

Childhood and adolescent fatalities at the Pretoria Medico-Legal Laboratory: 2005 - 2009

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Background. Children and young adults are particularly vulnerable to intentional and accidental fatal injuries. The majority of deaths in Africa in children <5 years of age are due to infectious diseases. Road traffic fatalities constitute a large proportion of deaths in children and young adults worldwide.

Objective. To evaluate the demographic details, external cause/circumstance of death and manner of death in children and young adults admitted to the Pretoria Medico-Legal Laboratory (PMLL).

Methods. A retrospective case audit was conducted on all persons aged 1 - 20 years admitted to the PMLL from January 2005 through December 2009.

Results. A total of 965 cases were identified. Childhood deaths constituted 7 - 9% of all cases admitted. The majority were aged between 16 and 20 years (42%), followed by children aged between 1 and 5 years (33%). The most common cause of death was injury due to road traffic accidents (this was present in all age groups).

Conclusion. Children and young adults contribute a relatively large number of admissions to the medico-legal mortuary. The majority of these deaths are accidental. Many of the accidents could have been prevented with stricter legislation with regard to transportation of children and safety surrounding swimming pools.

S Afr J Child Health 2016;10(1):52-56. DOI:10.7196/SAJCH.2016.v10i1.1047

Children and young adults (adolescents) are particularly vulnerable to inflicted and accidental fatal injuries.^[1,2] The United Nations Children's Fund (UNICEF) convention on the right of the child defines a child as 'a person below the age of 18, unless the laws of a particular country set the legal age for adulthood younger'.^[3]

According to Statistics South Africa (SA) (2008),^[4] the leading underlying natural cause of death in children <14 years of age was intestinal infectious diseases (21.8% of deaths), followed by influenza and pneumonia – collectively accounting for a third of deaths in this age group. HIV/AIDS is a leading cause of mortality, with a prevalence rate of 10.6% in SA in 2009, and an estimated 5.21 million people living with the disease.^[5,6] Individuals aged between 15 and 24 years are recorded as having the highest incidence of the disease. In SA, the age group 15 - 49 years is most at risk for non-natural deaths, with 13.9% of deaths in this group being non-natural and the most common circumstance/external cause of death interpersonal violence (assault).^[4]

The high incidence of child fatalities due to road traffic accidents has been well documented worldwide. In San Diego, Fraga *et al.*^[1] reported (in their study conducted at the medico-legal mortuary) that road traffic fatalities were the leading cause of accidental death (40.2% of cases). In Nebraska, Okoye and Okoye^[7] reviewed medico-legal childhood deaths over a 7-year period and reported motor vehicle accidents as the cause of death in 23.6% of cases. In Brazil, Modelli *et al.*,^[8] reporting on deaths in children <12 years, found the leading external cause of death to be road traffic fatalities (22% of cases). In Nigeria, Nwafor *et al.*^[9] reviewed deaths in children ≤14 years; in a 20-year period, road traffic accidents accounted for 74.6% of accidental deaths and 15.4% of total deaths. In SA, Bass *et al.*^[10] reviewed children <14 years who presented to Red Cross War Memorial Children's Hospital in Cape Town. They indicated that 430 children were involved as pedestrians in accidents over a 12-month period, with 106 fatalities.

Deaths due to asphyxia in children was the second most common cause of death in the study by Fraga *et al.*,^[1] accounting for 22.7% of cases.

Okoye and Okoye^[7] indicated asphyxia mainly in children <5 years, with a total of 22 (15.7%) cases, and 7 (5%) cases of drowning. Modelli *et al.*^[8] indicated asphyxia in 17% of cases.

Homicides in children <18 years accounted for 24.2% of deaths in San Diego,^[1] 5% in Nebraska,^[7] 1.5% in Nigeria,^[9] and 13% in Istanbul.^[11] Suicide in children accounted for 9.4% of deaths in San Diego,^[1] 13.6% in Nebraska,^[7] and 7.4% in the Istanbul study.^[11] Cases due to natural causes on completion of the medico-legal investigation of death and that were admitted to the medico-legal mortuaries mentioned in the abovementioned studies accounted for 30% of deaths in the Okoye and Okoye^[7] study, 50% in the Modelli *et al.*^[8] study, 77.5% in the Nwafor *et al.*^[9] study, and 12% in the Beyaztas *et al.*^[11] study.

Numerous countries, including Australia, the UK and the USA, have child fatality review programmes (also referred to as child death review programmes). These consist of a multidisciplinary approach to reviewing child deaths, ultimately providing prevention strategies to reduce childhood fatalities.^[12]

In 2009, SA had a population of 49.32 million, Gauteng being the most densely populated province with a population of 10.53 million.^[5] According to Statistics SA,^[4] the total number of registered deaths (including late submissions) were 598 131 in 2005, 612 778 in 2006, 603 094 in 2007 and 592 073 in 2008 (late submissions of deaths have not been completely analysed). In Gauteng, the total number of registered deaths for 2008 was 115 909.^[4] Pretoria had an estimated population of 1.6 million in 2012.^[13]

The Inquests Act 58 of 1959 governs the medico-legal investigations of death in SA. This legislation stipulates that the presiding officer would ultimately determine the cause of death and whether or not someone else could be held accountable for the death (therefore determining the manner of death). In SA, forensic pathologists do not determine the manner of death. In 2001, according to the National Non-Natural Mortality Surveillance System (NMSS), pathologists could give their opinion with regard to the manner of death at the time of the postmortem examination – for statistical purposes.^[14]

RESEARCH

The objective of this study was to identify the demographic details, external cause/circumstance and manner of death in child cases admitted to the Pretoria Medico-Legal Laboratory (PMLL) over a 5-year period. All children aged 1 - 20 years were included in the study, while infants (children <1 year of age) were excluded. The reasons for exclusion of such infants were twofold: (i) the report by Statistics SA indicated that the majority of deaths in infants are due to natural disease processes and previous studies conducted at the PMLL have indicated that even in those admitted to medico-legal mortuaries, most deaths are due to natural causes, with respiratory tract infections being the most common;^[4,15] and (ii) in international studies, such as the study by Lathrop^[16] in New Mexico, 41.4% of all children ≤19 years admitted were infants, and they contributed 77% to all natural causes of death. The rationale for inclusion of children ≤20 years was that in the final year of school in SA, although the majority of children are aged 18, a proportion have repeated at least 1 year and in many instances 2 years at school.^[17] The World Health Organization (WHO) defines an adolescent as a person ≤19 years.^[18] Adolescence is regarded as the transitional period between childhood and adulthood. In Canada, the Adolescent Health Committee indicated that adolescence ends when 'an

adult identity and behavior are accepted' and that the period roughly corresponds to the ages stated by the WHO, but that flexibility in the age span should be present.^[19] Our secondary objective was to identify certain trends and preventable causes of death.

Methods

A retrospective descriptive case audit was conducted on all children aged 1 - 20 years admitted to the PMLL from January 2005 through December 2009. The admission register at the mortuary, case files and NMSS data collection sheets were reviewed. The total caseload admitted each year was also recorded. The data collected included demographic details (age, gender and race), scene of accident, place of death, external cause/circumstance of death and manner of death.

Owing to the retrospective nature of the study, the completeness of the documentation at the PMLL was a limitation. Full ethical approval was obtained from the Faculty of Health Sciences, University of Pretoria Research and Ethics Committee before commencement of the study.

Results

A total study population of 965 cases was identified and included. The total caseload at the mortuary was 11 761 cases (over the 5-year period). Childhood deaths constituted 7 - 9% of all cases admitted annually.

Demographic details

The mean age of the entire population was 11 years. In 7 (1%) cases no specific age was recorded. Most deaths occurred in the

Table 1. Gender in relation to age groups

Age group (years)	Male, n (%)	Female, n (%)	Total, n (%)
1 - 5	191 (59)	132 (41)	323 (33)
6 - 10	55 (50)	56 (50)	111 (12)
11 - 15	75 (65)	41 (35)	116 (12)
16 - 20	289 (71)	119 (29)	408 (42)
Unknown	3 (43)	4 (47)	7 (1)
Total	613 (64)	352 (36)	965 (100)

Table 2. External cause/circumstance of death in relation to age group

External cause/circumstance of death	1 - 5 years, n (%)	6 - 10 years, n (%)	11 - 15 years, n (%)	16 - 20 years, n (%)	Age unknown, n (%)	Total, n (%)
Road traffic fatalities	91 (27)	50 (15)	39 (11)	160 (47)	1	341 (35)
Railway fatalities	0	0	2 (20)	7 (70)	1 (10)	10 (1)
Burns	48 (64)	8 (11)	6 (8)	12 (16)	1 (1)	75 (8)
Electrocution	8 (73)	0	1 (9)	1 (9)	1 (9)	11 (1)
Hanging	0	0	6 (16)	31 (84)	0	37 (4)
Smothering/strangulation	0	1 (9)	0	10 (91)	0	11 (1)
Drowning	44 (66)	10 (15)	9 (13)	4 (6)	0	67 (7)
Drug overdose/poisoning	11 (30)	4 (11)	6 (16)	16 (43)	0	37 (4)
Assault	2 (5)	0	4 (11)	31 (85)	0	37 (4)
Jump/fall/push from height	9 (31)	4 (14)	3 (10)	13 (45)	0	29 (3)
Gunshot wounds	5 (8)	2 (3)	10 (16)	44 (72)	1 (1)	62 (6)
Stab wounds	0	0	2 (7)	25 (89)	1 (4)	28 (3)
Natural causes	34 (50)	10 (14)	7 (10)	18 (26)	0	69 (7)
Unknown	39 (45)	13 (15)	9 (10)	25 (29)	0	86 (9)
Other	32 (49)	9 (14)	12 (18)	11 (17)	1 (2)	65 (8)
Total	323 (33)	111 (12)	116 (12)	408 (42)	7 (1)	965 (100%)

16 - 20-year group ($n=408$; 42%), followed by 1 - 5-year-olds ($n=323$; 33%). The 6 - 10-year group had 111 deaths and the 11 - 15-year group 116 deaths (12% each).

The majority were male ($n=613$; 64%), with 352 (36%) females. Table 1 indicates the gender in relation to the age groups.

The racial distribution showed that 693 (72%) children were black, 221 (23%) white, 31 (3%) coloured and 20 (2%) Asian. This is in keeping with the population of the mortuary.

External cause/circumstance of death

The most common external cause/circumstance of death was road traffic accidents (among all age groups) ($n=341$; 35%). Table 2 indicates the external cause/circumstance of death in relation to the age groups. Deaths categorised in the group 'other' included mostly anaesthetic/procedure-associated deaths ($n=36$), mainly in the 1 - 5-year group. The remaining 21 cases included aviation accidents, sport-related injuries, explosion deaths, lightning death ($n=1$) and other accidents such as electric gates falling on children.

The types of road traffic fatalities are summarised in Fig. 1. There were an equal number of deaths from pedestrians involved in accidents and from children as passengers. The highest number of pedestrian fatalities was in the 1 - 5-year group.

Manner of death

The manner of death (Fig. 2) was mostly accidental deaths in all age groups ($n=525$; 54%). Homicidal deaths accounted for 136 (14%) cases and suicidal deaths for 72 (7%). The majority of homicides (76%) and suicides (82%) were in the 16 - 20-year group. Natural disease processes were present in 69 (7%) (50% of these occurred in the 1 - 5-year group), and in 162 (17%) cases the manner was undetermined.

Homicidal deaths

The most common external circumstance/cause of homicidal deaths (Table 3) was gunshot wounds ($n=45$; 33%), followed by blunt force trauma (including assault) ($n=35$; 26%) and sharp-force injuries ($n=28$; 21%).

Suicidal deaths

The most common method of suicide was hanging ($n=37$; 52%), followed by poisoning/overdose on prescription drugs ($n=13$; 18%) (Table 4).

Discussion

In our study children aged 1 - 20 years contributed 7 - 9% to the annual caseload in the mortuary. In Nebraska,^[7] children aged 0 - 18 years constituted 10.9% of the caseload to the medico-legal mortuary, and in Nigeria,^[9] children ≤ 14 years contributed 12.3% to the total caseload. It should be noted that both of the latter studies included infants.

The gender differentiation in our study showed a male:female ratio of 1.7:1. This was the same as in the study by Fraga *et al.*^[1] Some studies^[7,11] indicated a relatively larger proportion of male descendants, with a

male:female ratio of 2.3:1 and 2.0:1, respectively. In other studies,^[8,9] the ratio was less, with proportionately more female admissions, i.e. 1.4:1 and 1.2:1, respectively.

The majority of the deaths in our study were due to road traffic accidents (35%). This was also the finding in other studies (Istanbul - 38.8%^[11] and Nebraska - 50.7%^[7]). The most common external cause of accidents in children in all the abovementioned studies^[1,7,9,11] was road traffic fatalities, which was also found in the study conducted at the PMLL. In our study,^[9] there were nearly equal numbers of passengers ($n=126$) and children as pedestrians ($n=121$) involved in accidents. In San Diego,^[1] there were more passengers than pedestrians involved. Worldwide, emphasis has been placed on reducing childhood mortality. The use of preventive measures, such as child restraint devices, has been well documented to reduce

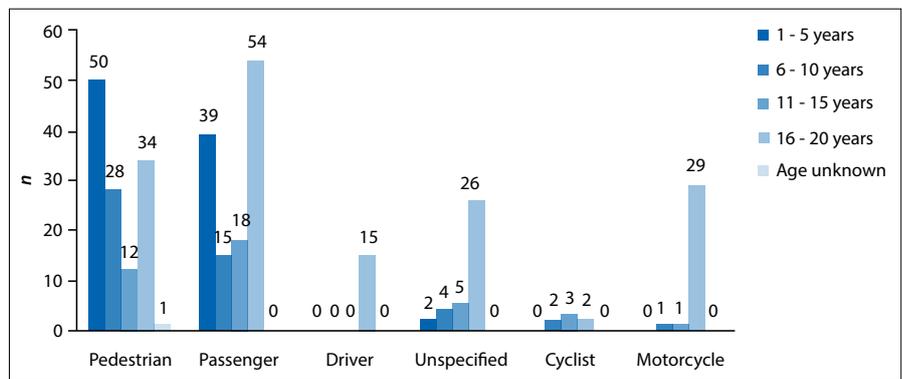


Fig. 1. Type of road traffic accident (N=341).

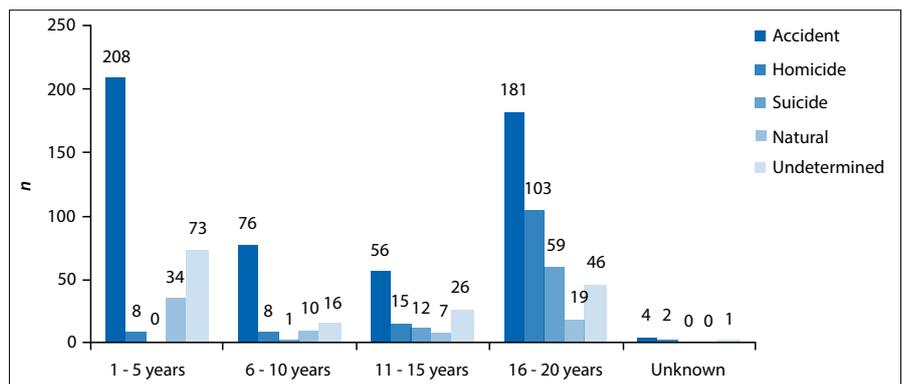


Fig. 2. Manner of death.

Table 3. Homicidal deaths: external cause/circumstance in relation to age group

External cause/circumstance	1 - 5 years	6 - 10 years	11 - 15 years	16 - 20 years	Age unknown	Total, n (%)
Gunshot wounds	2	1	7	34	1	45 (33)
Assault/blunt force	3	1	4	30	0	38 (26)
Sharp force	0	0	2	25	1	28 (21)
Strangulation	0	1	0	10	0	11 (8)
Other	3	5	2	4	0	14 (10)
Total	8 (6%)	8 (6%)	15 (11%)	103 (76%)	2 (1%)	136 (100)

Table 4. Suicidal deaths: method in relation to age group

Method	6 - 10 years, n	11 - 15 years, n	16 - 20 years, n	Total, n (%)
Hanging	0	6	31	37 (52)
Poisoning/drug overdose	1	2	10	13 (18)
Gunshot wounds	0	3	9	12 (17)
Jumped from height	0	0	6	6 (8)
Other	0	1	3	4 (5)
Total, n (%)	1 (1%)	12 (17%)	59 (82%)	72 (100)

the mortality of children as passengers in road traffic accidents.^[20,21] The current legislation pertaining to the use of child restraint devices in SA does not make its use mandatory, but prescribes that the restraint seat should be used 'if available' (National Road Traffic Act 93 of 1996, Regulation 213). The large number of pedestrians involved in accidents is worrisome. In our study, the majority of pedestrians were in the 1 - 5-year group. In a study conducted in Cape Town in 1990 - 1991,^[10] it was reported that the majority of pedestrian accidents in children occurred in the later part of the afternoon and in residential areas, and that only 24.3% of children were supervised by an adult at the time of the accident. The annual Road Traffic Report (2010 - 2011) released by Arrive Alive,^[22] indicated that 17.5% of fatalities due to road traffic accidents related to children <19 years.

In our study, burns were the second most common cause of accidental deaths in children, accounting for 8% of the total caseload. The WHO reported that the majority of burns occur in lower- and middle-income countries.^[23] The WHO also indicated that burns are the 11th leading cause of death in children aged between 1 and 9 years and emphasised that in a large proportion of burn cases in children, lack of adult supervision contributed to the child sustaining the burn injury.^[23] In the Nigerian study,^[9] accidental deaths due to burns occurred in 17.5% of cases compared with the study in Nebraska,^[7] which reported only 3 cases ($n=140$) over a 7-year period.

Deaths due to drowning in the study at the PMLL accounted for 7% of the total caseload ($n=67$), with the majority ($n=44$; 66%) in children aged 1 - 5 years. The WHO reported that low- and middle-income countries account for 96% of unintentional deaths from drowning.^[24] Generally (with the exception of Canada and New Zealand), children <5 years have a higher drowning mortality rate.^[24] In Istanbul,^[11] drowning accounted for 22% of accidental deaths and 8.7% of total deaths. In Nebraska,^[7] 7 cases of drowning were reported in a 7-year period (5% of the total caseload). Several practices

are well advertised to attempt to reduce the risk of drowning in children. These include safety nets (some with attached alarm systems), fences around swimming pools and adult supervision at all times. Most of the drownings in the PMLL study occurred in and around the house, with some of the younger children drowning in buckets and bathtubs. Stricter legislation pertaining to the enclosement of swimming pools and use of safety nets could possibly prevent at least some of these deaths.

Natural disease processes were encountered in 7% of children in the PMLL study, with 50% occurring in the 1 - 5-year group. Our study excluded infants (children <1 year of age). Nwafor *et al.*^[9] reported natural disease processes in 77.5% of their cases, including infants. According to Statistics SA,^[4] the majority of infants in SA die from natural disease processes. Lathrop^[16] indicated that natural causes were the most common cause of death among all age groups, accounting for 44.8% of all deaths, with 77% of these in infants. In 86 (9%) cases no cause of death could be ascertained at autopsy alone. The possibility exists that some of these deaths could have been due to underlying natural disease processes such as channelopathies, which could increase the number of natural disease processes. As this could not be established scientifically, these deaths were described as a separate group (unknown).

Homicidal deaths accounted for 14% of the caseload in children at the PMLL. This is less than the 24.2% reported by Fraga *et al.*,^[11] nearly the same as in the Beyaztas *et al.*^[11] study, but more than that in the Okoye and Okoye^[7] study (5%). Nwafor *et al.*^[9] reported homicidal deaths in children ≤14 years in only 1.5% of cases. The majority of homicidal deaths occurred in the PMLL and Fraga *et al.*^[11] studies (in children >15 years). This could explain the fairly low number of homicides in the studies by Nwafor *et al.*^[9] and Okoye and Okoye.^[7] In the PMLL study, the majority of homicidal deaths were the result of gunshot wounds (among all age groups). In the studies by Beyaztas *et al.*^[11] and Fraga *et al.*,^[11] the majority of homicides were due to stabbings.

Seven percent of cases in the PMLL study were as a result of suicide. In Okoye and Okoye's^[7] study suicides accounted for 14% of the caseload (a higher number, also taking into account that the majority of suicides in the PMLL study were among 16 - 20-year-old children; their study only included children ≤14 years^[7]). Suicides accounted for 9.4% of cases in the Fraga *et al.*^[11] study and 7.4% of those in the Beyaztas *et al.*^[11] study. The most prevalent external cause/circumstance of suicidal deaths in our study was as a result of hangings (among all age groups), followed by poisonings/overdose of prescription medication. The youngest child who committed suicide was 9 years old (prescription medication overdose). Hanging was the method mostly used in suicides in some studies.^[1,7,11]

Firearm-related deaths accounted for 6% of cases in the PMLL, Beyaztas *et al.*^[11] and Okoye and Okoye^[7] studies, but for 16% of cases in the Fraga *et al.*^[11] study. In the study by Modelli *et al.*,^[8] only two gunshot-related deaths were reported in a 1-year study in children <12 years. SA has strict legislation pertaining to firearm ownership and use and on storage in appropriate gun safes.

Lathrop^[16] indicated that 'complete medico-legal investigation of childhood fatalities is needed to provide public health agencies with adequate data to evaluate and prevent childhood deaths'. This author also suggests reporting the causes of death separately for each year of life rather than in groups.^[16] Accurate statistics on childhood and adolescent mortality in SA are lacking. McKerrow *et al.*^[25] indicated that using more than one data set could aid in better statistics, but that 'it is accepted that these data are incomplete'. The analysing of data sets from medico-legal mortuaries can aid in improving the statistics on deaths in children and young adults in SA and identifying preventable deaths.

Conclusion

Our study indicated that cases of children and young adults comprise a relatively large number of admissions to the medico-legal mortuary. The majority of these deaths are accidental. Many of the accidents could have been prevented with the application of stricter legislation with regard to transportation of children and safety surrounding swimming pools. A child death review programme can aid in identifying causes of death in children, which can be reduced with appropriate changes in legislation.

Acknowledgements. We thank Ms B English, Faculty of Health Sciences, University of Pretoria, for the language editing of the article.

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