

Towards determining the prevalence of fatalities from shaken baby syndrome in South Africa

Vimbayinashe S. Chibambo
Department of Psychology
University of Cape Town

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ABSTRACT

Shaken baby syndrome is an extreme form of head trauma that has characteristically been evidenced within the first two years of life. High prevalence rates have been reported in developed countries, and the head injuries incurred by these children are either fatal, or bear lifelong and adverse consequences for the survivors. The diagnosis of the syndrome is informed by the presence of three symptoms, namely; retinal and subdural haemorrhages, and encephalopathy, and these have been shown to occur in victims of both shaken baby syndrome and physical child abuse in high-income countries. Though South Africa has some of the world's highest rates of child homicide and abuse, shaken baby syndrome is currently not recognised as possible cause of death amongst abused infants in the country. This study sought to address this gap by determining whether shaking had contributed to the deaths of infants in the Western Cape Province, based on the forensic findings generated within medico-legal examinations. Court records from three courts were retrospectively reviewed, and a systematic, content analysis was used to uncover any concealed indications of shaking in the death registers and inquest of a moderate sample (n = 405). The study also sought to establish the context-specific risk factors for child maltreatment. Results indicated no substantial evidence of shaken infants, however, the fatal injuries evidenced in the abused infants within the study, gave reason to suspect possible shaking. Most of the deaths had been caused by unnatural factors. Findings outlined the need for forensic pathologists to develop and implement a standardised post-mortem protocol in South Africa aimed at distinguishing abused infants from shaken infants, and further studies would be required to make substantial diagnoses of the syndrome.

List of keywords: child abuse; fractures; postmortems; retinal haemorrhages; risk factors; shaken baby syndrome; subdural haemorrhages

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Towards determining the prevalence of fatalities from shaken baby syndrome in South Africa

Shaken baby syndrome, also known as abusive head trauma, is a form of child abuse that has been identified as a frequent cause of traumatic infant death in various developed countries, with annual incidence rates of 16 to 33 per 100,000; 24 to 34 per 100,000, and 33.8 per 100,000 in the United States, Canada and Scotland, respectively (Duhaime, Christian, Rorke & Zimmerman, 1998; Narang & Clarke, 2014; Piteau, Ward, Barrowman & Plint, 2012). The mortality and morbidity rates of the syndrome are high, with an estimated 45-50% of the survivors shown to exhibit neurologic and physical sequelae including epilepsy, learning disabilities and blindness (Bechtel et al., 2004; Duhaime et al., 1998; Minns, Jones & Mok, 2008; Wirtz & Trent, 2008). The literature suggests that the syndrome's occurrence has mainly been restricted to children below the age of two years, and is largely manifested by varying degrees of intracranial damage (Bechtel et al., 2004; Duhaime et al., 1998; Narang & Clarke, 2014; Piteau et al., 2012). In South Africa, relatively few cases of shaken baby syndrome have been identified despite the fact that South Africa has much higher rates of child maltreatment than countries such as the United States, Canada and Scotland that do record shaken baby syndrome (Fiegggen, Wiemann, Brown, van As, Swingler & Peter, 2004; Mathews, Abrahams, Jewkes, Martin & Lombard, 2013).

Pathology

The correct diagnosis of suspected cases of fatal shaken baby syndrome is achieved through the joint efforts of forensic neuropathologists, experienced ophthalmologists and radiologists (Matschke, Püschel & Glatzel, 2009; Squier 2011). The syndrome is commonly identified through a triad of symptoms namely: subdural haemorrhages, retinal haemorrhages, and encephalopathy, and is thought to result from repetitive shaking and the effects of rotational exertion (Barr, Trent & Cross, 2004; King, MacKay & Sirnick, 2003). In the early stages of development, infants' susceptibility to the incurrance of injuries is attributed to their large heads, unsupported necks, and minimally developed skulls with fast-growing brains (Le Roux-Kemp & Burger, 2014).

Subdural haemorrhages are evidenced as a thin film of blood that collects beneath the dura. It appears that repetitive acceleration and deceleration tear the bridging veins that join the dura to the brain resulting in haemorrhages, in the presence or absence of impact against a hard surface (Barr et al., 2004; King et al., 2003). Studies suggests that this type of hematoma can be identified in 74-90% of all shaken baby syndrome incidents (Duhaime et al., 1998; Fiegggen et al., 2004; Le Roux-Kemp & Burger, 2014; Narang & Clarke, 2014). Retinal

haemorrhages are reported to occur in 65-100% of infants with shaken baby syndrome (Duhaime et al., 1998; Gilliland et al., 2007; Narang & Clarke, 2014). Bleeding is often found at the posterior of the eyeball, and is suggested to be triggered by increased pressure in the brain, that then leads to an increase in the pressure within the retina (Le Roux-Kemp & Burger, 2014; Miller, Barnes & Miller, 2015). Encephalopathy, shown in infants who survive, encompasses neurological symptoms including seizures, irritability, impaired consciousness, vomiting, loss of appetite and abnormal breathing patterns. (Duhaime et al., 1998; Le Roux-Kemp & Burger, 2014).

Although extant literature recognises the triad as the primary diagnostic criteria of the syndrome, the diagnosis of shaken baby syndrome is not straightforward due to the occurrence of these same symptoms in other cases involving birth trauma, genetic syndrome infections, nutritional and metabolic disorders, anaemia, infections, tumours, coagulopathy and carbon monoxide poisoning (Le Roux-Kemp & Burger, 2014; Narang & Clarke, 2014; Squier, 2011). These other causes therefore need to be ruled out in order to make the diagnosis.

Indicators - Clinical Procedures, Risk Factors and Crying

Studies suggest that shaken baby syndrome is a condition that does not have definitive, diagnosable symptoms (Le Roux-Kemp & Burger, 2014). Consequently, medical staff ought to be thorough and suspicious when evaluating cases of suggestive diagnosis (Laurent-Vannier et al., 2011; Le Roux-Kemp & Burger, 2014). Clinical indicators of shaken baby syndrome include a medical history where the infants' symptoms are not consistent with the medical report, where medical attention is sought late and where accounts of events that led to the infant's injuries vary between the different caregivers (Laurent-Vannier et al., 2011; Le Roux-Kemp & Burger, 2014).

Parental and family risk factors that increase the likelihood of shaken babies include; the parents' ages (with younger parents, under 19, being more prone to shake their infants); marriage status; substance abuse, socioeconomic status - though not restricted to one socioeconomic class, it presents more frequently in deprived socioeconomic settings, and a history of domestic violence and/or spousal abuse (Duhaime et al., 1998; Hennes, Kini & Palusci, 2001; Laurent-Vannier et al., 2011; Le Roux-Kemp & Burger, 2014). Infant related risk factors consist of the presence of disabilities; mental health problems, prematurity and the gender of the child (with higher injuries and fatalities in boys) (Palusci & Covington, 2014; Lauren-Vannier, 2011). Investigations have shown that the most likely perpetrators of

shaken baby syndrome are fathers, mother's boyfriends (non-resident males), female babysitters, then mothers, in that order (Duhaime et al., 1998; Hennes et al., 2001).

Inconsolable crying, which tends to peak during the first three months of an infant's life, has been identified as a key trigger of caregiver violence, and studies have shown strong associations between the occurrence of shaken baby syndrome, other forms of physical abuse, and incessant crying (Barr et al., 2009, Barr, 2012, Narang & Clarke, 2014). Given that crying peaks during this period, infants within this range are most at risk of being shaken, and this finding is corroborated by the rates of shaken baby syndrome cases that have been evidenced within this age cohort, in developed countries (Barr et al., 2009, Palusci & Covington, 2014). In response to extreme crying bouts, some caregivers may shake their babies out frustration, feelings of inadequacy or as a form of exercising discipline (Barr, 2012).

Why is it Important to Study Shaken Baby Syndrome in South Africa?

One reason to study shaken baby syndrome is that the prospects of preventing its occurrence through easy-to-implement programmes are high. Given its' serious consequences, measures to alleviate this problem are becoming an increasing concern for researchers worldwide. Studies suggests that shaken baby syndrome may be preventable (Barr et al., 2009; Barr, 2012; le Roux-Kemp & Burger, 2014; Wirtz & Trent, 2008), and researchers have addressed the problem through raising caregiver awareness (Barr, 2012). For instance, a randomized control trial conducted in Canada showed that recipients of a prevention program had greater awareness regarding self-management during episodes of inconsolable crying and the adverse consequences of shaking (Barr et al., 2009). The program participants also displayed a greater appreciation for sharing newly acquired knowledge, relative to the control group. Due to these findings, the authors suggest that such interventions may reduce the prevalence of injuries incurred, particularly those that are reported during incidents where infants may have been shaken in response to their crying (Barr et al., 2009).

Second, at present, shaken baby syndrome statistics in South Africa are unknown, making it difficult to argue for, or to assess the efficacy of prevention programmes. This may result from the misclassification of the causes of death in case reports, the concealment of infant deaths and the underreporting of incidents (which has been revealed in the country's police reports; Mathews et al., 2013).

Third, the discrepancy between South Africa's high rates of child maltreatment and the low rates of shaken baby syndrome is quite puzzling. Comparative studies that have been

conducted between South Africa and other countries that fall within similar socioeconomic brackets (i.e., where there are similarly high pockets of entrenched poverty) show that South Africa has higher infant mortality rates than those identified in countries such as Brazil and Mexico (Shung-King & Proudlock). Also, trauma-related causes of death are most significantly noted in children aged between one to four years, with the majority of the identified causes of death being deemed as 'ill-defined' (Shung-King & Proudlock, 2002). Mathews et al. (2013) determined that South Africa has a child homicide rate that exceeds twice the worldwide estimate, but despite these statistics, shaken baby syndrome is not being reported. These findings are corroborated by a retrospective hospital-based study conducted in Cape Town over a three-year period that found only one shaken baby out of 68 diagnosed cases of non-accidental head injury in children (Fiegeen et al., 2004). These inconsistencies – namely, the high rate of child abuse but the apparently low rate of shaken baby syndrome – are worth exploring.

Shaken baby syndrome is a controversial topic that has far reaching consequences for those who survive (Kaltner, Kenardy, Le Broque & Page, 2013; King et al., 2003). It is recognised as a relatively high-prevalence problem in high income countries (Piteau et al., 2012), but surprisingly not so in South Africa, where the child violence and homicide rates are ranked higher than most countries, the world over (Mathews et al., 2013). In conjunction with these high rates of child maltreatment and homicide, the facts identified in the literature emphasize the need to determine whether shaken baby syndrome is occurring in South Africa or not.

Research Aim and Question

The aim of the study is to determine whether there are incidents of shaken baby syndrome that may be identified in the records of inquests into infant deaths. Specifically, the question that the study is aiming to answer is whether shaken baby syndrome can be identified in a sample of inquests from Cape Town based Magistrate Courts.

Methods

Design and Setting

A retrospective investigation was carried out at three of ten Magistrate Courts from the Western Cape Province to see if there were any indications of shaken baby syndrome that had been overlooked during the compilation of inquest records. Data were collected from the Cape Town, Mitchells Plain and Wynberg Magistrate Courts. These courts were selected because of their coverage of poor, high-risk, crime areas where child maltreatment is likely to

have occurred. The study also sought to determine the most prevalent, context-specific risk factors for child maltreatment. The areas under the three Courts are clustered as follows:

Table 1

The jurisdictions of the Magistrate Courts

Court	District covered
Cape Town	Atlantis, Camps Bay, Cape Town, Tableview Harbour, Kensington, Maitland, Milnerton, Sea Point, Tableview Woodstok
Mitchells Plain	Eastridge, Westridge, Colorado Park, Lentegour, New Woodlands. Rondevlai Park, Alpine Park, Tafelsig, Lost City, Strandfontein, Rocklands, Morgenster, London Village, Mandalay Merrydale, Hyde Park, Morgans Village
Wynberg	Mowbray, Steenberg, Kirstenhof, Hout Bay, Claremont, Retreat, Lansdowne, Mannenberg Grassy Park

Space limits within the archives of these Courts meant that only ten years' worth of documents could be stored, so this study was limited to a 10-year retrospective review. Registers and records that were available for analysis included the following: death registers from 2006 to 2016, the written statements provided by the legal and implicated parties in each case, and the chief post-mortem findings reported in the medico-legal examinations (van Vuuren, 2013). Where the registered cause of death clearly did not contain shaking, for instance, motor vehicle accidents or burns, the accompanying inquest record was not examined further.

Section 16(2) of the *Inquests Act* outlines the four findings made by the Magistrate conducting the inquest, and these are; (i) the identification of the demised, (ii) the cause or likely cause of death, (iii) the date of the deceased's death, and (iv) whether the death had been caused by another party's commission or omission of a particular action. (see *Inquests Act 58 of 1959*, p. 42). The Act also states that inquests are only included as part of a Court's stored records once the attorney-general has concluded all investigations pertaining to the specific inquest (see s 19(1) and (2) of *Act 58*), and so, investigations that fell into this category could not be included in this study. A systematic content analysis was then used to review the inquest records. Content analyses allow for the numerical analysis of the data

(Rose, Sparks and Canhoto, 2015), and SPSS was used for the comparison and crosstabulation of the variables obtained within the study.

Research Participants and Inclusion Criteria

Fatalities from shaking have been evidenced in 5-year old children, however, studies have by and large reported that infants within the first 24 months of life are at the highest risk of being shaken (Kelly & Farrant, 2007; Matsckhe et al., 2009; Narang & Clarke, 2014). In South Africa, the reported under-5 homicide rate is 7.9 per 100, 000, with approximately one third (29%) of these deaths occurring in the one to four-year age group (Mathews et al., 2013). Death reviews from 1998 to 2002 showed that 13.2% of the fatalities in this age range were attributed to unknown causes (Shung-King & Proudlock, 2002). This study, however, limited the definition of infancy to those aged 36 months, and below, and this is because the brain, skull and neck regions continue to undergo development during this period, and so, the prospects of suffering cranial injuries due to trauma are heightened (Al-Saadoon, Elnor & Ganesh, 2011; Case, Graham, Handy, Jentzen & Monteleone, 2001). Accordingly, the study looked at the causes of death for children aged three and below, and all fatalities with indistinct causes were closely analysed to determine whether shaking had contributed to these deaths.

The operationalisation of risk factors. The risk factors considered in this investigation were: (i) age – where the highest associations between shaking and crying have been shown to occur amongst infants between 2 and 6 months (Barr, 2012; Laurent-Vannier, 2011; Narang & Clarke, 2014); (ii) race and poverty - where factors such as the geographical location of squatter settlements, health risks, and access to medical services were formed around racially segregated categories and ethnicity during the Apartheid regime (SA History Online, 2015), and (iii) gender – where males have been identified as the most common victims and perpetrators of shaken baby syndrome (Lauren-Vannier, 2011; Le Roux-Kemp & Burger, 2014; Palusci & Covington, 2014). The use of these categories does not suggest any inherent implications that these variables might have, they do however, act as proxies to the psychosocial, and economic environments that are seen in South Africa today. Some of these variables will be further outlined in the section below.

Data Collection

Data from the three Courts was compiled in one Microsoft Excel spreadsheet, and where the evidence from the registers and the inquest records were available, that information was entered under columns with the following headings:

- Municipal Court

- Case number
- Age of the child
- Gender - male or female
- Race - White, Coloured, African, Asian, Indian
- Primary cause of death –these included: homicides, accidents (motor vehicle, burns, drowned), natural causes (intestinal infectious diseases, cardiovascular disorders, respiratory disorders, diarrhoea, malnutrition, influenza, pneumonia), undetermined/unknown
- Pathology – the presence of: retinal haemorrhages, subdural haemorrhages and encephalopathy
- Child maltreatment – neglect, abandonment, sexual abuse, physical abuse
 - Physical abuse – shaken baby, battering, shielding (where the death resulted from the baby being used as a ‘shield’ against an assailant’s attack (Fieggen, et al., 2004), head injuries, skull fractures, spinal injuries, rib and/or long bone fractures, bruising, contusions (frontal or temporal) (Barr et al., 2004; Laurent-Vannier et al., 2011)
- Seizures
- Unresponsive/unconscious body
- Delay in seeking medical assistance (number of days post the incident) (Laurent-Vannier et al., 2011; Le Roux-Kemp & Burger, 2014)
- Inconsistent historical account (no correlation between the infants’ presenting symptoms and the parents’ account of the events) (Laurent-Vannier et al., 2011; Le Roux-Kemp & Burger, 2014)
- Parental risk factors: substance abuse of the father and/or mother; previous social service interventions for the father and/or mother; a history of child abuse of either/or both parents ; a history of neglect (father/mother); a history of domestic violence/spousal abuse; young parental age of under, or equal to 19 (father and/or mother), socioeconomic status ; mother’s first child, multiple pregnancies, and a limited education background (Duhaime et al., 1998; Hennes et al., 2001; Laurent-Vannier et al., 2011).
- Other risk factors pertaining to shaking which include; prematurity of the infant, presence of disabilities, gender ratio (with greater incidents expected to occur with male infants) (Laurent-Vannier et al., 2011; Palusci & Covington, 2014)

- Perpetrator information, with fathers, mother's boyfriends (non-resident males), female babysitters or mothers (identified, whether the perpetrator had admitted to shaking or not) (Laurent-Vannier et al., 2011)

Shaken baby syndrome shares a number of risk factors with other potential causes of death, for instance, subdural haemorrhaging can also result from motor vehicle accidents and falls, amongst other causes (Shanahan, Zolotor, Parrish, Barr, & Runyan, 2013). Consequently, where the cause of the injury was clearly not shaking, those cases were not considered as probable shaken infants.

Ethical Considerations of the Study

The ethical considerations for this study were two-fold. Firstly, the study was required to safeguard the lives of the families, and the identities of the deceased, thus treating all matters with confidentiality. Secondly, inquests were only reviewed within the premises of the Courts to ensure that documents were not misplaced or damaged. Though consent from the participants was not required, access to the inquest records was requested from, and granted by the Department of Justice and Constitutional Development.

Confidentiality and privacy. During the data collection process, actual case numbers were recorded to ensure that there were no duplications in the dataset. In seeking to protect the rights and dignity of the deceased, any reference made to a case in the study did not provide any evidence, be it direct or implicit, linking identifiable characteristics to the data presented, duly, infants were assigned pseudonyms in all text and tables found in the study.

Caution and transparency. Lastly, findings were not manipulated, deleted or fabricated in order to create evidence in favour of the study's research aims (Society of American Archivists, 2005).

Data analysis

SPSS version 23 was used to generate descriptive statistics and crosstabulations for the categorical variables in the study (Field, 2009). Tabular representation of the studies' findings was used with the aim of visually presenting the factors that would help determine the prevalence of shaken baby syndrome within this given subgroup of the population.

Results

Certain cases were still undergoing investigation by the Director of Public Prosecutions (DPP) (as outlined in the *Inquests Act*), and this meant that these inquests were excluded from the sample as they were not yet finalised cases ($n = 3$). It was also noted that the records for some of the finalised inquests that presented with potentially relevant findings for shaken baby syndrome were also missing from the archives at the time of analysis ($n =$

10). Consequently, 405 of the 408 registered deaths within the specified age range were finalised cases, but access was restricted to 395 inquest records.

Causes of death in the sample

Table 2

Cause of death by gender across the Municipal Courts

Cause of death	Gender of the deceased			Total	%
	Male	Female	Missing ^a		
Burns	31	18	8	57	14.1
Motor vehicle accidents	35	13	3	51	12.9
Drowning	21	10	8	39	9.6
Abandonment/Neglect/Stillborn ^b	17	12	7	36	8.9
Heart related	11	11	12	34	8.4
Reduction/Deprivation of O ₂ /Cessation of breath ^c	11	11	11	33	8.1
Other - specified (unnatural causes)	18	8	5	31	7.7
Aspiration (of various contents)	8	10	8	26	6.4
Head Injury*	9	7	4	20	4.9
Other - specified (natural causes)	7	7	5	19	4.7
Lung Related	6	4	7	17	4.2
Sudden Infant Death Syndrome (SIDS)*	3	4	0	7	1.7
Blunt Force Trauma/Injury*	3	1	0	4	1.0
Birth Defect	2	0	2	4	1.0
Suspected non-accidental injury	4	0	0	4	1.0
Physical Abuse	3	0	0	3	0.7
Other - unspecified (natural causes)	0	2	1	3	0.7
Caught in domestic dispute	0	1	0	1	0.2
Unknown* ^d	10	4	2	16	4.0
Total	200	122	83	405	100.00

* The causes of death that are of potential relevance to shaken baby syndrome.

^a Missing gender information

^b All except one of these cases were deaths of either viable, or extremely premature foetuses, or newborns that had been abandoned, and the remaining one was a three-year old boy. 'Stillborn' babies evidenced signs of live birth but were found to have died soon afterwards and so, are included in this category.

^c These are all the cases where the cause of death was attributed to hypoxia, anoxia, apnoea, accidental suffocation or overlaying (where the infant shares a bed with someone else and dies when that person rolls over and suffocates them).

^d This variable is comprised of all infant deaths that were registered as 'unknown', 'undetermined due to the extent of decomposition', 'court could not make a finding', 'not conclusive in opinion of post mortem', or 'unascertained at second opinion'.

In totality, unnatural causes formed close to three-quarters of all the infant deaths within the sample (301; 74.3%). Burns were identified as the commonest cause of death, followed by motor vehicle accidents and drownings - together accounting for approximately

40% (147). Deaths from burns often occurred in households without electricity due to the use of open fires as a source of heat, and for meal preparation. Beyond these were fatalities from electrocutions, train accidents, accidental poisonings and dog bites. Heart-related diseases and complications were the leading cause of natural deaths. Malnutrition, multiple organ failure and pneumonia were amongst the more common natural causes of death in this study. Poverty seemed to be the underlying risk factor for many of these deaths, for instance, it was clear that many parents lacked the resources required to purchase separate cots, which was evidenced by the number of fatalities caused by co-sleeping. Deaths from burn wounds were another example of poverty-related fatalities within the sample.

Causes of death that may have masked cases of shaken babies. The death registers did not provide any overt evidence of shaking as a component cause of the deaths within the sample (refer to Table 2). However, there were four categories that could have included shaken infants, and together these covered 47 deaths (11.6%). These deaths were made up of the groups: unknown causes (16; 4.0%), head injuries (20; 4.9%), blunt force trauma (4; 1.0%) and SIDS (7; 1.7%). The available inquest records were scrutinized closely to look for symptoms of shaken baby syndrome. Ten of the 47 (21.3%) cases were amongst the registered deaths whose accompanying files were missing from the archives, thus, the reported findings from this study are not completely representative of all the recorded deaths that may have involved shaking.

Unknown causes. Four of the sixteen (25%) fatalities attributed to unknown and other such causes, occurred one or two days after birth, while three (18.8%) seemed to have been caused by extreme prematurity. Another three (18.8%) infants had died between 2 weeks and 2 months old but no cause of death was conclusively identified. For the remaining five (31.3%), the factors that resulted in the infants' deaths remained undetermined due to the extent of decomposition, and a comment made in the chief post-mortem findings of one such case indicated that the spinal column and cranial contents had not undergone examination. Notwithstanding this detail, none of the statements included accounts of shaking, and the medico-legal examinations from these inquests evidenced no signs of bodily harm, no abnormalities, and the absence of the pathological symptoms of shaken baby syndrome.

Head injuries. Deaths from head injuries were largely caused by accidental falls (7; 35%), and fewer incidents such as gunshot wounds were sustained from family suicides or accidental shootings by young siblings (4, 20%). Head injuries from traumatic births were the rarest cause of death in this category (1, 0.05%). Four inquest records (5%) from this category were not found in the archives.

Six (1.5%) male infants (from the 395 available records) appeared to have met the criteria for shaken baby syndrome and this was based on the evidence provided in the medico-legal examinations of these cases. In five of these, the post-mortems revealed at least one, or two co-occurring symptoms of the triad. In the last case, the infant appeared to have been shaken based on the extent of the fractures he incurred. The details of these six inquests will be explained in further detail when outlining the findings from the studies' risk factors.

Blunt force trauma injuries. Although infant deaths caused by blunt force trauma were flagged as a category which required rigorous investigation, the inquest records for these cases were not in the archives at the time of investigation, and so, no conclusions were drawn from this group. The study however, took note that three of the four victims were male infants who had sustained blunt force injuries to the head, chest and abdominal areas, all of which have been associated with shaken baby syndrome in the literature (Laurent-Vannier et al., 2011).

SIDS. Seven unexpected and sudden deaths were found in this study, and these had affected infants within days and 8 months after birth. In these cases, the cause of death remained undetermined at the primary opinion, with SIDS as only a likely diagnosis. The consistent narrative in the statements included information about co-sleeping, or of the routine procedures of feeding, burping, and then laying the infants to sleep on their stomachs. It was then reported that these infants were later found unresponsive in the same position, a finding which corresponds with extant literature that has shown the risk between being laid to sleep in a downward-facing position and sudden deaths amongst infants (Colvin, Collie-Akers, Schunn & Moon, 2014; Moon, Hauck & Colson, 2016). Autopsy findings from these cases indicated no signs of either internal or external abnormalities, no evidence of trauma, no gross pathology to account for death and no sign of the shaken baby syndrome triad.

Findings Pertaining to the Risk Factors for Shaken Baby Syndrome

There was little found in terms of the risk factors identified for the study because these had not been consistently recorded in the death registers, and as a result, the risk factors that predict child maltreatment amongst this high-risk population could not be clearly determined. Approximately 85% of the race data was missing and so, no inferences were made for this variable. Additionally, 20.5% of gender data was also missing. In some of these cases, however, this was because the gender of the deceased could not be determined due to the extent of decomposition that the decedents' bodies had undergone (1.2%). However, of those deaths where gender was recorded, nearly half (49.4%) were comprised of male infants, and the remaining 30.1% of females.

Table 3
Cause of death categorised according to age across the Magistrate Courts

Cause of death	Age bracket (in months)				Total
	Birth to 1 month	2 to 6 months*	7 to 36 months	Unknown	
Burns	1	11	45	0	57
Motor vehicle accidents	1	3	47	0	51
Drowning	1	0	34	4	39
Abandonment/Neglect/Stillborn	3	0	1	32	36
Heart related	8	7	19	0	34
Reduction/Deprivation of O ₂ /Cessation of breath	14	10	6	3	33
Other - specified (unnatural causes)	1	5	23	2	31
Aspiration (of various contents)	13	6	4	3	26
Head Injury**	1	4	14	1	20
Other - specified (natural causes)	2	8	8	1	19
Lung Related	5	8	4	0	17
Sudden Infant Death Syndrome (SIDS)**	3	3	1	0	7
Blunt Force Trauma/Injury**	0	0	4	0	4
Birth Defect	4	0	0	0	4
Suspected non-accidental injury	1	0	3	0	4
Physical Abuse	0	0	3	0	3
Other - unspecified (natural causes)	1	2	0	0	3
Caught in domestic dispute	1	0	0	0	1
Unknown**	6	3	1	6	16
Total	66	70	216	53	405

* Studies have identified this range as the period where both, the incidence of shaken baby syndrome, and crying bouts peak (Barr, 2012; Laurent-Vannier et al., 2011).

** Categories that may be concealing shaken babies.

Age group. The identified high-risk age range for shaking falls between 2 to 6 months (Barr, 2012; Laurent-Vannier et al., 2011), however, this study found that only one of six potential victims of shaking fell within this category (Case six, refer to Table 4). Since none of the other five suspected cases of shaken infants fell within this range, no further inferences were made for age as a possible predictor for ill-treatment or shaking in the given study.

(Head) injuries in cases of physical child abuse and suspected non-accidental injury. Of the six (1.5%) male infants who may have been shaken, three had been confirmed as victims of physical child abuse. Where it could not be confirmed, were the remaining three. Some of the findings from each inquest shall be described below.

Confirmed cases of physical child abuse (n = 3). As a result of the initial investigation of the first case, the court made no findings, and the infant's father claimed that the child had fallen. A second investigation was then requested by the court which revealed subdural haemorrhaging, and injuries that were consistent with old and recent trauma. This alerted the medico-legal team of a death that had been caused by chronic physical abuse, which was later confirmed by a statement provided by the mother who admitted to both parents having repeatedly assaulted the child.

In the second case, the perpetrators were identified as the infant's father and the father's girlfriend. The child died from fatal brain swelling, bleeding and multiple injuries. The chief post-mortem findings evidenced subdural and retinal haemorrhages, and the father's statement indicated that he had frequently pushed the child by the head against the floor, and had repeatedly beaten him with a belt, alternating with his partner. In addition to these injuries, the child had been found to be severely undernourished.

The first opinion in the third case did not identify the true cause of death, which was only determined after further examination. This infant suffered fatal injuries at the hand of his female caretaker, and the medico-legal examination showed rib fractures, in addition to a severed duodenum and lacerated liver.

Suspected cases of non-accidental injuries (n = 3). Where the cause of death was concluded under suspicion of non-accidental injury, inquest records contained statements that did not match the nature of the injuries evidenced in the infants. An infant who had allegedly fallen off a bed was taken to hospital, however, evidence of subdural haemorrhaging, brain swelling and blunt force trauma led to the likely consideration of inflicted injuries.

The second non-accidental death concerned the details around the unassisted delivery of a new-born. The statements indicated that the mother stayed in a shack and that none of her family members were aware of her pregnancy. She however, was alone at the time of deliver and claimed that the child had unexpectedly "fallen out" of her, but the injuries evidenced – severe blunt force wounds and subdural haemorrhaging - were not consistent with her testimony.

The last of the six inquests concluded that the death had been caused by 'brain injury as a consequence of blunt force trauma'. The infant had been admitted with diminished levels of consciousness, and had bruising over his chest cavity and occipital region. The forensic post mortem revealed numerous injuries including rib and skull fractures, brain swelling, extensive retinal haemorrhaging and a subdural haemorrhage that extended down the spinal cord.

Cases where shaking may have contributed to deaths. As indicated in Table 4, the study identified six male infants as possible shaken babies, and their deaths were categorised as follows:

Table 4
Possible cases of shaken babies

Case Number	Cause of death	Detailed cause of death (and cause of injury where recorded)	Overlap of the triad	Determined at the primary/secondary investigation
One	Head injury	Consistent with old and recent trauma injuries	Subdural haemorrhages	Secondary
Two	Head injury	Bleeding of the brain - blunt force assault to head and body	Subdural and retinal haemorrhages	Primary
Three	Unknown	Unable to determine at autopsy alone	None	Secondary
Four	Head injury	Bleeding disorder (primary cause) - blunt force trauma to head and brain swelling	Subdural haemorrhages	Primary
Five	Head injury	Multiple injuries from severe blunt force trauma	Retinal haemorrhages	Primary
Six	Head injury	Brain injury as a consequence of blunt force trauma	Retinal and subdural haemorrhages	Primary

Though such a small percentage (1.5%) of fatalities had been caused by these various forms of child maltreatment, the results from the study correspond with the trends that have been identified in the literature, that is that, male infants are predominantly the victims of child ill-treatment, which may include shaken baby syndrome (Duhaim et al., 1998; Laurent-Vannier et al., 2011). It is unclear as to whether the presence of one or more symptoms of the triad in the five cases, and the rib fractures in the one case had resulted from the infant being shaken, and this is because, neither the written statements, or the comments from the medico-legal examinations contained explicit information in this regard. Nonetheless, these cases raise the index of suspicion that shaking was a contributory cause in the deaths of these infants.

Discussion

The diagnosis of shaken baby syndrome has been closely associated with brain injuries and head trauma evidenced in abused infants (Kaltner et al., 2013; King et al., 2003), and the majority of shaken babies present with both, or either retinal and subdural

haemorrhages, axonal damage and encephalopathy (Barr et al., 2004; Duhaime et al., 1998; Gilliland et al., 2007; Matschke et al., 2009). Studies have identified head trauma as the primary cause of death in such cases of abuse (Choudhary, Ishak, Zacharia & Dias, 2014; Nishimoto, 2015). Other injuries that are commonly found in abused and shaken children include long bone, rib and skull fractures (Al-Saadoon et al., 2011; Barr et al., 2004), visible bruising along the shoulders, rib cage, face and surface of the scalp, and spinal subdural haemorrhaging (Byard & Krous, 1999; Choudhary et al., 2014; Gill, Andrew, Gilliland, Love, Matshes & Reichard, 2013).

A recent child death review conducted in the US indicated that fatalities caused by child maltreatment (i.e. abuse and neglect) accounted for 5% ($n = 2285$) of all the child deaths, nationally (Palusci & Covington, 2014). This proportion is comparatively smaller than the number of South African child deaths attributed to abuse, inflicted injuries and neglect, which were outlined in the country's first child death review (Mathews et al., 2016). Findings indicated that; first, 13.3% of all under 5 deaths were caused by the ill-treatment of children in the country, and second, that post-mortem examinations conducted on cases of chronic physical abuse are likely to be labelled as such – deaths caused by abuse.

On the other hand, Palusci and Covington (2014) made the further distinction of deaths caused by abusive head trauma, and like others' findings (Choudhary et al., 2014; Nishimoto, 2015), noted this as the predominant cause of death amongst physically abused infants (60%). The US review also revealed that shaken babies accounted for almost half (45%) of all deaths attributed to physical child abuse, and in 20% of these, crying had been identified as the trigger of the abuse (Palusci & Covington, 2014). These findings thus, highlight the need for more prevention programs that address the management of crying infants, such as those outlined by Barr and colleagues (2009) and Barr (2012). The difference in the results from the two recent death reviews show that shaken baby syndrome has not been recognised as a cause of death amongst South African infants, despite the extant evidence that has been provided for the overlap between incidence of physical abuse and shaken babies (Barlow & Minns, 2000; Feldman, Bethel, Shugerman, Grossman, Grady & Ellenbogen, 2001; Nishimoto, 2015). Therefore, it seems that considerable evidence is being overlooked where South African infant deaths are concerned.

This study did not provide any substantiated proof of shaken infants; however, it did identify six male infants whose deaths had been attributed to various causes that fell into one of two categories, namely, suspected non-accidental injuries, or proven cases of severe physical abuse. The study also showed some of the diagnostic symptoms of the syndrome.

The medico-legal examinations of these infants identified: retinal haemorrhages in case five, subdural haemorrhaging in cases one and four, subdural and retinal haemorrhages in case two, rib fractures in case three, and a combination of bruising, multiple rib fractures, retinal, subdural and spinal haemorrhaging in case six. According to findings from other studies and large-scale post-mortems, the range of the injuries exhibited in these six cases meet the diagnostic criteria for suspected cases of shaken babies (Choudhary et al., 2014; Duhaime et al., 1998; Gilliland et al., 2007; Matschke et al., 2009; Nishimoto, 2015).

A possible explanation for the dearth in shaken baby reports can be afforded to the country's disproportionately high demand for medico-legal examinations, and the comparatively smaller number of certified forensic specialists. Studies have shown that the high rates of traffic accidents, interpersonal violence, and homicides account for thousands of unnatural fatalities every year, each of which require a medico-legal investigation (du Toit-Prinsloo & Saayman, 2012; Mathews et al., 2013). As a consequence, du Toit-Prinsloo and Saayman (2012) have shown that many examinations are carried out by medical personnel with no, or minimal training in paediatrics or in the proper procedures required when conducting forensic autopsies. This is also coupled with limitations outlined by under-resourced laboratories (du Toit-Prinsloo & Saayman, 2012). Similar shortcomings have also been noted in some rurally located areas in Australia (Byard & Krous, 1999).

Second, there is a possibility that shaken baby syndrome is being misdiagnosed as SIDS. International studies have shown that 13 to 24% of all infant fatalities caused by shaken baby syndrome have been wrongly diagnosed as SIDS (Byard & Krous, 1999; Hunt, 2001). Although this study only identified seven suspected SIDS cases, each case was forensically concluded without the injuries commonly identified in shaken infants, and so, were also not considered as suspected shaken baby syndrome deaths. However, it is clear that the number of deaths attributed to SIDS is a growing concern in the South African literature, and the incidence rates reported in Cape Town alone, rank amongst the highest, globally (Dempers et al., 2016; du Toit-Prinsloo, Dempers, Wadee & Saayman, 2011). In light of this, the procedures followed during post mortems may need to be revised in order to detect the potential confounding of shaken baby syndrome during the numerous medico-legal investigations carried out in the country.

Recommendations and Future Studies

In order to address the burden placed on forensic pathologists, and the possible misdiagnosis of infant deaths in the country, a standardised medico-legal protocol should be developed and implemented. The primary purpose of such a protocol would be geared

towards the possible identification and diagnosis of shaken babies in the country, with a particular focus on victims of severe physical abuse. This would be done in the hopes of finally merging the two prevalence problems in a country which has solely focused on the conclusion of fatal injuries caused by physical abuse..

Various autopsy protocols where shaking and abuse are suspected have been developed in high-income countries. One such protocol was developed by Gill and colleagues (2013). It outlines the examination of specific areas of the body which are to follow after the initial post-mortem, which comprises of the exterior and interior examination of the body (Gill et al., 2013). The researchers recommended the rigorous and well documented analysis of the scalp, haemorrhages, brain, spinal cord, removed eyeballs, the posterior and anterior ends of the neck, and the bodies' extremities (i.e. the hands and feet) (Gill et al., 2013). Additionally, they state that forensic pathologists are to remain cognisant of the frequency, site and nature of the haemorrhages found in the cranial and ocular regions (Gill et al., 2013), particularly when examining younger infants. This is because the nature of the injuries they frequently exhibit have been shown to differ from those noted in infants older than one (Matschke et al., 2009).

Choudhary and colleagues (2014) also emphasized the importance of carrying out a thorough examination of the neck, the entire spinal column, and spine ligaments and tissues, while Gilliland and others (2007) proposed an 11-step protocol for the examination of the eyes (that would still enable the viewing process after the post-mortem). A further suggestion is made – where resources can permit it - for the use of a CT-scan at the first stage of investigation, followed by an MRI which can detect traces of intracranial bleeding that often go untraced during the first stage of the examination (Al-Saadoon et al., 2011). These suggestions developed as a result of the injuries that have been commonly identified in the deaths of shaken and abused infants, however, the absence of one or more of these injuries does not rule out the prospects of shaking or head trauma (Choudhary et al., 2014). Accordingly, the development and implementation of a standardised protocol that adheres to international standards will facilitate the comparability of findings from future studies (Byard & Krous, 1999; Dempers et al., 2016; du Toit-Prinsloo et al., 2011; Gilliland et al., 2007). Further, the close documentation of the post-mortem process would lead to the establishment of a child maltreatment database (Nishimoto, 2015), and together, these steps would provide sufficient grounds for future studies aimed at determining the prevalence of shaken baby syndrome on a national scale in the country.

Though this study is advocating for a standardised post-mortem protocol, it must be reiterated that the presence of the triad only serves as an indicator that raises the suspicion of shaken baby syndrome and abuse, and is not pathognomonic, as it was once perceived to be (Tuerkheimer, 2009). The diagnosis of the syndrome has been equated to the medical charge for murder (Tuerkheimer, 2009), and so, forensic pathologists ought to consider a range of diagnoses as the triad can be caused by non-abusive factors.

In one study, six infants with the triad were diagnosed as shaken babies under the assumption that they had been abused (Miller et al., 2015). In each case, the infants were younger than 12 months and had been removed from the care of their parents, who all pled their innocence. Deliberations between different specialists, later revealed alternative explanations for the presence of the triad which included; falls, ($n = 3$); an enlarged and growing head circumference (macrocephaly) ($n = 1$); re-bleeding from traumatic birth procedures ($n = 1$); and a “sinus thrombosis” ($n = 1$) (Miller et al., 2015, p. 114). A follow-up period verified that the injuries had indeed been caused by others factors that led to the development of injuries that were imitative of shaking and ill-treatment.

Another study reviewed the case of a male infant who had been presented to the hospital with a swollen parietal region, and an x-ray and CT-scan later revealed a bilateral fracture (Weir, Suttner, Flynn & McAuley, 2006). The practitioner considered inflicted harm, however, a radiologist concluded that the nature of the fractures resembled those found in a natural variant called ‘intraparietal sutures’, which were likely to have resulted from a fall (Weir et al., 2006). Similar findings were reported in study by Tuerkheimer (2009), where a caregiver who had been accused of shaking a baby was convicted, and only 12 years later had sufficient evidence emerged that proved her innocence.

Given these findings, when forensic pathologists examine a body with skull fractures or the triad, they should consider prospects of abuse, a medically defined cause, and inherent factors that may have increased susceptibility to death, prior to concluding the cause of death (Miller et al., 2015; Weir et al., 2006). Studies have shown that substantiated diagnoses of shaken baby syndrome have been achieved through collaborative efforts, where ophthalmologists have identified flame-shaped, bilateral, extensive and haemorrhages through all the layers of the eyes as common in shaken babies (Togoika et al., 2009). Radiologists have also distinguished between clinical variants and inflicted fractures (Al-Saadoon et al., 2011; Gill et al., 2013). Forensic pathologists should, therefore, be careful when discriminating between the possible causal factors of death so as not to unjustly accuse caregivers of child abuse, and should seek the guidance of specialists when it is necessary.

Owing to the fact that the injuries found in the six suspected cases of shaken babies are similar to those that have been identified in the literature, a recommendation for future studies would include the implementation of verbal autopsies. Byard and Krous (1999) outlined this as an optimal aspect of medico-legal investigations in areas characterised by limited resources, and the frequent designation of deaths to ‘unknown’ causes – both of which are common occurrences in South Africa.

In response to the incidental finding of poverty as a risk factor that underlay many infant fatalities, intensive multidisciplinary efforts are required to address this root cause. For instance, ‘Thula Baba Box’ intervention can be implemented on a wider scale, and in the most informal settlements to counter the number of fatalities caused by co-sleeping (Barford, 2016). Further, practical means of improving road safety, and providing awareness-raising programs that will instil a sense of urgency regarding road safety should be promoted to counter the numerous pedestrian-motor vehicle accidents occurring in South Africa every year.

Research implications. This study cannot make any definitive findings of whether shaken baby syndrome exists, or whether it can be separated from different forms of child abuse. Future research should, therefore, continue to investigate this question, and here are possible avenues to follow. In the short-term, the implicated parties in the deaths of the six male infants from this study could be interviewed to verify whether these infants had been shaken or not. Longer-term research goals could include the development of a clearer provincial picture, which would be achieved by conducting studies at all ten Magistrate Courts. Similar studies could then be conducted in all nine provinces, which will eventually lead to the generation of national reports that are inclusive of the possible diagnosis of shaken baby syndrome in South Africa. Where necessary, verbal autopsies should also be used. Lastly, larger-scale studies would also enable the determination of context-specific risk factors for shaken baby syndrome, with the potential of developing models that can predict and prevent the occurrence of this particular form of child maltreatment.

Limitations of the Study

The study was limited in scope by three main factors. One, the sample was acquired from existing data, and so this is a retrospective study. As a result, all inferences made were solely dependent on what had been recorded in the inquest records and deaths registers, which both indicated numerous inconsistencies in the manner in which the information had been recorded across the three Courts. Further, the lack of a standardised autopsy protocol meant that the standards upheld by forensic pathologists and medical personnel varied

between autopsy examinations, which in turn affects how accurate the records are (Byard & Krous, 1999; Kivlin, Simons, Lazoritz, & Ruttum, 2000).

Second, inquests are comprised of cases where death is an outcome, however, not all sufferers of rigorous shaking die, although repercussions can be lifelong, and so, this results in further under-representations of the possible prevalence of shaken babies within this subgroup (Kivlin et al., 2000).

Third, studies have shown that large samples are required in order to identify cases of shaking, however, this study only looked at 450 deaths from three of the ten Magistrate Courts in the Cape Town area, so no findings could be generalised, even at a provincial level. It must be noted, however, that time constraints, gatekeepers and mobility limited the study's investigation to no more than three Courts.

Conclusion

Only a minute proportion (1.5%) of the deaths within the age range for the study were distinguished as possible shaken infants whose deaths had been designated to other causes. This finding is much smaller than the Canadian proportion where 13.1 to 34.1% deaths under three constitute shaken infants (Statistics Canada, 2015). However, the six male infants had experienced head trauma (which accounts for approximately 25% of all shaken baby deaths) (Palusci & Covington, 2014), had overlapping symptoms of the triad, and were victims of suspected or proven child abuse (a scourge that affects the lives of many South African infants today) (Mathews et al., 2016). Consequently, following up these six deaths will be a step in right direction towards determining the prevalence of shaken babies in South Africa.

A surgeon and researcher in the field of public health, Atul Gawande (2001), correctly said of medical examinations and autopsies in an online article, "Whether living or cadavers, we do not know, until we look." (para. 50). This statement speaks to the dearth of shaken baby syndrome statistics in South Africa. Until forensic pathologists decide to consider the diagnosis as a plausible cause of death amongst South African infants, the ability to determine whether infants are being shaken or not will remain unlikely. For this reason, the answer to the research question is no - shaken baby syndrome was not proven to be a contributing factor in the deaths of the infants from these high-risk, crime areas. Even so, the suspected and substantiated evidence of child abuse, the injuries the infants evidenced, and the current standard of medico-legal examinations, warrant the need for better trained medical personnel, potential revisions to the current post-mortem procedures and the further investigation of this "ghost" form of child maltreatment in South Africa.

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