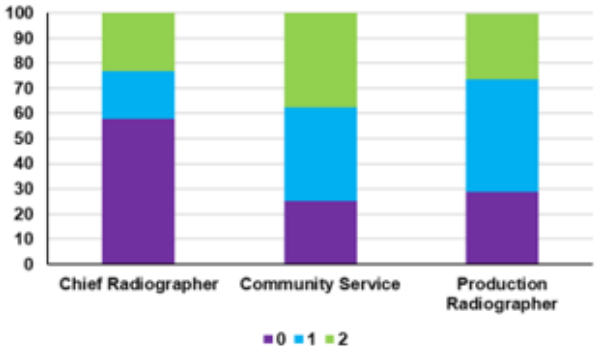

Figure 4.13: Radiographers' knowledge of reporting procedures of confirmed NAI scores across job ranks

A similar trend with regard to radiographers' knowledge of reporting procedures was observed when comparing radiographers holding a ND to those with a BTech or BSc qualification. Among ND holders, 59% (n=13/22) scored 0, while 24% (n=6/25) of BTech graduates and 36% (n=9/25) of BSc graduates scored 0 (Refer to Figure 4.14).

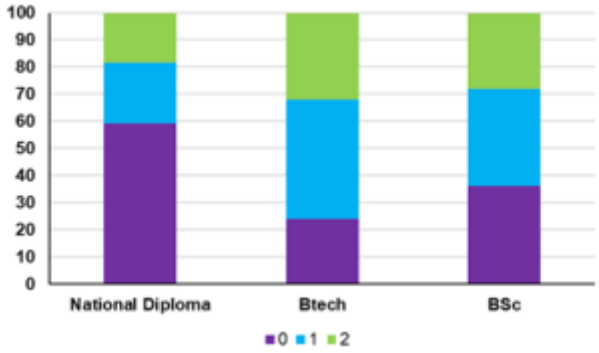

Figure 4.14: Radiographers' knowledge of reporting procedures of confirmed NAI scores across qualification attained

4.8. Radiographer's knowledge of perpetrators of NAI

Two questions were formulated within the questionnaire to evaluate radiographers' knowledge regarding the usual perpetrators for suspected NAI cases (see Addendum A7: Q19-20). Questions carried a maximum score of 2 for both correct answers, 1 for only one correct answer and a 0 was graded for a wrong response. Results varied somewhat, with 19% of chief radiographers scoring 0, compared to 4% of production radiographers soring 0 (i.e. poor responses for both groups). About 50% of community service radiographers scored 1 and 2 respectively (suggesting both moderate and good responses).

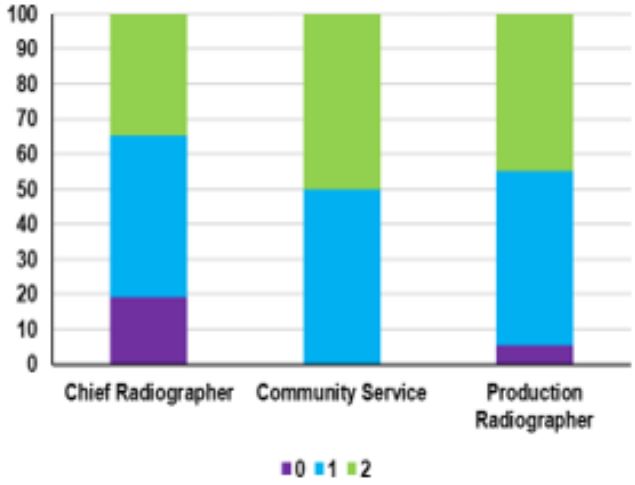

Figure 4.15: Radiographers' knowledge of the common perpetrators of NAI across job ranks

For the same question regarding possible perpetrators of NAI, results varied amongst different qualifications with about 18% of radiographers with a ND, 2% of those with a BTech and 8 % of those with a BSc degree scoring 0 respectively.

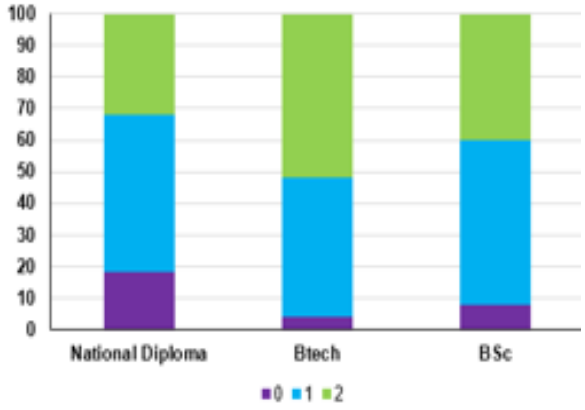

Figure 4.16: Radiographers' knowledge of the common perpetrators of NAI across qualifications

4.9. Radiographer's knowledge regarding imaging required for suspected NAI cases

4.9.1. Common/recommended views

Two questions were formulated to evaluate the radiographer's knowledge regarding recommended conventional diagnostic views to be taken for suspected NAI cases for children younger or older than two years of age (see Addendum A7: Q15 and Q16). The first two questions aimed to assess radiographers' knowledge and adherence to department-specific protocols for imaging suspected NAI. Each question carried a maximum score of 2. A score of 0 was graded for none or one correct response, while a score of 1 was graded for two correct responses and a maximum score of 2 was graded for three correct answers. Since each question included three correct answers, the two questions combined, allowed for a maximum of six correct responses. The questions differentiated the recommended views into two categories, either below two years old or above two years old.

The overall scores regarding radiographers' knowledge on recommended X-ray views across different job ranks and qualifications indicated a substantial proportion of respondents scoring 0 (refer to Figures 4.17 and 4.18). For recommended views for children below two years old, 81% of chief radiographers, 78% of production radiographers and 100% of community service radiographers scored 0, suggesting a poor understanding.

Regarding recommended views for children above two years old, 80,5% of chief radiographers, 72% of production radiographers and 73.6% of community service radiographers scored 0, suggesting a poor understanding across all job ranks.

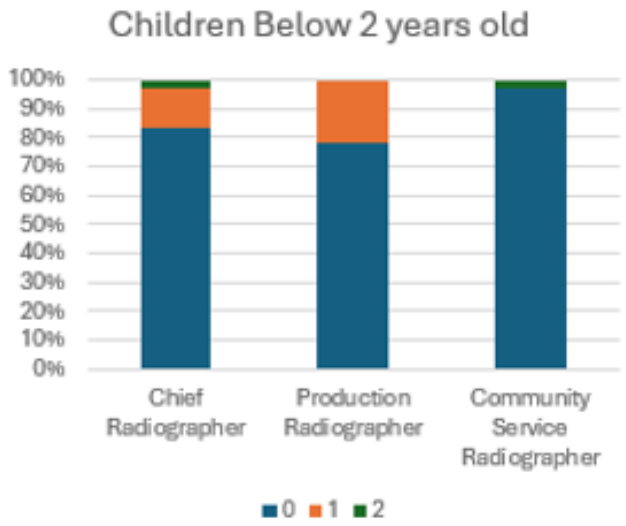

Figure 4.17: Radiographers' knowledge of the common and recommended views taken for suspected NAI cases scores across job ranks

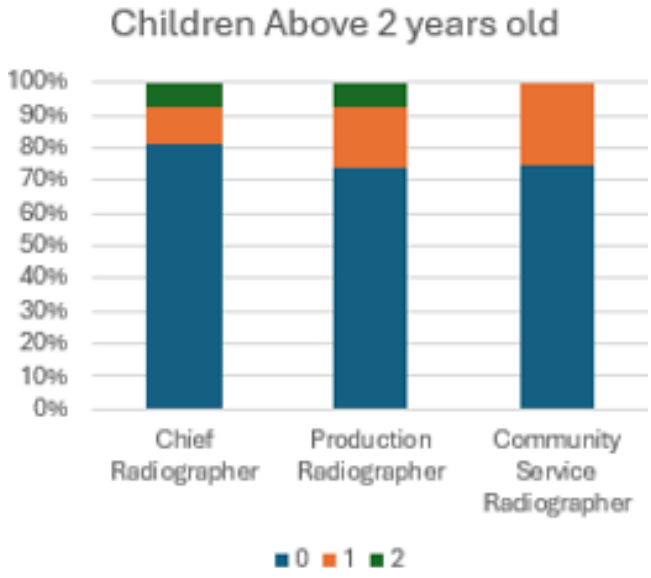

Figure 4.18: Radiographers' knowledge of the common and recommended views taken for suspected NAI cases scores across job ranks

When examining scores based on the highest qualification achieved (Figures 4.19 and 4.20), 72.7% ND holders, 92% of BSc graduates and 84% of BTech graduates scored 0 for recommended views for children below two years of age. About 77,3% of ND holders, 71% of BSc graduates and 80% of BTech graduates scoring 0 for recommended views for children above two years old.

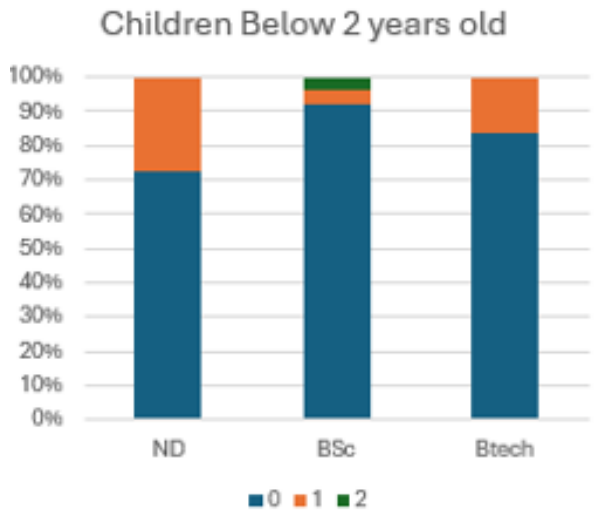

Figure 4.19: Radiographers' knowledge of the common and recommended views taken for suspected NAI cases scores across qualification attained

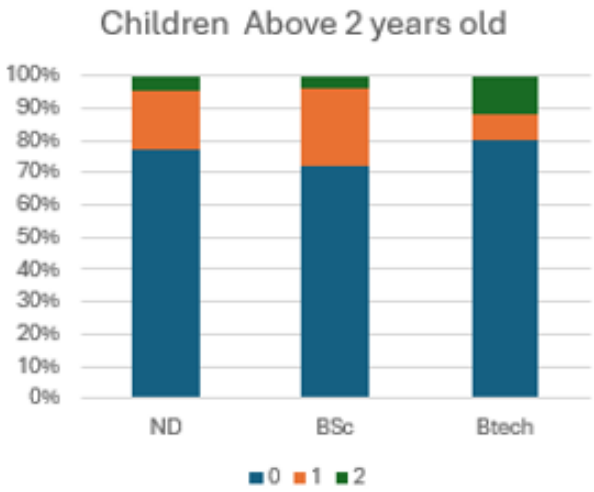

Figure 4.20: Radiographers' knowledge of the common and recommended views taken for suspected NAI cases scores across qualification attained.

4.9.2. Evaluation of Radiographer Knowledge and Specified Views in Suspected NAI cases

Radiographers' knowledge of the appropriate imaging views required for suspected NAI were also assessed (See Addendum A7: Q17). Given that certain fractures and injuries are highly suggestive of abuse, a standardised skeletal survey is essential for accurate diagnosis. A maximum possible score of 18 could be attained based on responses to the graded question. Correct responses to the questionnaire were determined by guidelines drawn up by RCR and American Academy of Pediatrics (AAP) based on the imaging guidelines for suspected NAI cases (AAP, 2009) and (The RCR & SCoR, 2018). Among the

32 available options were options such as lateral skull, erect abdomen, oblique rib views and lateral chest views amongst others. The final score was then converted into percentage for an easier interpretation of the findings. The mean score across all 72 (total n=149) respondents was 48%, with the range being between 17-78%. No significant difference was observed when comparing scores across either job ranks or highest qualification achieved. The box and whisker plots below provide a detailed measure of dispersion and central tendency for each of the listed categories. The whiskers extend from the lowest to the highest score. The box encapsulates the 50% percentile of scores (the 2nd and 3rd quartiles) and the central line within the box denotes the median.

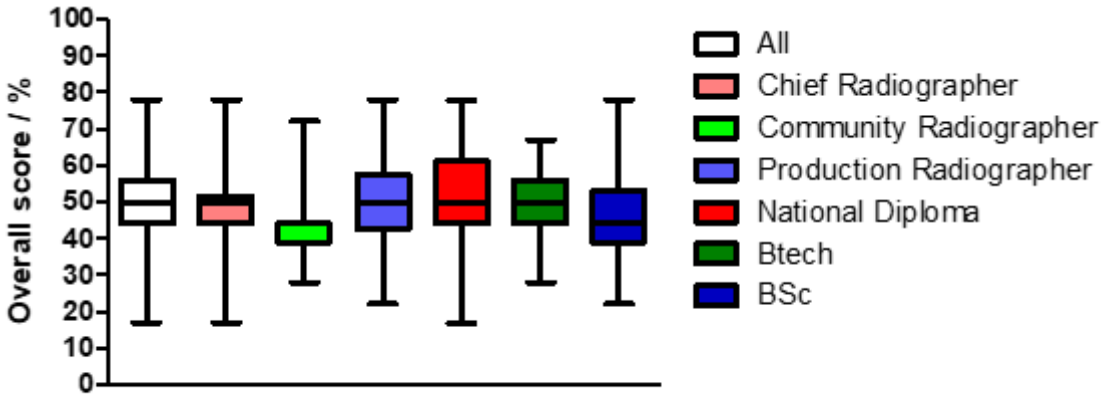

Figure 4.21: Radiographers overall knowledge of specified views for NAI across job ranks and highest qualification achieved

4.10. Radiographer's knowledge on direct line of reporting for suspected NAI cases

In response to the question regarding to whom suspected cases of NAI should be reported radiographers selected a variety of options. The distribution of responses was as follows: 97.2% (n=70/72) of radiographers indicated that they would report to the immediate supervisor or the referring physician on duty if the supervisor was not available. A smaller number of radiographers, 1.38% (n=1/72), chose to report to the immediate supervisor or referring physician on duty as well as colleagues. Another 1.38% (n=1/72) selected a combination of reporting to the immediate supervisor or referring physician on duty, the victim's parents or the guardian if no parent was present.

4.11. Radiographer's knowledge on the role of bone scintigraphy in imaging NAI

In response to the question regarding the role of bone scintigraphy in imaging suspected NAI cases, 33.3% of radiographers (n=24/72) answered affirmatively, earning a score of 1 point, while the remaining respondents either answered 'no' or expressed uncertainty about its purpose in suspected NAI cases. The proportion of correct responses was almost similar among chief radiographers (38.5%) (n=10/26) and community radiographers (37.5%) (n=3/8), with the lowest correct response rate observed among production radiographers (28.9%) (n=11/38). No significant differences were observed across the highest qualifications attained, with a marginal difference of 4% across groups. The distribution of correct responses based on qualifications was as follows: BSc Radiography 32% (n=8/25), BTech Radiography 36% (n=9/25), and National Diploma 31.81% (n=7/22).

4.12. Comparison of radiographers' general knowledge of NAI across the three hospitals

The box and whisker plot compares the overall scores of radiographers' knowledge of NAI across three hospitals. General knowledge of NAI was determined for each participant by adding the overall scores they obtained for each question included in the questionnaire. Then, this overall knowledge was evaluated for each hospital by plotting the median and interquartile range for participants in each hospital, and these metrics compared across hospitals.

When comparing the overall performance scores among the participating hospitals, Hospital Two recorded the highest average mean score of 57.3%. This result was statistically significantly higher than that of Hospital One, which had the lowest average score at 42.9%, indicating a meaningful disparity in performance levels between these two institutions. Although Hospital Two also achieved a higher average score when compared to Hospital Three, which recorded a mean of 49.7%, the difference between these two was not statistically significant. The dispersion across scoring was comparable for Hospital Two and Hospital One (SD: 8.9% and 9.5% respectively) and was highest for Hospital Three (SD: 13.7%).

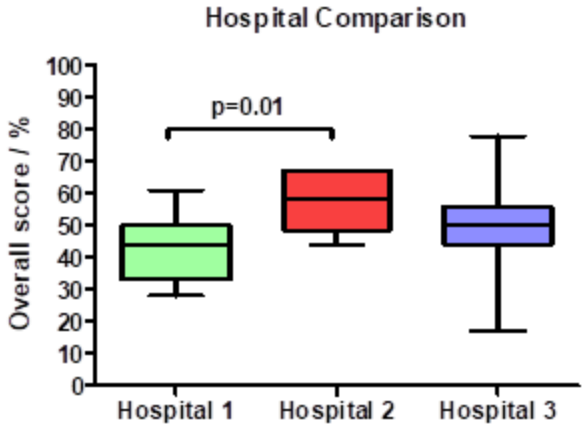

Figure 4.22: Comparison of radiographers' overall knowledge of NAI across the three hospitals indicates that hospital one achieved the lowest overall score with hospital two being the highest and hospital three ranked in between

Hospital Two had the highest and most consistent scores, with a narrow interquartile range (IQR) and scores ranged between 40% to 80%. Hospital one had the lowest median scores, indicating the lowest overall knowledge, as scores ranged between 30% to 70%. Hospital three had a wider range of scores, showing more variability, as scores ranged between 20% to 80%. The overall scores across the three hospitals were compared using one-way analysis of variance. An overall p-value of 0.0038 was indicative of differences for overall scores across the three hospitals. Bonferroni's Multiple Comparison Test then revealed a p-value of 0.001 when comparing Hospital 1 to Hospital 2.

The p-value (p=0.01) indicates a statistically significant difference in scores between Hospital Two and Hospital One. This suggests that radiographers at Hospital Two had better general knowledge of NAI, while radiographers at Hospital One may need improved training. Hospital Three shows variability, suggesting diverse educational backgrounds or understanding of the subject.

4.13. Chapter Conclusion

The findings in this chapter highlighted variability amongst the scores across the different questions posed. Some radiographers had a good level of awareness with regard to the NAI definition, and what the signs and symptoms are, yet revealed knowledge gaps related to imaging protocols, views to be taken and reporting procedures. While job ranks and educational background had limited influence on the respondents scores, there was variation found across the three hospitals. Hospital two demonstrated higher overall

knowledge regarding NAI as a subject. These results highlight the need for targeted training interventions and programs in order to ensure consistency in practice and standardisation of effective radiographic protocols and procedures in suspected NAI cases. In the next chapter the findings are interpreted and its relevance for radiographers' practice is discussed and associated recommendations are made.

CHAPTER FIVE

DISCUSSION & CONCLUSION

5.1. Chapter Introduction

This discussion chapter provides a comprehensive interpretation and critical analysis of the findings presented in Chapter Four. The chapter examines the participants responses as it relates to the research questions and provides exploration of demographical variables such as the gender distribution, job ranks and educational qualifications of participants. Other aspects described are radiographers understanding of NAI terminology, radiographic views required and protocols to follow in suspected child abuse cases. The chapter concludes with insights into the professional implications of the findings and a description of a series of recommendations derived from the study's results. This chapter also describe the limitations of this research study.

5.2. Demographic and occupational characteristics of respondents

5.2.1. Response Rate

Of the 149 eligible participants identified across the three tertiary academic hospitals, 72 diagnostic radiographers responded to the study questionnaire, resulting in a response rate of 48%. Achieving a responses rate of 48% is acceptable for a survey of this nature. A meta-analysis conducted by Wu et al. (2022:9) deemed a response rate of 44.1% with an online survey as reasonable as it indicates a reasonable level of participation. Therefore, a response rate of 48% within the current study can be considered acceptable and comparable to a study by Van Rijn et al. (2009:147-148) that achieved 39%. Conversely, considering that the sample frame consisted of three tertiary academic hospitals, where teaching and learning as well as research is important, a higher interest in participation was anticipated for this survey.

5.2.2. Gender Distribution

The gender distribution among the respondents was unsurprising. Over 93% of the respondents identified as females, while only 6.9% identified as males. This gender disparity in this study is consistent with national demographical trends (Mkhize et al., 2022:1).

5.2.3. Job ranks of respondents

The study achieved good participation across the three job ranks within the three hospitals. Junior production radiographers accounted for more than half of the respondents, indicating that the study captures responses from those at the frontlines of radiographic practice. Notably, there was a difference in the proportion of respondents identifying as chief radiographers across the three hospitals. Hospital Two had a significantly higher percentage of chief radiographers (60%) compared to Hospital Three (34.2%) and Hospital One (29.6%).

5.2.4. Qualifications amongst participants

The distribution of qualifications namely National Diploma, BTech Radiography, and BSc Radiography was almost evenly split among radiographers across the three hospitals. This is an important finding as it suggests that the sample was diverse in terms of educational background, which can be an advantage when evaluating knowledge and skills across different qualifications achieved. It also reflects the heterogenous nature of qualifications within the Radiography profession based on anecdotal evidence particularly in the metropole where the study was conducted. These findings therefore provide a balanced and representative view of the knowledge and practices of radiographers at the three research sites.

5.3. Knowledge of NAI Terminology

Very few research studies exist which measured radiographer's knowledge of NAI and the protocols to be followed during imaging and the management of suspected NAI cases. This research, therefore, will add to the limited body of knowledge in this area.

The study reveals that the majority of radiographers demonstrated familiarity with the NAI acronym, with an overwhelming 96% of respondents correctly identifying the meaning. This finding suggests that radiographers within this study were well-informed about the term 'NAI'.

When radiographers were asked to select the best description of NAI from a list of options, a substantial majority (97.2%) correctly identified *'Physical Abuse and Neglect'* as the most appropriate description for this disease entity. However, it is worth noting that a small percentage (1.4%) chose alternative incorrect options, such as *'Domestic Abuse'* and *'Pathology'*. These responses could be indicative of some confusion or differing interpretations of NAI. A study by Ewuzie (2021:100) found that 98% of participants

recognised the need for additional training for radiographers in the identification and management of NAI cases.

5.4. Knowledge of Signs and Symptoms

Radiographers' knowledge of the potential signs and symptoms that a child with suspected NAI may present with is a critical aspect of their role in managing and identifying possible cases of abuse. This study presented a detailed list of 24 potential indicators for suspected NAI of which only 13 indicators were correct. Among the options were long bone fractures, skull fractures, bruises, burns, lack of eye contact, fear of sudden movement, delayed developmental milestones, withdrawal, poor hygiene or dental care, bite marks, belt marks, inconsistent clinical history and varying explanations for injuries, drowsiness, excessive crying, skull fractures, bruises, burns and a lack of eye contact; which are common abuse indicators (Mohamed & Naidoo, 2014:253; Quigley & Stafrace, 2014:83,84). This format enabled radiographers to identify multiple relevant signs and symptoms. A scoring system was used to evaluate their responses, with a score of 0 indicating poor knowledge and a score of 2 reflecting a good ability to recognise NAI signs and symptoms.

The findings indicated that just under a quarter of radiographers (37.5%) achieved the highest score of 2, suggesting that some had a good understanding of the potential signs and symptoms associated with NAI. Half of the respondents fell in the intermediate category with a score of 1. Nevertheless, it is concerning that 12.5% of respondents exhibited poor knowledge with an aggregated score of 0.

When analysing the scoring for the same question based on job ranks, a higher proportion of chief radiographers scored the highest, possibly, as a result of them being more experienced and having had more exposure in dealing with child abuse cases. Notably, 12.5% (n=9/72) scored 0 across all three job rank categories, underscoring lack of understanding of indicators for suspected NAI cases amongst the job ranks.

Surprisingly, when stratifying the scores based on the qualification attained, there were no apparent trends. This suggests that knowledge regarding the clinical indicators for suspected NAI, such as relevant signs and symptoms, did not significantly vary based on educational qualifications. The researcher could not compare these findings against similar studies in the exiting literature, as no directly comparable research focusing on radiographers’ qualifications and NAI knowledge could be found.

The results of this study indicate that radiographers generally have a good understanding of NAI terminology and its description. Nonetheless, there is room for improvement, particularly their knowledge regarding the potential signs and symptoms of NAI. It is important for radiographers, to fully understand NAI and their associated signs and symptoms for the early identification and intervention of child abuse cases. It is imperative to avoid missing a diagnosis of child abuse, as failure to do so can significantly increase the risk of further harm to the child [and siblings] (Strouse, 2018:446).

5.5. Familiarity with Radiographic Protocol

This study revealed that 71% of the respondents reported familiarity with the radiographic protocol for NAI cases. This is a favourable outcome, suggesting that a significant proportion of participating radiographers possess adequate knowledge of the appropriate imaging procedures to follow in cases of suspected NAI.

Further analysis showed that familiarity with the radiographic protocol did not significantly vary across different job ranks. This suggests that radiographers across the various job ranks levels were reportedly equally aware of these protocols. As the study relied on questionnaire response-based data collection, there was no objective or scientific method employed to independently verify or dispute these findings. However, it is essential to ensure that this knowledge is maintained and updated, as imaging and managing protocols may change over time as guidelines and best practices evolve (Nguyen & Hart, 2018:125).

One of the primary roles of the radiographer is to produce high-quality diagnostic X-ray images using appropriate and standardised protocols. Other imaging modalities can be beneficial in identifying injuries related to NAI. For instance, CT and MRI scanning offer the advantage of cross-sectional imaging. CT is particularly effective in detecting subtle skull fractures or intracranial haemorrhages, and MRI being adept at identifying intracranial parenchymal injuries or extracranial soft tissue haematomas (Nguyen & Hart, 2018:126,127). Therefore, the use of multiple imaging techniques is pivotal in the assessment of NAI, and radiographers play a crucial role in this process.

Radiographers' familiarity with NAI protocols is crucial as they play a significant role in detection, reporting, and appropriate management of child abuse cases (Antwi et al., 2019:51). Radiographic protocols for suspected or confirmed cases of NAI are critical in ensuring that radiographers adhere to appropriate imaging and documentation procedures (Doyle & Vuong, 2019:5). Skeletal injuries are widely regarded as the strongest markers of child abuse (AAP, 2009) and indirectly indicates the critical role imaging play in the

diagnosis. Radiographers therefore have an essential role in obtaining good quality images and need to know how to identify and report child abuse. It is imperative that healthcare institutions facilitate comprehensive and ongoing training and education programs on how to manage suspected NAI patients.

5.6. Radiographers' knowledge of protocols for confirmed NAI and hospital reporting

Once NAI is confirmed, radiographers need to know the proper procedures to follow when handling such cases. The study found that, among the 51 respondents who reported being familiar with the radiographic protocols to follow, only 49% reported knowing the process to follow once a diagnosis of NAI has been made. This indicates a potential gap in understanding how to proceed once child abuse has been confirmed, which is a crucial phase in ensuring the safety of the child. Naddour et al. (2024:2) concurs by emphasising the need for structured referral mechanisms and training for healthcare professionals to enhance child protective efforts.

In this study 60% of radiographers reported being familiar with the hospital protocol for reporting suspected NAI cases. This level of familiarity appeared consistent across job ranks, which indicated that knowledge of the hospital protocol was not influenced by job ranks.

Dessena and Mullan (2018:61) identified significant deficiencies in both the perceived and actual knowledge of healthcare providers regarding the emergency management of child abuse cases. Their study underscores the urgent need to expand and enhance training programs and knowledge among healthcare providers such as emergency medicine registrars and emergency care practitioners, particularly in the Cape Metropole. It is imperative that radiographers are well-equipped to accurately identify and report cases of child abuse. Furthermore, it is the authors' view that continuous research in this domain is essential to refine training programs and interventions, ultimately improving the healthcare system's response to child abuse cases.

Finally, it was encouraging that a greater portion of radiographers (n=43/72) (59.7%) were aware of the hospital's reporting procedure for suspected NAI cases. Continuous education and updates on NAI protocols and procedures will be essential to maintain and improve the knowledge and response of those radiographers who reported not knowing the protocols for identifying and managing child abuse cases.

5.7. Knowledge of reporting procedures for confirmed NAI

With regards to reporting procedures for confirmed NAI cases, the results indicated that a significant proportion of radiographers scored 0, reflecting suboptimal knowledge of the reporting procedures for confirmed NAI cases. Chief radiographers demonstrated particularly poor understanding, with 57.7% scoring 0. In contrast, lower percentages of 0 scores were observed among community service radiographers (25%) and production radiographers (29%).

When comparing different qualifications obtained a very similar pattern was observed, suggesting that level of training did not significantly improve radiographers' knowledge of reporting procedures for confirmed NAI cases. These findings highlight a notable gap in knowledge that could be related to theoretical training, among radiographers as it relates to reporting procedures for confirmed NAI cases. Ulhaq (2021:179), highlights the crucial role that healthcare professionals play in the reporting of abuse cases as they are often the first to detect signs of abuse. Given the importance of this aspect in ensuring child safety and the legal obligations associated with reporting such cases (South Africa, 2006), targeted education and training programs are warranted to enhance radiographers understanding of reporting practices.

A study by Ewuzie (2021:100) reported a lack of standardised practices for paediatric imaging with only 20.4% of their respondents having received formal training in paediatric radiography while 65.3% were not taught any aspects related to NAI. The study participants expressed a strong belief that radiographers would greatly benefit from specialised training in handling NAI cases in children. A comparable finding was made by Rigney and Davis (2004:7), where a large majority of radiographers (70%) requested further education and training for managing NAI based on their minimal training and limited knowledge.

5.8. Knowledge of Common/Recommended Imaging Views for Suspected NAI Cases

The study also evaluated radiographers' knowledge about recommended radiographic views for suspected NAI cases in children both younger and older than 2 years of age. The results indicated an overwhelmingly low level of knowledge among the participating radiographers. Close to 70% of respondents scored 1 or 2 out of a maximum possible score of 6 correct responses across job ranks, and the highest qualifications attained. This suggest that the radiographers in this study were not adequately aware of the appropriate diagnostic

conventional diagnostic radiographic views to perform for suspected NAI cases. The lack of knowledge in this regard could impact radiological interpretation and subsequent assessments of potential NAI, which could potentially lead to misdiagnosis. Offiah and Hall (2003:704) highlight that babygrams do not produce skeletal images of sufficient resolution or diagnostic quality to accurately assess cases of NAI. The RCR & SCoR, (2018) suggest that at least two appropriately trained radiographers should perform prescribed skeletal survey in suspected cases to improve standardisation and increase accuracy in diagnosis of abuse.

Considering the critical role of acquiring correct diagnostic images in the radiological investigation of NAI and safeguarding the welfare of affected children, the study findings emphasise the importance of enhancing radiographers' knowledge and understanding about the recommended imaging protocols for suspected NAI cases (Berger et al., 2016:310).

Doyle and Vuong (2019:5) advocate for radiographers involved in paediatric imaging to undergo appropriate training in paediatric radiography techniques. These authors also assert that forensic radiography techniques and skeletal surveys should be performed by radiographers with accredited education and training in imaging for suspected physical abuse to achieve the highest quality images (Doyle and Vuong, 2019:5).

5.9. Knowledge of direct line of reporting for suspected NAI cases

The study also assessed radiographers' knowledge of the direct line of reporting for suspected NAI cases. In response to the question as to whom suspected NAI cases should be reported; all participating radiographers selected a combination of options that included the immediate supervisor (or referring physician) on duty. This is an encouraging finding, as it reflects a suitable understanding of the reporting hierarchy within healthcare institutions.

Antwi et al. (2019:51) assert that radiographers occupy a crucial role in identifying NAI in children, given their unique position within the imaging process. Radiographers also play a pivotal role in providing evidentiary support through the diagnostic images they produce, thereby significantly contributing to the investigation of NAI. These programs should not only address the knowledge gaps but also ensure that radiographers are well-equipped with reporting lines to fulfil their responsibilities in the protection of children at risk of NAI.

In this study, the knowledge of direct reporting NAI cases appeared to be more consistently applied as 97.2% (n=70/72) of radiographers selected the correct response for reporting

suspected NAI cases. Nonetheless, as with other areas, ongoing reinforcement and education in this area can improve radiographers' knowledge and potentially enhance the healthcare system's response to child abuse cases.

5.10. Knowledge of the use of bone scintigraphy in Imaging NAI

The study revealed a significant lack of awareness among radiographers regarding the role of bone scintigraphy in diagnosing NAI, with only 33.3% acknowledging its relevance. This low level of knowledge is concerning, as bone scintigraphy is a critical adjunct diagnostic tool to skeletal surveys for detecting NAI related fractures, particularly in complex areas such as the ribs and spine (Bandyopadhyay & Yen, 2002:146; Nguyen & Hart, 2018:126).

Low knowledge levels related to the role of bone scintigraphy were relatively consistent across job ranks, with chief and community service radiographers demonstrating slightly higher awareness (38.5% and 37.5%) compared to production radiographers (28.9%). Similarly, there was minimal variation (4%) in knowledge across different qualification levels, indicating a widespread gap in understanding.

A possible explanation for this poor understanding could be that bone scintigraphy falls within the domain of Nuclear Medicine in South Africa, leading to limited exposure among diagnostic radiographers. Nuclear medicine radiographers are trained to perform a variety of diagnostic procedures including bone scintigraphy for the identification of skeletal abnormalities such as fractures (HPCSA, 2021). These findings underscore the need for enhanced education and training of radiographers involved in imaging NAI related cases to ensure effective identification and management thereof.

5.11. Consistency in knowledge across positions and qualifications

The study used a comprehensive questionnaire to assess the overall knowledge of radiographers regarding NAI. Each question was assigned a score, with a maximum potential score of 18 for all questions in the questionnaire where a grade could be assigned. The mean score among the 72 participants was 48%, with individual participant scores ranging from 17 to 78%. This variation reflects a varying spectrum of knowledge levels, notably, without any significant difference when analysed by job rank or highest educational qualification.

The box and whisker plots (refer to Chapter four, Section 4.12) offered a visual representation of the dispersion and central tendency of the overall knowledge scores across different categories. The findings reveal that radiographers overall scored an average

of 48% indicating a significant need for improvement in their understanding of NAI and related imaging and management. This gap in knowledge should be addressed, as radiographers are instrumental in obtaining images, identifying NAI cases through imaging techniques, and reporting such cases where needed; a similar gap was noted in a study by Ewuzie (2021:102), which found that staff had neither formal training nor departmental protocols to guide their practice. Enhanced expertise in this area can lead to more precise identification and reporting of potential child abuse cases, thereby contributing to the safety and well-being of vulnerable children. As emphasised by Antwi et al., (2021:821), there is a pressing need for comprehensive training and education of radiographers in the field of child maltreatment.

Despite the identified knowledge gaps, it is encouraging that there were no significant differences in the overall knowledge scores based on job rank or educational qualification. This indicates that knowledge of NAI among radiographers remains relatively consistent across different professional levels and academic background. Consequently, educational interventions and training programmes can be uniformly implemented throughout the profession, ensuring that all radiographers, irrespective of their role or level of qualification, can benefit from standardised knowledge enhancement. Strengthening radiographers' understanding of NAI is crucial for the early detection and effective management of child abuse.

Hospital two emerged as the hospital with the highest average knowledge score, recording 57.3%. This finding suggests that radiographers at Hospital two overall possess a better understanding of NAI. Conversely, Hospital one exhibited the lowest average knowledge score, recording 42.9%, indicating deficiencies in the understanding of NAI among radiographers at this institution.

One notable characteristic of hospital two was the higher proportion of chief radiographers (60%) in this respondent group. While the study did not establish a causal relationship, the greater representation of senior staff at hospital two may have influenced the overall score, as chief radiographers generally have more years of clinical exposure and involvement in departmental processes. Since the distribution of qualifications was similar across the hospitals, differences in academic background are unlikely to explain the variation in scores. These finding suggest that staffing composition may have contributed to the observed differences, although further research would be required to confirm this relationship.

The box and whisker plot complements the aforementioned findings by visually representing the distribution of knowledge scores. These results underscore the importance of implementing tailored interventions to address knowledge gaps among radiographers, especially in hospitals with lower average knowledge scores. The aim of such interventions should be to elevate knowledge levels uniformly across all three hospitals to ensure that radiographers can effectively identify and report potential cases of NAI.

5.12. Study strengths

The following aspects highlight the strength of this study.

- **Comprehensive Data Collection**: The study utilised a well-structured electronic questionnaire to collect comprehensive data related to NAI such as the signs and symptoms, radiographic imaging appearances, views to be acquired and the management thereof amongst practicing diagnostic radiographers. This enabled acquisition of relevant data which was used for critical analysis and interpretation.
- **Diverse Sample:** The inclusion of radiographers from three different hospitals, along with varied job ranks and educational backgrounds, provided a modest but diverse stratified sample and subsequent findings. This diverse sample provided a cross-sectional snapshot of the radiographers understanding of the topic at hand.
- **Notable Response Rate:** Achieving a response rate of 48%, is acceptable for surveys and suggests a good level of engagement from the participants as stated by Wu et al. (2022:9).
- **Pilot Testing:** Conducting a pilot study to refine the questionnaire ensured that the data collection tool was clear and effective, thus enhancing the reliability of the responses received.
- **Use of Composite Scoring System:** The implementation of a composite scoring system for evaluating multiple-response questions allowed for an unbiased analysis of the participants' knowledge levels, providing a more accurate assessment of the findings.
- **Focus on NAI:** By focusing on radiographers' knowledge regarding NAI, the study provides insights into a critical aspect of paediatric imaging in Radiography which subsequently showed areas for improvement and further training.
- **Analysis of Knowledge Dispersion**: The study's analysis of knowledge dispersion across different aspects of NAI and associated management thereof

across three different hospitals and job ranks provided insights into variations in knowledge levels, identifying specific areas that require targeted interventions.

- **Ethical Considerations**: The study adhered to prescribed ethical guidelines, ensuring that participants' welfare and anonymity and confidentiality amongst others were prioritised, and potential risks were minimised, thereby maintaining the integrity of the research study.

The findings of the study provide a balanced and representative view of the knowledge and practices within the field of radiography at the three research sites. These strengths collectively contribute to the robustness and credibility of the study, offering valuable insights into the knowledge and practices of radiographers regarding NAI.

5.13. Practical Implications

The 48% response rate, although acceptable, indicates that a substantial proportion of radiographers did not participate. This highlights a potential lack of engagement or limited time available for research participation within tertiary hospitals. This suggests a need for departments to create more protected time for staff to engage with research, quality assurance, and professional development activities.

There was generally good familiarity with the term ‘NAI’ which is encouraging; yet occasional misinterpretation indicates that core definitions should be reinforced.

Radiographers had good knowledge (97.2%) of whom to report suspected NAI cases to which was a positive finding. This aspect could further be reinforced by maintaining clear communication channels and ensuring supervisor availability during after-hours shifts. To strengthen sustainability, hospitals should include NAI reporting procedures in routine departmental briefings or provide handover mechanisms.

The study findings have several practical implications for clinical practice, including workflow efficiency, and patient care. First, standardising protocols and ensuring consistent adherence by all staff is essential to minimise variability, reduce the risk of error and improve image quality. Clear communication pathways amongst radiographers, radiologists, other health care professionals such as paediatricians, social workers and emergency care physicians and administrative staff can enhance coordination, particularly during busy periods or when unexpected findings require additional imaging or urgent reporting. Strengthening clinical suspicion is essential to avoid missing early indicators of abuse, which could place children at further risk. As imaging protocols evolve, departments must also

create structured update pathways, such as annual protocol reviews, to ensure radiographers knowledge remain current. In practice, this could be addressed through case-based learning, visual reference guides in departments, and interdisciplinary sessions with paediatricians or social services. Departments could introduce laminated imaging checklists, ensure access to the RCR and SCoR guidelines, and encourage paired radiographer practice as recommended. Regular practical workshops in paediatric imaging could also improve familiarity with skeletal survey protocols.

5.14. Study limitations

The small sample size used may not be representative of the broader population of diagnostic radiographers, limiting the generalisability of the results. A larger, more diverse sample would provide a stronger basis for drawing conclusions applicable to radiographers across different settings. The study did not include diagnostic radiographers employed in the private sector. As a result, insights into the knowledge, understanding, and practices of these radiographers regarding the recognition and management of NAI were not assessed. Including private-sector radiographers in future research could provide a more comprehensive understanding of the profession as a whole and highlight differences in practice, training needs, and resource availability between public and private healthcare settings.

Additionally, the inclusion of radiographers in academic hospitals only may have introduced selection bias in the sense that the views and opinions of radiographers in regional and or day hospitals were not measured. Including radiographers from other levels of care could have influenced the overall findings of the study.

Another limitation relates to the reliance on self-reported data to evaluate participants' knowledge of NAI management. Although radiographers were encouraged to respond honestly, there was no independent method to verify the accuracy of their responses. This introduces the potential for response bias, including overestimation or underestimation of knowledge, which may affect the validity of the findings. Despite this, self-reported perceptions of knowledge are still valuable, as they provide insight into areas where radiographers feel confident or uncertain. These perceptions can guide the design of targeted educational programs, continuing professional development opportunities, and policy interventions aimed at improving the identification and management of suspected NAI cases.

A further methodological limitation is that internal consistency measures such as Cronbach's alpha, was not calculated for the questionnaire. The absence of this reliability assessment restricts the researchers' ability to determine how consistently the questionnaire items measured the intended constructs.

5.15. Recommendations

- Continuous education and training programs will contribute to a more consistent and comprehensive understanding of NAI among radiographers, as advocated by Dessena and Mullan (2018:62), ultimately enhancing their ability to play a critical role in the early detection and intervention of child abuse cases (Ewuzie, 2021:102; Alzahrani et al., 2022).
- Non-profit professional associations such as the Society of Radiographers of South Africa and the Radiological Society of South Africa, could take a leading role in disseminating essential information and updates in this field. Finally, radiography department-led driven methodologies could be implemented to facilitate immediate and cutting-edge knowledge dispersion. Methods could include the use of posters within the radiography departments information sharing via email and noticeboards and awareness campaigns. These strategies could facilitate the awareness of critical information including the signs and symptoms of NAI, the protocols to follow and overall management of NAI.
- Universities have the potential to play a pivotal role in the education and preparedness of radiography students by expanding NAI content in their curricula. Expansion of the curriculum could be achieved in the form of dedicated modules that focus on the clinical indicators of NAI, the legal and ethical responsibilities of radiographers, and the imaging protocols for suspected cases.
- Intervention studies could be designed to evaluate the effectiveness of targeted educational programs and training initiatives on improving radiographers' knowledge and clinical practice regarding NAI. Such studies could employ pre- and post-intervention assessments, hands-on workshops, simulation-based training, or online learning modules. By measuring changes in knowledge and practical application, these studies would provide evidence-based guidance on the educational strategies most effective for enhancing early detection and intervention in suspected child abuse cases.
- Future studies should include a larger and representative sample of radiographers in both the public and private sector and possibly extending to other provinces in

SA. This will give a broader perspective of radiographer's knowledge of NAI and the management thereof.

5.16. Chapter Conclusion

The study contributed to the body of knowledge regarding diagnostic radiographers understanding of NAI. Specifically, the findings provided insights into radiographers' knowledge regarding NAI and the management thereof. Gaps were identified in participants' knowledge regarding the signs and symptoms of NAI and internationally recommended imaging views. Disparities in knowledge across the three hospitals further indicate the need for standardised training to ensure that all radiographers are equipped with the knowledge to identify the early signs and management of NAI, contributing to the protection of vulnerable children. The study results suggest ongoing education and training, whether led by professional organisations, hospitals or universities, to strengthen radiographers' roles in the identification, management and reporting of NAI cases.

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ADDENDUM A1: RCR AND SCoR PROTOCOLS

Head, chest, spine and pelvis:

- Anterior-posterior (AP) and lateral skull
- AP chest (to include the shoulders) and both obliques (obliques to include all ribs, left and right, 1–12)
- AP abdomen and pelvis
- Lateral views to include the whole spine. (For children under one year, this may be possible with one view, for larger children and those over one year, separate views will probably be required.)

Upper limbs:

Where possible:

- AP of the whole arm (centred at the elbow if possible)
- Coned lateral elbow
- Coned lateral wrist
- Posterior-anterior (PA) hand and wrist

In larger children where a single whole arm view is not possible:

- AP humerus (including the shoulder and elbow)
- AP forearm (including the elbow and wrist)
- Coned lateral elbow
- Coned lateral wrist
- DP hand and wrist

• **Lower limbs:**

Where possible:

- Whole AP lower limb, hip to ankle
- Coned lateral knee and ankle
- Coned AP ankle (mortise view)
- DP foot

For larger children

- AP femur
- AP tibia and fibula
- AP knee
- AP ankle
- Coned lateral knee
- Coned lateral ankle
- DP foot

Follow-up imaging: 11–14 days, no later than 28 days after initial skeletal survey.

- Follow-up radiographs should be performed of any abnormal or suspicious areas on the initial skeletal survey plus the following views:
- Chest AP and both obliques (to include the shoulders and all ribs, left and right, 1–12)

4

[4] Permission to include protocol granted by The Royal College of Radiologists & Society and College of Radiographers (2018)

Upper limbs:

Where possible:

- AP whole arm (centred at the elbow if possible)

In larger children where whole arm views are not possible:

- AP humerus (including the shoulder and elbow)
- AP forearm (including the elbow and wrist)

Lower limbs:

Where possible

- Whole AP lower limb, hip to ankle

For larger children:

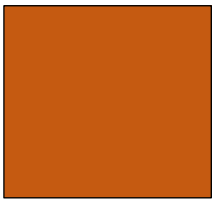
- AP femur
- AP tibia and fibula

Follow-up imaging should be obtained ideally between 11–14 days after the initial skeletal survey, or as soon as possible thereafter. However, useful information can still be obtained up to 28 days later. If follow-up imaging is not performed within 28 days, the child will need to be reassessed as for an original consultation and full skeletal survey may be required.

[5]

[5] Permission to include protocol granted by The Royal College of Radiologists & Society and College of Radiographers (2018)

ADDENDUM A2: LETTER TO ASSISTANT DIRECTOR: HOSPITAL ONE



Dear 

Re: Request for permission to conduct research within radiography department

I am a diagnostic radiographer enrolled for a Master of Science degree: Radiography at the Department of Medical Imaging and Therapeutic Sciences, Faculty of Health and Wellness Sciences, Cape Peninsula University of Technology.

I would like to conduct a study entitled *"Diagnostic Radiographers' knowledge about the management of Non-accidental Injury".* The purpose of this survey is to determine the knowledge base of radiographers with regards to the radiographic appearance of non-accidental Injury (NAI), the physical signs and symptoms of NAI amongst paediatric patients as well as the protocol to follow for the management of such cases.

An electronic survey using a questionnaire as a data collection tool will be used. Inclusion Criteria and Exclusion Criteria for the research are as follow: All qualified Diagnostic Radiographers only, this includes Community service radiographers; and excludes Locum radiographers, undergraduate students and radiographers from other disciplines.

The study will take place with the use of an online questionnaire, sent via email. The questionnaire consists of 21 questions, that does not take more than 10 minutes to complete. Participation is completely voluntary. All radiographers who elect to participate will remain anonymous, as the questionnaire does not require any personal details/information in order to complete it.

Therefore, I require your permission as Assistant-Director: Radiography to conduct the study amongst the radiographers in your department. In order to maintain confidentiality of all participants, the link to the questionnaire will need to be sent to you, and then further disseminated to all staff that meet the inclusion criteria. Staff that want to participate would do so by following the link and those that do not want to participate, would not continue to the questionnaire. All completed surveys will only be returned to me as the researcher. For your benefit, I have included my full proposal.

Should you require more information please to not hesitate to contact me. Thank you in advance.

Yours faithfully

Aneeqa Basardien

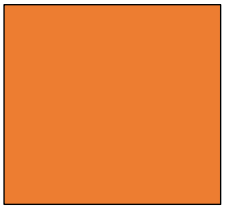
0768112292

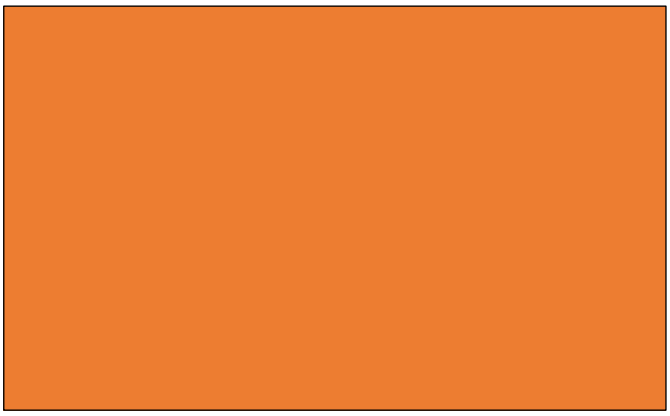
aneeqa.basardien@gmail.com

MSc Radiography Student,

Cape Peninsula University of Technology

ADDENDUM A3: LETTER TO ASSISTANT DIRECTOR: HOSPITAL TWO





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Should you require more information please to not hesitate to contact me.

Thank you in advance.

Yours faithfully

Aneeqa Basardien

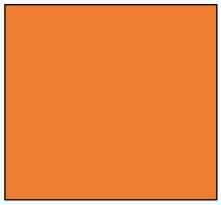
0768112292

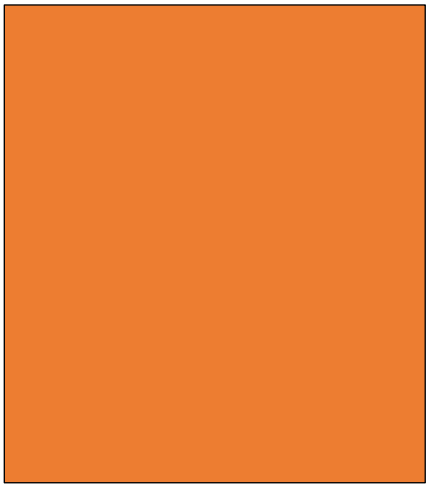
aneeqa.basardien@gmail.com

MSc Radiography Student,

Cape Peninsula University of Technology

ADDENDUM A4: LETTER TO ASSISTANT DIRECTOR: HOSPITAL THREE





Dear 

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I am a diagnostic radiographer enrolled for a Master of Science degree: Radiography at the Department of Medical Imaging and Therapeutic Sciences, Faculty of Health and Wellness Sciences, Cape Peninsula University of Technology.

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The study will take place with the use of an online questionnaire, sent via email. The questionnaire consists of 21 questions, that does not take more than 10 minutes to complete. Participation is completely voluntary. All radiographers who elect to participate

will remain anonymous, as the questionnaire does not require any personal details/information in order to complete it.

Therefore, I require your permission as Assistant-Director: Radiography to conduct the study amongst the radiographers in your department. In order to maintain confidentiality of all participants, the link to the questionnaire will need to be sent to you, and then further disseminated to all staff that meet the inclusion criteria. Staff that want to participate would do so by following the link and those that do not want to participate, would not continue to the questionnaire. All completed surveys will only be returned to me as the researcher. For your benefit, I have included my full proposal.

Should you require more information please to not hesitate to contact me.

Thank you in advance.

Yours faithfully

Aneeqa Basardien

0768112292

aneeqa.basardien@gmail.com

MSc Radiography Student,

Cape Peninsula University of Technology

ADDENDUM A5: RESEARCH SITE ETHICS PERMISSION HOPITAL ONE

[redacted]

MS ANEEQA BASADIEN
CAPE PENINSULA UNIVERSITY OF TECHNOLOGY

E-mail: aneeqa.basadien@gmail.com

Dear Ms Basadien

RESEARCH PROJECT: Diagnostic Radiographers Knowledge about the Signs and Symptoms and Management of Non-Accidental Injruy

Your recent letter to the hospital refers.

You are granted permission to proceed with your research, which is valid until **14 December 2022.**

Please note the following:

a) Your research may not interfere with normal patient care.
b) Hospital staff may not be asked to assist with the research.
c) Confidentiality must always be maintained.
d) No additional costs to the hospital should be incurred as indicated in your Annexure 2 i.e. Lab, consumables or stationery. **If access to TRACK Care/NHLS is required, kindly attach our letter of approval to the application form and approach Information Management to assist with data.**
e) **No patient folders may be removed from the premises or be inaccessible.**
f) Please provide the research assistant/field worker with a copy of this letter as verification of approval.
g) **Should you at any time require photographs of your subjects, please obtain the necessary indemnity forms from our** [redacted]
h) Should you require additional research time beyond the stipulated expiry date, please apply for an extension.
i) Please discuss the study with the HOD before commencing.
j) Please introduce yourself to the person in charge of an area before commencing.
k) On completion of your research, please forward any recommendations/findings that can be beneficial to use to take further action that may inform redevelopment of future policy / review guidelines.
l) Please contact [redacted] to ascertain if there will be charges for conducting the Research and to obtain a quote or to discuss charges
m) **Kindly submit a copy of the publication or report to this office on completion of the research.**
n) At no time should any posters encouraging patients to partake in research, be displayed within a clinical area.
o) Please adhere to ALL COVID-19 regulations and Groote Schuur Hospital policies.

I would like to wish you every success with the project.

Yours sincerely

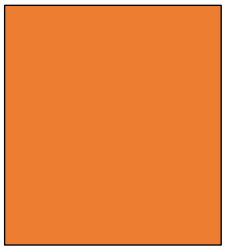
[redacted]

[6]

[6] Permission from Hospital two and Hospital three was received via email. No formal letter received.

ADDENDUM A6: LETTER TO PARTICIPANTS

DIAGNOSTIC RADIOGRAPHERS' KNOWLEDGE ABOUT THE MANAGEMENT OF NON-ACCIDENTAL INJURY.



Dear Radiography Colleague

REQUEST TO PARTICIPATE IN A RESEARCH STUDY

I am a Diagnostic radiographer enrolled for a Master of Science degree at the Cape Peninsula University of Technology. I am conducting a study entitled *"Diagnostic Radiographers' knowledge about the management of non-accidental Injury (NAI)".* The purpose of this survey is to determine the knowledgebase of radiographers with regards to the radiographic appearance of NAI, the physical signs and symptoms of NAI amongst paediatric patients as well as the protocol to follow when suspecting NAI amongst paediatric patients.

I thus need your participation in order to conduct this research study. Participation in this study is completely voluntary. Should you decide to participate you will be required to complete an online questionnaire. All information collected will be anonymous and no information will be linked to you as a participant. It will take you 10 minutes to complete this questionnaire. This electronic questionnaire must preferably be completed afterhours so not to interfere with your workload.

No participant will be coerced to participate. The Protection of Personal Information Act (POPIA), Act No. 4 of 2013, is South Africa's data protection law, which was established with the purpose of protecting individuals from harm by protecting their personal information. Here personal information may be referred to as any information related to a person that can be considered as identifiable information of that individual. This can be any personal information related to gender, age, financial status, professional qualification; disclosure of names or any information that would reveal the identity of a person, or study participant in this case (South Africa, 2013). The researcher undertook to protect all your collected data for this study at all costs in accordance with the POPI Act.

Some of these provisions are as follows: This study requires participants to be anonymised. This means that your name or personal information is not required for this study. Furthermore, based on POPIA the researcher will thus ensure that data is anonymised, stored on a password protected computer, only the researcher will have access to the computer and data. In order to protect the identity of participants and the research sites, participants names and that of the research sites will not be revealed when publishing the results of the study. Kindly note that should you wish to withdraw from the study after submission of your questionnaire, the researcher will not be able to retract your questionnaire due to the anonymity thereof.

The responses to the online questionnaire will be sent directly to myself, the researcher. The responses and results will be inaccessible by any outside persons or personnel with only the researcher and the supervisors of this study having access to the data. Data will be kept on a password protected hard drive and stored on a password protected computer with anti-hacking or phishing software, accessible only by myself, the researcher. It is recommended that this survey be completed in your free time or afterhours so not to interfere with your workload. The data collected will only be used for this study and will not be used for secondary studies in the future. If you have any questions or complaints concerning the way in which this research project was conducted, please do not hesitate to contact the following persons:

Ms N. Seth at sethn@cput.ac.za (Tel: 021 959 6917) for attention Dr D. Bester, Faculty Research Co-ordinator, or Ms C. Lackay, Chairperson, Research Ethics Committee, Faculty of Health and Wellness Sciences, Cape Peninsula University of Technology.

Thank you in advance for your participation. Please indicate at the end of the questionnaire if you would like feedback on the outcome of this study.

Your faithfully

Aneeqa Basardien

aneeqa.basardien@gmail.com

0768112292

MSc Radiography Student

Cape Peninsula University of Technology

Principle supervisor: Dr A. Speelman

Senior Lecturer: Diagnostic Radiography

Department of Medical Imaging and Therapeutic Sciences

Health and Wellness Sciences Faculty

Cape Peninsula University of Technology

Co-supervisor: Dr H. Thomas

Diagnostic Lecturer:

Department of Medical Imaging and Therapeutic Sciences

Health and Wellness Sciences Faculty

Cape Peninsula University of Technology

ADDENDUM A7: QUESTIONNAIRE

DIAGNOSTIC RADIOGRAPHERS' KNOWLEDGE ABOUT THE MANAGEMENT OF NON-ACCIDENTAL INJURY

Please provide the following information by ticking the correct answer

1. Name of Hospital where you are employed:

Hospital One	Hospital Two	Hospital Three

2. Job rank:

Community Service radiographer	Junior Radiographer	Chief Radiographer	Assistant-Director

3. Your highest academic qualification:

National Diploma	BTech Radiography	BSc Radiography	Masters

4. Which gender do you identify yourself with?

Male	
Female	
Agender	
Androgene	
Bigender	
Butch	
Cisgender	
Gender expansive	
Gender fluid	
Gender outlaw	
Gender queer	
Transgender	
Other	

5. Do you know the definition of the abbreviation NAI?

☐ Yes

☐ No

☐ Not sure

6. Select an option below that best describes NAI.

☐ Emotional Abuse

☐ Physical abuse and Neglect

☐ Pathology

☐ Domestic Abuse

7. Select below all the potential signs and symptoms a child with suspected NAI may present with. You may select more than one option.

☐Drowsiness

☐Excessive crying

☐Long bone fractures

☐Skull fractures

☐Shortness of breath

☐Diarrhoea

☐Constipation

☐Runny nose

☐Bruises

☐Allergic reaction

☐Burns

☐No eye contact

☐Excessive eye contact

☐Urinary Incontinence

☐ Fear of sudden movement

☐ Delay in reaching certain milestones

☐ Underweight

☐ Short attention span

☐Withdrawn

☐Lack of hygiene/poor dental care

☐Bite marks on skin

☐Belt marks on skin

☐Clinical history that does not fit the actual injury

☐Varying explanation of the cause of the injury

8. Select below all the symptoms of NAI: You may select more than one option.

☐Fatigue

☐Long bone fractures

☐Spinal/ Axial Skeleton fracture

☐Skull Fractures

☐Rib Fractures

☐Metacarpal Fractures

☐Diarrhoea

☐Urinary Incontinence

☐Burns

☐Excessive crying

9. There are many radiographic appearances possible for NAI on conventional (plain) diagnostic images. Select all the possible radiographic appearances related to NAI? You may select more than one option.

☐Hilar lymphadenopathy

☐Femur fractures

☐Rib fractures

☐Cholelithiasis

☐Pleural effusion

☐Skull fractures

☐Appendicitis

☐Long bone fractures

☐Spinal/ Axial Skeleton fracture

☐Metacarpal Fractures

☐Periosteal Reaction to long bones

☐Pneumoperitoneum

☐Pneumothorax

☐Spiral fractures

☐Fractures in different stages if healing

☐Fractures in a non-ambulant child.

10. Who are the potential victims of NAI? You may select more than one option.

☐ Adults

☐ Elderly

☐ Adolescents and Children

☐ All of the above

11. Does your Radiology Department have departmental protocols for suspected NAI?

☐ Yes

☐ No

☐ Unsure

12. Does your Radiology Department have protocols on how to handle a suspected victim of child abuse?

☐Yes

☐No

☐Not sure

13. Is there a reporting procedure for suspected NAI at the hospital you work at?

☐ Yes

☐ No

☐ Unsure

14. Parents and caregivers are usually emotional when bringing a child into the hospital for an injury. As radiographers what should your reaction be when seeing fractures or injuries on x-ray imaging?

☐Ask parents/guardians what they did.

☐Inform radiologist.

☐Show other colleagues.

☐Inform immediate supervisor.

☐Ask parents/guardians if child has any diagnosed pathologies.

15. What are the common/recommended views taken for suspected NAI cases in your department for children under 2 years old? You may select more than one option.

☐ X-ray examinations requested by the referring doctor.

☐ X-ray images of the affected part

☐ Full Skeletal Survey

☐ Long bone x-rays only

☐ Unsure

☐ Other

16. What are the common/recommended views taken for suspected NAI cases in your department for children above 2 years old? You may select more than one option.

☐ X-ray examinations requested by the referring doctor.

☐ X-ray images of the affected part

☐ Full Skeletal Survey

☐ Long bone x-rays only

☐ Unsure

☐ Other

17. Select the common views taken for suspected NAI case in children younger than 2 years of age. Tick where appropriate.

Patella Axial		Submentovertex Skull	
AP Femur		Oblique Rib views	
Lateral Skull only		Standing Bilateral Knees	
Erect Abdomen		Dorso-palmar view of both feet	
AP forearm		Swimmers lateral	
Calcaneus Axial		Open mouth	
Lateral Decubitus Abdomen		Erect chest	
Coned lateral ankle		Valsalva Manoeuvre	
AP and Lateral Skull		AP chest including shoulders	
Towns only of skull		Lateral chest only	
AP abdomen and pelvis		AP of the full upper arm	
Lateral view of the whole spine		Coned lateral views of elbow	
AP view of the whole spine		Coned lateral wrist views	
AP humerus including shoulder and elbow		Dorso-palmar view of hand and wrist	
Whole AP lower limb (hip to ankle)		Coned lateral knee	
Follow up views within 11 – 14 days of any abnormal or suspicious area		Chest AP and both obliques views to include the shoulders and all ribs (left and right 1 – 12.)	

18. To whom should suspected cases of NAI be reported to?

☐ Victims' parents

☐ Guardian, if no parent present

☐ Colleagues

☐ Media

☐ Immediate supervisor (or referring physician) on duty if supervisor is not present for examination.

19. Do you think that common perpetrators are those living in the household as the victims?

☐ Yes

☐ No

☐ Not sure

20. Who are the possible perpetrators of NAI amongst children? You can select more than one option

☐ Parents

☐ Neighbours

☐ Grandparents

☐ Stepparents

☐Teachers

☐Partner of one of the parents

☐ All of the above

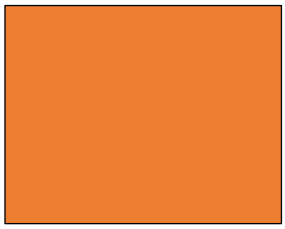
21. Bone scintigraphy has a role to play in imaging NAI

☐Yes

☐No

☐Not sure

ADDENDUM A8: LETTER TO RESEARCH ETHICS COMMITTEE



Ms C Lackay
Chairperson
Research Ethics Committee
Faculty of Health and Wellness Sciences
Cape Peninsula University of Technology
PO Box 1906
Bellville
7535

Dear Ms Lackay

REQUEST FOR ETHICS APPROVAL TO CONDUCT A RESEARCH STUDY

I am a radiographer enrolled for a Master of Science degree: Radiography within the Department of Medical Imaging and Therapeutic Sciences, Faculty of Health and Wellness Sciences, Cape Peninsula University of Technology.

I would like to conduct a study entitled *"Diagnostic Radiographers' knowledge about the management of Non-accidental Injury".* The purpose of this survey is to determine the knowledge base of radiographers with regards to the radiographic appearance of non-accidental injury (NAI), the physical signs and symptoms of NAI amongst paediatric patients as well as the protocol to follow for the management of such cases.

An electronic survey using a questionnaire as a data collection tool will be used. All participants will be fully informed about the purpose of the research study. All participants responses will be anonymised as no names are required for completion of the questionnaire. Participation will not be incentivised. Once a prospective participant has read a full description of what the questionnaire entails, passive consent will be assumed when participants complete the questionnaire. Participation is completely voluntary, and participants may withdraw from the study without any consequences. Completion of the

questionnaire should take place during participants spare time and will not interfere with participants workload.

No personal data will be required, nor patient information for completing the questionnaire would be required as all questions posed are solely in alignment with the research objectives, which relates to theoretical knowledge of imaging appearances of NAI images and departmental protocols for reporting suspected abuse cases.

All data will be treated as confidential. The data collected and results will be inaccessible by any third party by ensuring that it is kept on a password protected computer with anti-hacking or phishing software, which only the researcher will have access to. All completed surveys will only be returned to me as the researcher.

However, in order to adhere to the Protection of Personal Information Act, the researcher will request the Assistant-Director's Radiography to obtain permission from each radiographer before providing us with their email addresses. The researcher will only send the questionnaire to those radiographers that gave expressed permission to the Assistant-Director for the researcher to contact them regarding participation in this survey, or alternatively the link will be sent to the Assistant-Directors for dissemination to their staff. All completed surveys will only be returned to me as the researcher. For your benefit, I have included my full proposal.

Thank you in advance.

Yours faithfully

Aneeqa Basardien

0768112292

aneeqa.basardien@gmail.com

MSc Radiography Student,

Cape Peninsula University of Technology

ADDENDUM A9: CPUT RESEARCH ETHICS CERTIFICATE

Cape Peninsula
University of Technology

HEALTH AND WELLNESS SCIENCES RESEARCH ETHICS COMMITTEE (HWS-REC)
Registration Number NHREC: REC- 230408-014

P.O. Box 1906 • Bellville 7535 South Africa
Symphony Road Bellville 7535
Tel: +27 21 959 6917
Email: sethn@cput.ac.za

13 December 2021
REC Approval Reference No:
CPUT/HW-REC 2021/H39

Faculty of Health and Wellness Sciences

Dear Mr A Speelman

Re: APPLICATION TO THE HW-REC FOR ETHICS CLEARANCE

Approval was granted by the Health and Wellness Sciences-REC to **Ms A Basardien** for ethical clearance. This approval is for research activities related to research for **Ms A Basardien** at Cape Peninsula University of Technology.

TITLE: Diagnostic Radiographers knowledge about the signs and symptoms and management of non-accidental injury

Supervisors: Mr A Speelman and Ms H Thomas

Comment:

Approval will not extend beyond 14 December 2022. An extension should be applied for 6 weeks before this expiry date should data collection and use/analysis of data, information and/or samples for this study continue beyond this date.

The investigator(s) should understand the ethical conditions under which they are authorized to carry out this study and they should be compliant to these conditions. It is required that the investigator(s) complete an **annual progress report** that should be submitted to the HWS-REC in December of that particular year, for the HWS-REC to be kept informed of the progress and of any problems you may have encountered.

Kind Regards

Carolynn Lackay
Chairperson – Research Ethics Committee
Faculty of Health and Wellness Sciences

ADDENDUM A10: DATA COLLECTION SHEET: PART 1

RANK:	YOUR HIGHEST	WHICH GENDER DO Y	Do yo	Poi	Select an option below	Po	Select below all the potential signs and symptoms a	Poi	Select below all the symptoms of NAI	Pi	CU	There are many radiographic appearances
CHIEF RADIOGRAPHE	NATIONAL DIPLOMA	Woman	Yes	2	Physical Abuse and Neglect	1	Drowsiness;Excessive crying;Long bone fractures;Skull fractures	12	Fatigue;Excessive crying;	1	SELEI	Femur fractures ;Rib fractures;Pleural effusion;Skul
PRODUCTION RADIO	BSc RADIOGRAPHY	Woman	Yes	2	Physical Abuse and Neglect	1	Excessive crying;Long bone fractures;Skull fractures;Shortness c	10	Long bone fractures;Skull Fractures;Rib Fractur	6		Femur fractures ;Rib fractures;Skull fractures;Long
PRODUCTION RADIO	BTECH RADIOGRAPH	Woman	Yes	2	Physical Abuse and Neglect	1	Drowsiness;Excessive crying;Long bone fractures;Skull fractures	10	Long bone fractures;Skull Fractures;Rib Fractur	6	SELEI	Femur fractures ;Rib fractures;Skull fractures;Pleura
COMMUNITY SERVICI	BSc RADIOGRAPHY	Woman	Yes	2	Domestic Abuse	0	Long bone fractures;Skull fractures;Fear of sudden movement;Bi	9	Long bone fractures;Spinal/ Axial Skeleton fract	6		Rib fractures;Femur fractures ;Skull fractures;Long
CHIEF RADIOGRAPHE	NATIONAL DIPLOMA	Woman	Yes	2	Physical Abuse and Neglect	1	Long bone fractures;Skull fractures;Bruises;Burns;No eye contac	7	Fatigue;Long bone fractures;Spinal/ Axial Skele	7	SELEI	Femur fractures ;Rib fractures;Pleural effusion;Skul
COMMUNITY SERVICI	BSc RADIOGRAPHY	Woman	Yes	2	Physical Abuse and Neglect	1	Excessive crying;Long bone fractures;Skull fractures;Runny nose	7	Fatigue;Urinary Incontinence;Excessive crying;	1	SELEI	Femur fractures ;Rib fractures;Skull fractures;Long
CHIEF RADIOGRAPHE	BTECH RADIOGRAPH	Woman	Yes	2	Physical Abuse and Neglect	1	Long bone fractures;Skull fractures;Clinical history that does not f	4	Long bone fractures;Skull Fractures;Rib Fractur	5		Femur fractures ;Rib fractures;Skull fractures;Long
CHIEF RADIOGRAPHE	NATIONAL DIPLOMA	Woman	Yes	2	Physical Abuse and Neglect	1	Bruises;Burns;Bite marks on skin;Drowsiness;Shortness of breath	10	Excessive crying;	1		Fractures in different stages if healing;Fractures in a
PRODUCTION RADIO	BSc RADIOGRAPHY	Woman	Yes	2	Physical Abuse and Neglect	1	Long bone fractures;Excessive crying;Skull fractures;Bruises;No	8	Long bone fractures;Skull Fractures;Metacarpa	4	SELEI	Femur fractures ;Skull fractures;Long bone fracture
PRODUCTION RADIO	BTECH RADIOGRAPH	Woman	Yes	2	Physical Abuse and Neglect	1	Drowsiness;Excessive crying;Long bone fractures;Skull fractures	12	Fatigue;Long bone fractures;Spinal/ Axial Skele	7	SELEI	Femur fractures ;Rib fractures;Pleural effusion;Skul
PRODUCTION RADIO	BTECH RADIOGRAPH	Man	Yes	2	Physical Abuse and Neglect	1	Excessive crying;Long bone fractures;Skull fractures;Bruises;Bur	10	Long bone fractures;Spinal/ Axial Skeleton fract	7		Rib fractures;Femur fractures ;Skull fractures;Long
PRODUCTION RADIO	BSc RADIOGRAPHY	Woman	Yes	2	Physical Abuse and Neglect	1	Long bone fractures;Skull fractures;Bruises;Fear of sudden move	7	Skull Fractures;Metacarpal Fractures;Excessive	3		Rib fractures;Skull fractures;Metacarpal Fractures;F
CHIEF RADIOGRAPHE	BTECH RADIOGRAPH	Woman	Yes	2	Physical Abuse and Neglect	1	Drowsiness;Excessive crying;Long bone fractures;Skull fractures	12	Long bone fractures;Spinal/ Axial Skeleton fract	7	SELEI	Hilar lymphadenopathy;Femur fractures ;Rib fractur
COMMUNITY SERVICI	BSc RADIOGRAPHY	Woman	Yes	2	Physical Abuse and Neglect	1	Excessive crying;Skull fractures;Bruises;Long bone fractures;Bur	11	Long bone fractures;Spinal/ Axial Skeleton fract	7	SELEI	Rib fractures;Femur fractures ;Skull fractures;Long
CHIEF RADIOGRAPHE	BTECH RADIOGRAPH	Woman	Yes	2	Physical Abuse and Neglect	1	Drowsiness;Excessive crying;Long bone fractures;Skull fractures	10	Fatigue;Diarrhoea ;Urinary Incontinence;Excess	1	SELEI	Femur fractures ;Rib fractures;Skull fractures;Long
PRODUCTION RADIO	BSc RADIOGRAPHY	Woman	Yes	2	Physical Abuse and Neglect	1	Excessive crying;Long bone fractures;Skull fractures;Bruises;Fea	8	Long bone fractures;Spinal/ Axial Skeleton fract	6		Femur fractures ;Rib fractures;Skull fractures;Long
PRODUCTION RADIO	BSc RADIOGRAPHY	Woman	Yes	2	Physical Abuse and Neglect	1	Bruises;Burns;Clinical history that does not fit the actual injury;Bite	11	Long bone fractures;Spinal/ Axial Skeleton fract	6		Rib fractures;Femur fractures ;Skull fractures;Long
PRODUCTION RADIO	BTECH RADIOGRAPH	Woman	Yes	2	Physical Abuse and Neglect	1	Long bone fractures;Skull fractures;Bruises;Burns;Underweight ;	8	Fatigue;Long bone fractures;Spinal/ Axial Skele	6	SELEI	Rib fractures;Skull fractures;Long bone fractures;S
PRODUCTION RADIO	BTECH RADIOGRAPH	Woman	Yes	2	Physical Abuse and Neglect	1	Excessive crying;Long bone fractures;Skull fractures;Runny nose	12	Fatigue;Long bone fractures;Spinal/ Axial Skele	7	SELEI	Femur fractures ;Rib fractures;Pleural effusion;Skul
PRODUCTION RADIO	BTECH RADIOGRAPH	Woman	Yes	2	Physical Abuse and Neglect	1	Excessive crying;Long bone fractures;Skull fractures;Bruises;Bur	10	Long bone fractures;Rib Fractures;Skull Fractur	5		Femur fractures ;Rib fractures;Skull fractures;Long
PRODUCTION RADIO	BTECH RADIOGRAPH	Woman	Yes	2	Physical Abuse and Neglect	1	Long bone fractures;Bruises;Burns;Fear of sudden movement;Ur	7	Burns;Urinary Incontinence;Excessive crying;Sk	4	SELEI	Femur fractures ;Rib fractures;Pleural effusion;Long
CHIEF RADIOGRAPHE	NATIONAL DIPLOMA	Woman	Yes	2	Physical Abuse and Neglect	1	Long bone fractures;Constipation;Bruises;Burns;Fear of sudden	10	Fatigue;Diarrhoea ;Urinary Incontinence;Excess	1	SELEI	Femur fractures ;Rib fractures;Cholelithiasis;Skull fr
PRODUCTION RADIO	BTECH RADIOGRAPH	Woman	Yes	2	Physical Abuse and Neglect	1	Long bone fractures;Skull fractures;Bruises;Fear of sudden move	7	Long bone fractures;Rib Fractures;Spinal/ Axial	4		Rib fractures;Pleural effusion;Skull fractures;Long b
COMMUNITY SERVICI	BSc RADIOGRAPHY	Woman	Yes	2	Physical Abuse and Neglect	1	Bruises;No eye contact;Burns;Fear of sudden movement;Withdra	5	Long bone fractures;Spinal/ Axial Skeleton fract	5	SELEI	Femur fractures ;Rib fractures;Pleural effusion;Skul
PRODUCTION RADIO	BSc RADIOGRAPHY	Woman	Yes	2	Physical Abuse and Neglect	1	Excessive crying;Long bone fractures;Skull fractures;Shortness c	9	Long bone fractures;Spinal/ Axial Skeleton fract	7		Femur fractures ;Rib fractures;Skull fractures;Long
CHIEF RADIOGRAPHE	NATIONAL DIPLOMA	Man	Yes	2	Physical Abuse and Neglect	1	Long bone fractures;Skull fractures;Bruises;Withdrawn;Bite mark:	6	Long bone fractures;Skull Fractures;Rib Fractur	4		Rib fractures;Skull fractures;Long bone fractures;S
PRODUCTION RADIO	BTECH RADIOGRAPH	Woman	Yes	2	Physical Abuse and Neglect	1	Excessive crying;Long bone fractures;Skull fractures;Bruises;Bur	12	Long bone fractures;Spinal/ Axial Skeleton fract	7		Femur fractures ;Rib fractures;Skull fractures;Long
CHIEF RADIOGRAPHE	BTECH RADIOGRAPH	Woman	Yes	2	Physical Abuse and Neglect	1	Excessive crying;Long bone fractures;Skull fractures;Bruises;Fea	7	Long bone fractures;Skull Fractures;Rib Fractur	5		Femur fractures ;Rib fractures;Skull fractures;Long
JUNIOR RADIOGRAPI	BTECH RADIOGRAPH	Woman	Yes	2	Physical Abuse and Neglect	1	Long bone fractures;Skull fractures;Bruises;Burns;No eye contac	11	Long bone fractures;Skull Fractures;Rib Fractur	5		Femur fractures ;Rib fractures;Skull fractures;Long
CHIEF RADIOGRAPHE	NATIONAL DIPLOMA	Woman	Yes	2	Physical Abuse and Neglect	1	Excessive crying;Long bone fractures;Skull fractures;Bruises;Bur	11	Long bone fractures;Spinal/ Axial Skeleton fract	7	SELEI	Femur fractures ;Rib fractures;Skull fractures;Long
CHIEF RADIOGRAPHE	BTECH RADIOGRAPH	Woman	Yes	2	Physical Abuse and Neglect	1	Long bone fractures;Skull fractures;Burns;No eye contact;Withdr	8	Long bone fractures;Skull Fractures;Rib Fractur	5		Femur fractures ;Rib fractures;Skull fractures;Long
JUNIOR RADIOGRAPI	BSc RADIOGRAPHY	Woman	Yes	2	Physical Abuse and Neglect	1	Excessive crying;Long bone fractures;Skull fractures;Bruises;Bur	10	Long bone fractures;Skull Fractures;Rib Fractur	6		Femur fractures ;Rib fractures;Skull fractures;Long
CHIEF RADIOGRAPHE	NATIONAL DIPLOMA	Woman	Yes	2	Physical Abuse and Neglect	1	Long bone fractures;Drowsiness;Excessive crying;Skull fractures	9	Long bone fractures;Spinal/ Axial Skeleton fract	6		Femur fractures ;Rib fractures;Skull fractures;Fractu
JUNIOR RADIOGRAPI	BTECH RADIOGRAPH	Woman	Yes	2	Physical Abuse and Neglect	1	Excessive crying;Long bone fractures;Skull fractures;Bruises;Bur	11	Fatigue;Long bone fractures;Spinal/ Axial Skele	7	SELEI	Femur fractures ;Rib fractures;Pleural effusion;Skul
CHIEF RADIOGRAPHE	NATIONAL DIPLOMA	Woman	Yes	2	Physical Abuse and Neglect	1	Drowsiness;Excessive crying;Long bone fractures;Skull fractures	9	Long bone fractures;Skull Fractures;Rib Fractur	4		Femur fractures ;Rib fractures;Skull fractures;Long
COMMUNITY SERVICI	BSc RADIOGRAPHY	Woman	Yes	2	Physical Abuse and Neglect	1	Long bone fractures;Skull fractures;Bruises;Burns;No eye contac	9	Skull Fractures;Long bone fractures;Rib Fractur	4		Femur fractures ;Rib fractures;Skull fractures;Long
CHIEF RADIOGRAPHE	NATIONAL DIPLOMA	Woman	Yes	2	Physical Abuse and Neglect	1	Excessive crying;Long bone fractures;Skull fractures;Bruises;Bur	10	Long bone fractures;Spinal/ Axial Skeleton fract	7		Femur fractures ;Rib fractures;Skull fractures;Long
CHIEF RADIOGRAPHE	NATIONAL DIPLOMA	Woman	Yes	2	Physical Abuse and Neglect	1	Excessive crying;Bruises;Urinary Incontinence;Withdrawn;Bite ma	7	Long bone fractures;Skull Fractures;Rib Fractur	4	SELEI	Femur fractures ;Rib fractures;Skull fractures;Long
JUNIOR RADIOGRAPI	BTECH RADIOGRAPH	Woman	Yes	2	Physical Abuse and Neglect	1	Fear of sudden movement;Underweight ;Clinical history that does	3	Skull Fractures;Long bone fractures;Fatigue;Uri	2	SELEI	Femur fractures ;Skull fractures;Long bone fracture
COMMUNITY SERVICI	BSc RADIOGRAPHY	Woman	Yes	2	Physical Abuse and Neglect	1	Bruises;Burns;Clinical history that does not fit the actual injury;Bite	7	Long bone fractures;Spinal/ Axial Skeleton fract	5		Femur fractures ;Pleural effusion;Skull fractures;Lo
JUNIOR RADIOGRAPI	NATIONAL DIPLOMA	Woman	Yes	2	Physical Abuse and Neglect	1	Excessive crying;Long bone fractures;Skull fractures;Constipatio	10	Long bone fractures;Fatigue;Spinal/ Axial Skele	7	SELEI	Femur fractures ;Rib fractures;Skull fractures;Long
JUNIOR RADIOGRAPI	BTECH RADIOGRAPH	Woman	Yes	2	Physical Abuse and Neglect	1	Drowsiness;Excessive crying;Long bone fractures;Skull fractures	8	Long bone fractures;Spinal/ Axial Skeleton fract	6		Femur fractures ;Rib fractures;Skull fractures;Long
CHIEF RADIOGRAPHE	BTECH RADIOGRAPH	Woman	Yes	2	Physical Abuse and Neglect	1	Long bone fractures;Bruises;Burns;No eye contact;Excessive ey	7	Long bone fractures;Rib Fractures;Urinary Incor	4	SELEI	Femur fractures ;Rib fractures;Pleural effusion;Long
COMMUNITY SERVICI	BSc RADIOGRAPHY	Woman	Yes	2	Physical Abuse and Neglect	1	Bite marks on skin;Lack of hygiene/poor dental care;Clinical histo	8	Burns;Urinary Incontinence;Rib Fractures;Skull I	5	SELEI	Fractures in different stages if healing;Spiral fractur
JUNIOR RADIOGRAPI	NATIONAL DIPLOMA	Woman	Yes	2	Physical Abuse and Neglect	1	Long bone fractures;Skull fractures;Bruises;Clinical history that d	4	Long bone fractures;Spinal/ Axial Skeleton fract	5		Femur fractures ;Rib fractures;Skull fractures;Long
JUNIOR RADIOGRAPI	BTECH RADIOGRAPH	Woman	Yes	2	Physical Abuse and Neglect	1	Drowsiness;Long bone fractures;Skull fractures;Bruises;No eye c	10	Long bone fractures;Spinal/ Axial Skeleton fract	5		Femur fractures ;Rib fractures;Skull fractures;Long
CHIEF RADIOGRAPHE	NATIONAL DIPLOMA	Man	Yes	2	Physical Abuse and Neglect	1	Excessive crying;Long bone fractures;Skull fractures;Shortness c	11	Fatigue;Long bone fractures;Skull Fractures;Rib	6	SELEI	Femur fractures ;Rib fractures;Pleural effusion;Skul
COMMUNITY SERVICI	BSc RADIOGRAPHY	Woman	Yes	2	Physical Abuse and Neglect	1	Excessive crying;Long bone fractures;Skull fractures;Bruises;Bur	11	Long bone fractures;Spinal/ Axial Skeleton fract	6		Femur fractures ;Rib fractures;Pleural effusion;Skul
CHIEF RADIOGRAPHE	NATIONAL DIPLOMA	Woman	Yes	2	Physical Abuse and Neglect	1	Long bone fractures;Skull fractures;Bruises;Burns;No eye contac	9	Long bone fractures;Spinal/ Axial Skeleton fract	6		Femur fractures ;Rib fractures;Pleural effusion;Skul
CHIEF RADIOGRAPHE	NATIONAL DIPLOMA	Woman	Yes	2	Pathology	0	Allergic reaction;Fear of sudden movement;Underweight ;Lack o	2	Fatigue;	0		Hilar lymphadenopathy;Cholelithiasis;Pleural effusio
JUNIOR RADIOGRAPI	BSc RADIOGRAPHY	Woman	Yes	2	Physical Abuse and Neglect	1	Long bone fractures;Excessive crying;Skull fractures;Bruises;Bur	10	Spinal/ Axial Skeleton fracture;Long bone fractu	6		Femur fractures ;Rib fractures;Skull fractures;Long
JUNIOR RADIOGRAPI	BSc RADIOGRAPHY	Man	Yes	2	Physical Abuse and Neglect	1	Excessive crying;Long bone fractures;Skull fractures;Bruises;Fea	7	Long bone fractures;Skull Fractures;Rib Fractur	3		Femur fractures ;Rib fractures;Pleural effusion;Skul
CHIEF RADIOGRAPHE	NATIONAL DIPLOMA	Woman	Not sure	1	Physical Abuse and Neglect	1	Drowsiness;Excessive crying;Long bone fractures;Skull fractures	13	Fatigue;Long bone fractures;Spinal/ Axial Skele	7	SELEI	Hilar lymphadenopathy;Cholelithiasis;Pleural effusio
CHIEF RADIOGRAPHE	BSc RADIOGRAPHY	Woman	No	0	Physical Abuse and Neglect	1	Excessive crying;Long bone fractures;Skull fractures;Bruises;No	10	Spinal/ Axial Skeleton fracture;Skull Fractures;R	5	SELEI	Femur fractures ;Rib fractures;Skull fractures;Metac

ADDENDUM A11: DATA COLLECTION SHEET: PART 2

Formula Bar

	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD
oint	There	Point	Who a	Poi	Does	P	Do	Po	Is th	F	Paren	Point	Feedl	What ar	Points
sive cry	Femur fractures ;Rib	All of the a	0	Unsure	1	Not su	1	Yes	2	Inform radiologist.;			X-ray examinations req	
ctures;S	Femur fractures ;Rib	All of the a	0	No	0	Not su	1	Yes	1	Inform immediate supervisor.;Ir			Full Skeletal Survey;X-r	
ctures;S	Femur fractures ;Rib	Adolesce	1	Unsure	1	Not su	1	Yes	1	Inform radiologist.;Inform imme			Unsure;	
ctures;S	Rib fractures;Femur	All of the a	0	Unsure	1	Not su	1	Yes	1	Ask parents/guardians if child h			X-ray examinations req	
bone fra	Femur fractures ;Rib	All of the a	0	Yes	2	Not su	1	Yes	1	Inform radiologist.;Inform imme			X-ray examinations req	
y Incon	Femur fractures ;Rib	All of the a	0	Unsure	1	Not su	1	Yes	1	Ask parents/guardians if child h			X-ray examinations req	
ctures;S	Femur fractures ;Rib	Adolesce	1	Unsure	1	Not su	1	Yes	1	Inform radiologist.;Inform imme			Long bone x-rays only;	
ng;	Fractures in differen	Adolesce	1	Unsure	1	Not su	1	Yes	1	Inform radiologist.;Ask parents			Full Skeletal Survey;	
ctures;S	Femur fractures ;Sku	Adolesce	1	Unsure	1	Not su	1	Yes	2	Inform radiologist.;			Full Skeletal Survey;	
bone fra	Femur fractures ;Rib	Adolesce	1	Unsure	1	Not su	1	Yes	1	Inform immediate supervisor.;Ir			Unsure;	
ctures;S	Rib fractures;Femur	All of the a	0	Yes	2	Yes	2	Yes	2	Inform radiologist.;Show other			X-ray examinations req	
s;Metac	Rib fractures;Skull fr	Adolesce	1	Unsure	1	Not su	1	Yes	2	Inform immediate supervisor.;Ir			Unsure;	
ctures;S	Hilar lymphadenopa	All of the a	0	No	0	No	0	Yes	0	Inform radiologist.;Inform imme			Unsure;	
ctures;S	Rib fractures;Femur	Adolesce	1	Unsure	1	Yes	2	Yes	2	Inform radiologist.;			Full Skeletal Survey;	
oea ;Ur	Femur fractures ;Rib	All of the a	0	Unsure	1	Not su	1	Yes	1	Inform radiologist.;Inform imme			X-ray examinations req	
ctures;S	Femur fractures ;Rib	Adolesce	1	Unsure	1	Not su	1	Yes	1	Inform radiologist.;			Full Skeletal Survey;	
ctures;S	Rib fractures;Femur	All of the a	0	Yes	2	Yes	2	Yes	2	Inform radiologist.;Inform imme			Unsure;	
bone fra	Rib fractures;Skull fr	Adolesce	1	Yes	2	Not su	1	Yes	1	Ask parents/guardians if child h			Unsure;	
bone fra	Femur fractures ;Rib	Adolesce	1	Unsure	1	Not su	1	Yes	1	Inform immediate supervisor.;			Unsure;	
ctures;F	Femur fractures ;Rib	Adolesce	1	Unsure	1	Not su	1	Yes	1	Ask parents/guardians what th			X-ray examinations req	
Incontir	Femur fractures ;Rib	Adolesce	1	Unsure	1	Not su	1	Yes	1	Ask parents/guardians if child h			Full Skeletal Survey;	
oea ;Ur	Femur fractures ;Rib	All of the a	0	Unsure	1	Not su	1	Yes	1	Inform radiologist.;			X-ray examinations req	
ctures;F	Rib fractures;Pleura	Adolesce	1	Yes	2	Yes	2	Yes	2	Inform radiologist.;Inform imme			X-ray examinations req	
ctures;S	Femur fractures ;Rib	Adolesce	1	Yes	2	Yes	2	Yes	2	Inform immediate supervisor.;A			Full Skeletal Survey;	
ctures;S	Femur fractures ;Rib	All of the a	0	Unsure	1	Not su	1	Yes	1	Inform radiologist.;Inform imme			Full Skeletal Survey;	
ctures;S	Rib fractures;Skull fr	Adolesce	1	Yes	2	Yes	2	Yes	2	Inform radiologist.;			Full Skeletal Survey;	
ctures;S	Femur fractures ;Rib	Adolesce	1	Yes	2	Yes	2	Yes	1	Inform immediate supervisor.;A			Full Skeletal Survey;	
ctures;S	Femur fractures ;Rib	Adolesce	1	Yes	2	Yes	2	Yes	2	Inform radiologist.;			Full Skeletal Survey;	
ctures;S	Femur fractures ;Rib	Adolesce	1	Yes	2	Yes	2	Yes	2	Ask parents/guardians if child h			Full Skeletal Survey;	
ctures;S	Femur fractures ;Rib	Adolesce	1	Yes	2	No	0	Yes	2	Inform radiologist.;			Full Skeletal Survey;	
ctures;S	Femur fractures ;Rib	All of the a	0	Yes	2	Yes	2	Yes	2	Inform radiologist.;			Full Skeletal Survey;	
ctures;S	Femur fractures ;Rib	Adolesce	1	Yes	2	No	0	Yes	1	Inform radiologist.;			Full Skeletal Survey;	
ctures;S	Femur fractures ;Rib	Adolesce	1	Yes	2	Yes	2	Yes	2	Inform radiologist.;			X-ray examinations req	
bone fra	Femur fractures ;Rib	Adolesce	1	Yes	2	Yes	2	Yes	2	Inform radiologist.;Inform imme			Full Skeletal Survey;	
ctures;S	Femur fractures ;Rib	Adolesce	1	Yes	2	Yes	2	Yes	2	Inform radiologist.;Inform imme			Full Skeletal Survey;	
s;Long I	Femur fractures ;Rib	All of the a	0	Yes	2	Yes	2	Yes	2	Inform radiologist.;			Full Skeletal Survey;	
ctures;S	Femur fractures ;Rib	Adolesce	1	Yes	2	No	0	Yes	2	Inform radiologist.;			Full Skeletal Survey;	
ctures;S	Femur fractures ;Rib	Adolesce	1	Yes	2	No	0	Yes	2	Inform radiologist.;			Full Skeletal Survey;	
s;Long I	Femur fractures ;Sku	Adolesce	1	Yes	2	Not su	1	Yes	1	Ask parents/guardians if child h			Full Skeletal Survey;	
ctures;S	Femur fractures ;Ple	All of the a	0	Yes	2	Not su	1	Yes	1	Ask parents/guardians if child h			Full Skeletal Survey;	
ctures;F	Femur fractures ;Rib	All of the a	0	Yes	2	Not su	1	Yes	2	Inform radiologist.;Ask parents			Long bone x-rays only;	
ctures;S	Femur fractures ;Rib	Adolesce	1	Yes	2	Yes	2	Yes	1	Inform immediate supervisor.;Ir			Full Skeletal Survey;	
ctures;F	Femur fractures ;Rib	All of the a	0	Yes	2	Not su	1	Yes	2	Inform radiologist.;Inform imme			Full Skeletal Survey;	
Incontir	Fractures in differen	All of the a	0	Yes	2	Yes	2	Yes	2	Inform immediate supervisor.;A			Full Skeletal Survey;	
ctures;S	Femur fractures ;Rib	Adolesce	1	Yes	2	Not su	1	Yes	2	Inform radiologist.;Inform imme			X-ray examinations req	
ctures;S	Femur fractures ;Rib	Adolesce	0	Yes	2	Not su	1	Yes	2	Inform radiologist.;			Full Skeletal Survey;	
bone fra	Femur fractures ;Rib	Elderly	0	Yes	2	Yes	2	Yes	2	Inform radiologist.;Inform imme			Full Skeletal Survey;	
ctures;S	Femur fractures ;Rib	All of the a	0	Yes	2	Yes	2	Yes	2	Inform radiologist.;Inform imme			Full Skeletal Survey;	
ctures;S	Femur fractures ;Rib	All of the a	0	Yes	2	Yes	2	Yes	2	Ask parents/guardians what th			X-ray examinations req	
	Hilar lymphadenopa	Elderly	0	Yes	2	No	0	Yes	1	Ask parents/guardians if child h			Full Skeletal Survey;Lor	
keleton	Femur fractures ;Rib	Adolesce	1	Yes	2	Yes	2	Yes	2	Inform radiologist.;Inform imme			Full Skeletal Survey;	
ctures;S	Femur fractures ;Rib	Adolesce	1	Yes	2	Yes	2	Yes	2	Inform radiologist.;Ask parents			X-ray examinations req	
bone fra	Hilar lymphadenopa	Elderly	0	No	0	Not su	1	Yes	0	Ask parents/guardians what th			X-ray examinations req	
keleton	Femur fractures ;Rib	Adolesce	1	Yes	2	Not su	1	Yes	2	Inform radiologist.;			X-ray examinations req	
ctures;S	Rib fractures;Spiral f	Adolesce	1	Yes	2	Not su	1	Yes	2	Inform radiologist.;			Full Skeletal Survey;	
bone fra	Femur fractures ;Rib	Elderly	0	Yes	2	No	0	Yes	1	Inform radiologist.;Inform imme			Full Skeletal Survey;	

ADDENDUM A12: DATA COLLECTION SHEET: PART 3

AD	AE	AG	AH	AI	AJ	AK	AL	AM	AN	AO
ints	Feedba	What	Points	Feedba	Select	Point	Feedbac	To wh	Point	Feedbac	Do you t
ons requested by the		X-ray examinations requested by t			AP abdomen and pelvis;AP chest i			Immediate supervisor (or referring p			Yes
vey;X-ray examinatio		X-ray examinations requested by t			Chest AP and both obliques views			Immediate supervisor (or referring p			Yes
		Unsure;			Lateral Skull only;AP Femur;AP for			Immediate supervisor (or referring p			Yes
ons requested by the		X-ray examinations requested by t			Lateral Skull only;AP of the full upp			Immediate supervisor (or referring p			Yes
ons requested by the		X-ray examinations requested by t			AP humerus including shoulder an			Immediate supervisor (or referring p			Yes
ons requested by the		X-ray examinations requested by t			AP Femur;Lateral Skull only;AP for			Immediate supervisor (or referring p			Yes
s only;		Full Skeletal Survey;			AP Femur;Lateral Skull only;AP for			Immediate supervisor (or referring p			Yes
vey;		Full Skeletal Survey;X-ray examin			Lateral Skull only;AP chest includir			Immediate supervisor (or referring p			Yes
vey;		Long bone x-rays only;			AP Femur;Lateral Skull only;AP for			Immediate supervisor (or referring p			Yes
		Unsure;			AP Femur;AP forearm;AP and Late			Immediate supervisor (or referring p			Yes
ons requested by the		Unsure;			AP Femur;Lateral Skull only;Chest			Immediate supervisor (or referring p			Yes
		Unsure;			Lateral Skull only;			Immediate supervisor (or referring p			Yes
		Unsure;			Chest AP and both obliques views			Immediate supervisor (or referring p			Yes
vey;		Full Skeletal Survey;			AP and Lateral Skull;AP abdomen			Immediate supervisor (or referring p			Yes
ons requested by the		Long bone x-rays only;X-ray exan			AP Femur;Lateral Skull only;AP for			Immediate supervisor (or referring p			Yes
vey;		Full Skeletal Survey;			AP Femur;Lateral Skull only;Latera			Immediate supervisor (or referring p			Yes
		Full Skeletal Survey;			AP Femur;Lateral Skull only;AP for			Immediate supervisor (or referring p			Yes
		X-ray examinations requested by t			Lateral Skull only;Erect Abdomen;A			Immediate supervisor (or referring p			Yes
		X-ray examinations requested by t			Patella Axial;AP Femur;Lateral Sku			Immediate supervisor (or referring p			Yes
ons requested by the		X-ray examinations requested by t			AP Femur;Lateral Skull only;AP for			Immediate supervisor (or referring p			Yes
vey;		Long bone x-rays only;			AP chest including shoulders;			Immediate supervisor (or referring p			Yes
ons requested by the		X-ray examinations requested by t			Lateral Skull only;AP Femur;AP ab			Immediate supervisor (or referring p			Yes
ons requested by the		Long bone x-rays only;X-ray exan			AP Femur;AP forearm;Lateral Skul			Immediate supervisor (or referring p			Yes
vey;		Long bone x-rays only;			AP Femur;AP and Lateral Skull;AP			Immediate supervisor (or referring p			Yes
vey;		Long bone x-rays only;			AP Femur;Lateral Skull only;AP for			Immediate supervisor (or referring p			Yes
vey;		Full Skeletal Survey;			AP Femur;Lateral Skull only;AP for			Immediate supervisor (or referring p			Yes
vey;		Full Skeletal Survey;			AP Femur;Lateral Skull only;AP for			Immediate supervisor (or referring p			Yes
vey;		Full Skeletal Survey;			AP Femur;AP forearm;Coned later			Immediate supervisor (or referring p			Not Sure
vey;		Full Skeletal Survey;			Lateral Skull only;AP abdomen anc			Immediate supervisor (or referring p			Yes
vey;		X-ray images of the affected part;			AP Femur;Lateral Skull only;AP for			Immediate supervisor (or referring p			Yes
vey;		X-ray images of the affected part;			AP Femur;AP forearm;AP abdome			Immediate supervisor (or referring p			Yes
vey;		Full Skeletal Survey;X-ray examin			AP Femur;AP forearm;AP abdome			Immediate supervisor (or referring p			Yes
ons requested by the		Full Skeletal Survey;			Oblique Rib views;AP chest includi			Immediate supervisor (or referring p			Yes
vey;		X-ray images of the affected part;I			AP Femur;Erect Abdomen;AP fore			Immediate supervisor (or referring p			Yes
vey;		X-ray images of the affected part;I			AP Femur;AP forearm;Coned later			Immediate supervisor (or referring p			Yes
vey;		Unsure;			Chest AP and both obliques views			Immediate supervisor (or referring p			Yes
vey;		Full Skeletal Survey;			AP Femur;AP abdomen and pelvis			Immediate supervisor (or referring p			Yes
vey;		Full Skeletal Survey;			AP Femur;Lateral Skull only;AP for			Immediate supervisor (or referring p			Yes
vey;		X-ray images of the affected part;I			Lateral Skull only;AP forearm;Late			Immediate supervisor (or referring p			Yes
vey;		Full Skeletal Survey;			AP Femur;Lateral Skull only;AP for			Immediate supervisor (or referring p			Yes
s only;		Long bone x-rays only;			AP Femur;Lateral Skull only;Conec			Immediate supervisor (or referring p			Yes
vey;		Full Skeletal Survey;			AP Femur;Lateral Skull only;AP for			Immediate supervisor (or referring p			Yes
vey;		Full Skeletal Survey;			Lateral Skull only;Lateral view of th			Immediate supervisor (or referring p			Yes
vey;		Full Skeletal Survey;			AP Femur;Lateral Skull only;Erect A			Colleagues;Immediate supervisor I			Yes
ons requested by the		X-ray examinations requested by t			AP Femur;Lateral Skull only;AP for			Immediate supervisor (or referring p			Yes
vey;		Full Skeletal Survey;			AP Femur;Lateral Skull only;AP for			Immediate supervisor (or referring p			Yes
vey;		Full Skeletal Survey;			AP Femur;Lateral Skull only;AP for			Immediate supervisor (or referring p			Not Sure
vey;		X-ray examinations requested by t			AP Femur;AP forearm;Coned later			Immediate supervisor (or referring p			Yes
ons requested by the		X-ray examinations requested by t			AP Femur;AP forearm;Coned later			Immediate supervisor (or referring p			Not Sure
vey;Long bone x-ray:		Full Skeletal Survey;			AP Femur;AP forearm;Lateral view			Immediate supervisor (or referring p			Not Sure
vey;		Long bone x-rays only;			AP Femur;Lateral Skull only;AP for			Immediate supervisor (or referring p			Yes
ons requested by the		X-ray examinations requested by t			AP Femur;Lateral Skull only;AP for			Immediate supervisor (or referring p			Not Sure
ons requested by the		X-ray examinations requested by t			Patella Axial;AP Femur;Erect Abdc			Immediate supervisor (or referring p			No
ons requested by the		Full Skeletal Survey;			AP Femur;AP forearm;AP humerus			Immediate supervisor (or referring p			Yes
vey;		Unsure;			AP Femur;Lateral Skull only;Conec			Immediate supervisor (or referring p			Yes
vey;		X-ray examinations requested by t			AP Femur;Lateral Skull only;AP for			Immediate supervisor (or referring p			Yes

ADDENDUM A13: DATA COLLECTION SHEET: PART 4

AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	
Feedbac	Do you t	Poi	Feedb	Who are the	Points	Feedb	Bone sc	Points	F	Do yo	Poin
or referring p	Yes			All of the Above;			Maybe			No	
or referring p	Yes			All of the Above;			No			Yes	
or referring p	Yes			All of the Above;			Maybe			No	
or referring p	Yes			All of the Above;			No			Yes	
or referring p	Yes			All of the Above;			Yes			No	
or referring p	Yes			Parents ;Stepparents;Partner of one of th			Yes			No	
or referring p	Yes			All of the Above;			Maybe			No	
or referring p	Yes			All of the Above;			Maybe			Yes	
or referring p	Yes			Parents ;Grandparents;Stepparents;Part			No			Yes	
or referring p	Yes			All of the Above;			Maybe			Yes	
or referring p	Yes			Parents ;Grandparents;Stepparents;Part			Maybe			No	
or referring p	Yes			All of the Above;			Maybe			Yes	
or referring p	Yes			All of the Above;			Yes			Yes	
or referring p	Yes			Parents ;Stepparents;Partner of one of th			Yes			No	
or referring p	Yes			Parents ;Grandparents;Partner of one of t			Maybe			No	
or referring p	Yes			Parents ;Partner of one of the parents;Te			Maybe			No	
or referring p	Yes			All of the Above;			Maybe			No	
or referring p	Yes			All of the Above;			Yes			No	
or referring p	Yes			All of the Above;			Maybe			No	
or referring p	Yes			Parents ;Grandparents;Stepparents;Part			Maybe			No	
or referring p	Yes			Parents ;Stepparents;Partner of one of th			Yes			No	
or referring p	Yes			Parents ;Stepparents;Partner of one of th			Yes			No	
or referring p	Yes			Partner of one of the parents;Stepparents			Yes			No	
or referring p	Yes			Parents ;Partner of one of the parents;Te			Yes			Yes	
or referring p	Yes			Parents ;Grandparents;Stepparents;Part			Yes			No	
or referring p	Yes			Parents ;Partner of one of the parents;Ste			Yes			No	
or referring p	Yes			Stepparents;Partner of one of the parents			Yes			Yes	
or referring p	Not Sure			Stepparents;Partner of one of the parents			Maybe			Yes	
or referring p	Yes			All of the Above;			Yes			No	
or referring p	Yes			Parents ;Stepparents;Partner of one of th			Yes			No	
or referring p	Yes			All of the Above;			Maybe			No	
or referring p	Yes			All of the Above;			Maybe			No	
or referring p	Yes			Neighbours;Stepparents;Parents ;			Maybe			Yes	
or referring p	Yes			Partner of one of the parents;Stepparents			Maybe			Yes	
or referring p	Yes			Parents ;			Yes			Yes	
or referring p	Yes			Partner of one of the parents;Stepparents			No			No	
or referring p	Yes			Parents ;Partner of one of the parents;Ne			Yes			No	
or referring p	Yes			Parents ;Stepparents;Partner of one of th			No			No	
or referring p	Yes			All of the Above;			Maybe			Yes	
or referring p	Yes			All of the Above;			Maybe			No	
or referring p	Yes			All of the Above;			Maybe			Yes	
or referring p	Yes			Parents ;Grandparents;Stepparents;Part			Maybe			No	
or referring p	Yes			All of the Above;			Yes			Yes	
supervisor I	Yes			All of the Above;			Maybe			No	
or referring p	Yes			Parents ;Partner of one of the parents;			No			No	
or referring p	Yes			All of the Above;			No			No	
or referring p	Not Sure			Parents ;Grandparents;Stepparents;Part			No			Yes	
or referring p	Yes			Parents ;Neighbours;Grandparents;Step			Maybe			No	
or referring p	Not Sure			All of the Above;			Maybe			No	
or referring p	Not Sure			Parents ;Neighbours;Stepparents;Partne			Yes			Yes	
or referring p	Yes			Parents ;Stepparents;Partner of one of th			Yes			No	
or referring p	Not Sure			Parents ;Stepparents;Partner of one of th			Yes			No	
or referring p	No			Teachers;			No			No	
or referring p	Yes			Partner of one of the parents;			Maybe			No	
or referring p	Yes			Parents ;Stepparents;Partner of one of th			No			No	
or referring p	Yes			Parents ;Stepparents;Partner of one of th			Yes			Yes	