Injury-related mortality in South Africa: a retrospective descriptive study of postmortem investigations

Richard Matzopoulos, a Megan Prinsloo, b Victoria Pillay-van Wyk, a Nomonde Gwebushe, b Shanaaz Mathews, c Lorna J Martin, d Ria Laubscher, b Naevah Abrahams, b William Msembali, a Carl Lombard b & Debbie Bradshaw a

Objective To investigate injury-related mortality in South Africa using a nationally representative sample and compare the results with previous estimates.

Methods We conducted a retrospective descriptive study of medico-legal postmortem investigation data from mortuaries using a multistage random sample, stratified by urban and non-urban areas and mortuary size. We calculated age-specific and age-standardized mortality rates for external causes of death.

Findings Postmortem reports revealed 52 493 injury-related deaths in 2009 (95% confidence interval: CI 46 930–58 057). Almost half (25 499) were intentionally inflicted. Age-standardized mortality rates per 100 000 population were as follows: all injuries: 109.0 (95% CI: 97.1–121.0); homicide 38.4 (95% CI: 33.8–43.0); suicide 13.4 (95% CI: 11.6–15.2) and road-traffic injury 36.1 (95% CI: 30.9–41.3). Using postmortem reports, we found more than three times as many deaths from homicide and road-traffic injury than had been recorded by vital registration for this period. The homicide rate was similar to the estimate for South Africa from a global analysis, but road-traffic and suicide rates were almost fourfold higher.

Conclusion This is the first nationally representative sample of injury-related mortality in South Africa. It provides more accurate estimates and cause-specific profiles that are not available from other sources.

Introduction

In South Africa in the year 2000, injury-related mortality accounted for 12% of deaths and 16% of years of life lost. This was primarily due to high mortality rates from road-traffic injury and homicide, which were approximately twice and eight times the global average, respectively. A previous South African national study of the burden of injury-related mortality used triangulation and modelling techniques to overcome deficiencies in vital registration data and national statistics, such as underreporting and the urban bias of national injury mortality surveillance. These surveillance data are no longer suitable for burden of disease modelling. They are not nationally representative, since they are only available for two of nine provinces, and use mortuary registers rather than postmortem reports. For deaths of undetermined cause, mortality registers fail to differentiate routinely between deaths from natural or external causes and, for external-cause deaths, between accidental and deliberate events.

Under the Inquests Act of 1959, postmortem investigations are a statutory requirement for all deaths that are not clearly from natural causes. This is a potentially useful alternative source of data on injury-related mortality. Here, we use postmortem records to provide a more accurate cause-specific profile of injury-related mortality in South Africa for the year 2009. This enables comparison with data from several sources including official statistics, the national survey of female homicides and global burden of disease estimates. The study was commissioned by the South African Medical Research Council as part of its second national burden of disease study.

Methods

We conducted a retrospective descriptive study, using routine data collected through postmortem investigations during 2009. Data were obtained from postmortem reports and ancillary documentation, including police reports and hospital records. A multistage stratified cluster sample was drawn for eight provinces, using mortuaries as the primary sampling unit. A sampling frame of 57 274 postmortem reports from 106 mortuaries was used to draw a representative sample stratified by metro and non-metro area and mortuary size (stratified as less than 500, 501–1500, and more than 1500 cases). Forty-five mortuaries were selected with an expected sample of 22 733 records. All records for the Western Cape were obtained from the Provincial Injury Mortality Surveillance System to complete the national sample. We assessed whether each death was from natural, external or undetermined cause. Field workers recorded the date of death, circumstances of death and the apparent manner of death (homicide, suicide, transport-related, or other unintentional or undetermined intent) consistent with the 10th revision of the International Statistical Classification of Diseases and Related Health Problems, 2007 (ICD-10; Table 1).

We excluded deaths from natural causes, fetal deaths and deaths that occurred outside South Africa. To account for the selection probabilities of mortuaries within survey strata, we applied analysis weights. Cases with unknown-age were proportionally redistributed to all other ages using a scaling factor. Age-standardized mortality rates were calculated for manner of death by age, sex, race, metro and non-metro.
area using alternate mid-year population estimates\(^2\) and the World Health Organization’s (WHO) world standard population.\(^3\)

We recruited field workers and tested them for their ability to extract data from records. Field workers used a mobile phone based questionnaire to collect demographic information from the postmortem report, including age, sex and race of the deceased. Post-mortem and police reports categorize individuals by the races black, coloured, Asian and white, and we kept those categories when conducting the study. We also recorded whether each death was related to a legal intervention, occurred in custody or if there was evidence of sexual assault. The mortuary death register number and the death notification number were collected as identifiers for follow-up to resolve data capture errors. The data captured on the mobile phone questionnaire application (Mobenzi Researcher, Cape Town, South Africa) were submitted to a central web-based platform. The project manager and biostatistician conducted quality checks while data were collected and resolved any data quality problems with the national level coordinator. Interobserver reliability was tested by two fieldworkers collecting data independently from the same folder on the same day for 5% of the sample. Reliability was high for cause of death ($K = 0.86; 95\%$ confidence interval, CI: 0.84–0.88), age ($K = 0.95; 95\%$ CI: 0.93–0.98) and sex ($K = 0.94; 95\%$ CI: 0.92–0.97). Further details are available from corresponding author.

### Table 1. Categories included in the injury-related mortality survey and corresponding ICD-10 codes, South Africa, 2009

| Cause of injury                  | ICD-10 code   |
|---------------------------------|---------------|
| Homicide                        | X85–X99, Y00–Y09 |
| Suicide                         | X60–X84       |
| Transport injuries              | V00–V09       |
| Road traffic injuries           | V00–V04, V06, V09–V80, V82–V85, V87, V89 |
| Other transport injuries        | V05, V81, V86, V88, V90–V99 |
| Poisonings                      | X40–X49, X67–X69 |
| Falls                           | W00–W19       |
| Fires, heat and hot substances  | X00–X19       |
| Drowning                        | V90, V92, W65–W70, W73, W74 |
| Mining accidents                | W77, Y37      |
| Other threats to breathing      | W75–W84       |
| Mechanical forces               | W24–W34, W45–W46 |
| Exposure to natural forces      | X30–X39       |
| Adverse effects of medical and surgical treatment | Y39–Y66, Y68–Y84, Y88 |
| Animal contact                  | W53–W59, X20–X27, X29 |
| Other unintentional injuries    | W20–W23, W35–W44, W49–W52, W60, W64, W85–W94, W99, X28, X50–X59, Y38 |
| Unspecified or not listed        | Y09, Y10–Y34, Y36, Y85–Y87, Y89 |

ICD-10: International Statistical Classification of Diseases, 10th revision (2007).

### Fig. 1. Cause of death recorded by mortuaries, South Africa, 2009

![Cause of death recorded by mortuaries, South Africa, 2009](image)

Note: Weighted analysis, $n = 66,693.$

### Ethics

The South African Medical Research Council’s Health Research Ethics Committee approved the study.

### Results

A total of 22,583 cases were drawn from the eight provinces – more than 99% of the expected total of 22,733. The discrepancy arose from invalid entries that had been included in the sampling frame – such as deaths that occurred before 2009 – and a small number of cases not recorded in mortuary registers or lacking records. A further 9418 cases were appended from the Western Cape database, providing a total unweighted data set of 32,001 records. After the application of sampling weights it was estimated that a total of 66,693 (95% CI: 60,356–73,030) deaths were processed by the forensic pathology service in 2009, of which 52,493 (95% CI: 46,930–58,057), or 78.7%, were from external causes (Fig. 1).

The age-standardized mortality rate from all external causes in South Africa in 2009 was 109.0 per 100,000 population (95% CI: 97.1–121.0). The mortality rate among males (181.0; 95% CI: 161.3–200.7) was significantly higher than for females (42.7; 95% CI: 37.1–48.4), equivalent to 4.2 male deaths per female death (Table 2).

Approximately half of all injury-related deaths were intentionally inflicted (48.6%; 25,499/52,493). Homicide was the leading apparent manner of death, accounting for 36.2% (19,028/52,493) of all external causes (95% CI: 34.2–38.3) or 38.4 per 100,000 population (95% CI: 33.8–43.0). The male homicide rate (67.4; 95% CI: 58.9–75.8) was significantly higher than the female rate (11.3; 95% CI: 9.5–13.0). The male-to-female ratio of homicide (6 male deaths per female death) was higher than for any other apparent manner of death. This was due to the particularly high rate ratios for three major external causes of death that were attributed to homicide: sharp force injuries/stabbing, gunshot injuries and blunt-force injuries (Table 2).

The suicide rate of 13.4 per 100,000 population (95% CI: 11.6–15.2) was approximately one third of the homicide rate. Males were again over represented and overall there were five male suicides for every female suicide.
Table 2. Apparent manner and major external causes of mortality, South Africa, 2009

| Apparent manner and external causes of death | No. (95% CI) | Female* | Mortality rate per 100 000 population (95%CI)* | Total* | Mortality rate per 100 000 population (95%CI)* | RR |
|---------------------------------------------|-------------|---------|-----------------------------------------------|--------|-----------------------------------------------|----|
| All injuries (V01–Y34)                      | 10 541 (9306–11 777) | 10 541 (9306–11 777) | 39.1 (33.8–43.0) | 39.1 (33.8–43.0) | 78.2 (71.5–84.9) | 1.0 |
| Intentional injuries (X60–Y09)              | 3 894 (3442–4 345) | 2 802 (2 281–3 323) | 7.1 (5.2–9.0) | 7.1 (5.2–9.0) | 14.2 (12.4–16.1) | 1.0 |
| Homicide (X85–Y09)                          | 2 740 (2440–3 041) | 1 924 (1 534–2 314) | 5.7 (4.4–7.1) | 5.7 (4.4–7.1) | 11.4 (9.9–13.0) | 1.0 |
| Sharp force/stabbing (X99)                   | 823 (724–923) | 418 (352–479) | 1.5 (1.0–2.0) | 1.5 (1.0–2.0) | 3.0 (2.2–3.9) | 1.0 |
| Firearm injuries (X93–X95)                  | 611 (539–684) | 359 (307–411) | 0.9 (0.6–1.4) | 0.9 (0.6–1.4) | 1.8 (1.3–2.5) | 1.0 |
| Blunt force (Y00)                           | 735 (628–843) | 472 (389–556) | 1.1 (0.7–1.6) | 1.1 (0.7–1.6) | 2.2 (1.6–2.9) | 1.0 |
| Strangulation/threats to breathing (X91)    | 315 (261–368) | 223 (179–268) | 0.7 (0.4–1.1) | 0.7 (0.4–1.1) | 1.4 (1.0–1.9) | 1.0 |
| Fire/burns (X97–X98)                        | 79 (51–107) | 56 (38–74) | 0.2 (0.1–0.3) | 0.2 (0.1–0.3) | 0.4 (0.2–0.7) | 1.0 |
| Poisioning/ingestion (X85)                  | 72 (52–112) | 50 (35–66) | 0.2 (0.1–0.3) | 0.2 (0.1–0.3) | 0.4 (0.2–0.7) | 1.0 |
| Other†                                      | 87 (65–109) | 60 (44–76) | 0.2 (0.1–0.3) | 0.2 (0.1–0.3) | 0.4 (0.2–0.7) | 1.0 |
| Unknown (Y09)                               | 17 (8–27) | 11 (5–17) | 0.0 (0–0) | 0.0 (0–0) | 0.2 (0.1–0.4) | 1.0 |
| Suicide (X60–X84)                           | 1 153 (976–1 311) | 451 (359–543) | 0.9 (0.6–1.4) | 0.9 (0.6–1.4) | 1.8 (1.3–2.5) | 1.0 |
| Hanging (X70)                               | 488 (410–567) | 229 (184–274) | 0.5 (0.3–0.8) | 0.5 (0.3–0.8) | 1.0 (0.7–1.3) | 1.0 |
| Poisoning/ingestion (X60–X65)               | 463 (351–575) | 217 (158–276) | 0.8 (0.6–1.1) | 0.8 (0.6–1.1) | 1.6 (1.1–2.2) | 1.0 |
| Unintentional injuries (V00–X59)            | 6 186 (5373–6 999) | 2 891 (2 386–3 406) | 53.7 (50.9–56.6) | 53.7 (50.9–56.6) | 107.4 (101.6–113.3) | 1.0 |
| Transport (V00–V99)                         | 4 229 (3575–4 882) | 2 891 (2 386–3 406) | 11.3 (10.4–12.3) | 11.3 (10.4–12.3) | 22.6 (21.4–23.8) | 1.0 |
| Motor vehicle pedestrian injuries (V00–V04) | 1 299 (1 149–1 448) | 722 (630–804) | 1.6 (1.3–1.9) | 1.6 (1.3–1.9) | 3.2 (2.8–3.7) | 1.0 |
| Motor vehicle driver injuries (V40–V79 [0,5]) | 1 760 (1 383–2 138) | 1 024 (844–1 204) | 3.8 (3.3–4.3) | 3.8 (3.3–4.3) | 7.6 (6.7–8.6) | 1.0 |
| Rail pedestrian injuries (V05)              | 72 (46–98) | 47 (30–65) | 0.4 (0.3–0.6) | 0.4 (0.3–0.6) | 0.8 (0.5–1.1) | 1.0 |

(continues . . .)
| Apparent manner and external causes of death | Females* | Males* | Total* | RR |
|---------------------------------------------|----------|--------|--------|----|
| **All road-traffic injuries (V00–V89)**    | 4135 (3492–4778) | 12942 (11245–14639) | 17103 (14781–19425) | 3.4 |
| **Other unintentional injuries (W00–X59)** | 1958 (1727–2188) | 5151 (4608–5693) | 7153 (6411–7895) | 3.3 |
| Fire/burns (X00–X19)                       | 720 (613–828) | 1239 (1108–1371) | 1973 (1751–2195) | 1.9 |
| Drowning (W65–W74)                         | 307 (243–371) | 1376 (1159–1593) | 1690 (1430–1950) | 48 |
| Falls (W00–W19)                            | 154 (120–187) | 538 (442–634) | 697 (572–823) | 290 |
| Surgical and medical complications (Y40–Y84) | 216 (168–264) | 182 (134–230) | 402 (312–492) | 1.1 |
| Poisoning/ingestion (X40–X43)              | 104 (76–132) | 231 (164–298) | 337 (255–419) | 388 |
| Electrocution (W85–W99)                    | 66 (45–86) | 200 (166–234) | 267 (228–305) | 40 |
| Lightning (X33)                            | 60 (32–88) | 198 (150–246) | 258 (186–330) | 45 |
| Suffocation/threats to breathing (W75–W84) | 53 (35–72) | 152 (111–192) | 205 (154–256) | 113.4 |
| Other#                                      | 139 (106–172) | 675 (557–792) | 819 (676–962) | 150 |
| Unknown (X59)                              | 109 (101–118) | 187 (166–207) | 303 (278–328) | 20 |
| Undetermined intent (Y09–Y34, Y36, Y85–Y87, Y89) | 461 (340–582) | 1618 (1269–1967) | 2099 (1643–2554) | 42 |
| Poisoning/ingestion (Y10–Y15)              | 121 (86–156) | 293 (217–368) | 417 (314–520) | 2.6 |
| Fire/burns (Y25–Y27)                       | 101 (61–141) | 179 (96–262) | 283 (164–402) | 2.3 |
| Other#                                      | 154 (106–202) | 728 (595–862) | 882 (711–1054) | 66 |
| Unknown (Y34)                              | 85 (59–111) | 418 (303–533) | 517 (391–643) | 6.3 |

CI: confidence interval; RR: rate ratio.
* For females: unweighted n = 4831 and weighted n = 10 341. For males: unweighted n = 19 283 and weighted n = 41 807. For total: unweighted n = 24 197 and weighted n = 52 493.

The numbers for total deaths exceed the sum of deaths by sex due to 145 deaths in which sex could not be determined.

Age-standardized to the WHO world standard population.

† Include abandoned babies (Y06: 69 deaths), pushing (Y01: 27 deaths), drowning (X92: 26 deaths), poisoning/gassing (X86–X90: 25 deaths).

‡ Include sharp force injuries (X78: 62 deaths), fire/burns (X75–X77: 52 deaths) and railway pedestrian injuries (X81–X82: 48 deaths).

§ Include sharp force injuries (X78: 62 deaths), fire/burns (X75–X77: 52 deaths) and railway pedestrian injuries (X81–X82: 48 deaths).

‖ Include blunt force injuries (X20–X29: 377 deaths), bicycle riders (Y10–Y19: 4, 234 deaths), railway passengers (Y81: 70 deaths), aviation (V95–V97: 40 deaths) and motor-cycle passengers (V20–V29: 1, 5) 19 deaths.

¶ Include blunt force injuries (X20–X29: 377 deaths), bicycle riders (Y10–Y19: 4, 234 deaths), railway passengers (Y81: 70 deaths), aviation (V95–V97: 40 deaths) and motor-cycle passengers (V20–V29: 1, 5) 19 deaths.

†† Include blunt force injuries (Y22–Y24: 87 deaths), poisoning/gassing (Y16–Y19: 85 deaths), falls (Y50–Y51: 69 deaths), hanging (Y20: 66 deaths), strangulation (Y20: 37 deaths), surgical and medical complications (Y33: 23 deaths), sharp force injuries (Y28: 22 deaths), electrocution (Y33: 21 deaths) and transport fatalities of undetermined intent (Y32: 10 deaths).
Transport-related injuries accounted for more than one-third of all external causes of death 33.8% (17 742/52 493; 95% CI: 31.9–35.7) and the majority of deaths due to unintentional injury. Most of the transport-related deaths were due to road traffic injuries, which represented 32.6% (17 103/52 493) of all injury-related deaths (95% CI: 30.7–34.5) or 36.1 per 100 000 population (95% CI: 30.9–41.3). Pedestrian deaths accounted for 40.0% (5604/14 010) of the road traffic deaths in which the road user group was defined. Drivers and passengers accounted for 22.9% (3205/14 010) and 32.6% (4572/14 010) of deaths respectively (Table 2). The other major causes of unintentional injuries included burns, drowning and falls. The male-to-female mortality ratios were lower for accidental than for intentional injuries.

For a small subset of deaths from external causes (4.0%; 2099/52 493) it was not possible for the medical examiners to determine intent. This was most common among deaths arising from the ingestion of poisonous substances (including drugs), deaths from fires, burns and hot substances, and instances where decomposed bodies, bones or skeletons were found. Fig. 2 shows the distribution of male and female fatalities.

Gunshot injuries were a leading cause across several categories, accounting for 6428 deaths, equivalent to 17.6 firearm-related deaths per day (95% CI: 15.7–19.6). Of these, 5513 were homicides, 780 were suicides, 48 were unintentional and 87 were deaths of undetermined intent.

Table 3 presents the metro and non-metro mortality rates for homicide, suicide and road traffic injuries by sex, age and race. For all injuries and for homicide, metro mortality rates were notably higher than for non-metro areas. This finding was consistent when the data were stratified by sex and age.

Male injury rates were consistently and significantly higher than female rates in both metro and non-metro areas, with the highest male-to-female mortality ratio presenting among metro homicides (7 male deaths for every female death) and non-metro suicides (4.6 male deaths for every female). For road traffic fatalities, there were 3.6 male deaths for every female.

The age pattern for homicide was similar across metro and non-metro areas, albeit with the metro rates being noticeably higher in all but the youngest age category. Homicide rates were highest among teenagers and young adults in the 15–29 years age group in metro areas, and the 30–44 years age group in non-metro areas. Within age strata, the differences between metro and non-metro areas were not significant except for teenagers and young adults (15–29 years age group) among whom metro homicide rates were significantly higher, subjecting them to twice the risk of their non-metro counterparts. Suicide rates by age followed a similar pattern to homicide rates.

Fig. 2 shows the homicide, suicide and road-traffic injury rates by race for metro and non-metro areas. The metro and non-metro homicide and suicide patterns by race were inconsistent. People categorized as coloured experienced the highest homicide risk overall. Homicide rates among people categorized as black were highest in metro areas; conversely, among people categorized as white, the highest rates were found in non-metro areas.

Road traffic mortality rates were higher in non-metro areas for people categorized as black, children and the elderly.

Differences in metro/non-metro mortality risk affected the provincial mortality profiles depicted in Fig. 4. Homicide ranked highest for five provinces: Eastern Cape, Gauteng, KwaZulu-Natal, the Northern Cape and the Western Cape, of which all except the Northern Cape have large urban centres.

Discussion

This study provides a comprehensive profile of injury-related mortality in South Africa in the year 2009 and provides cause-specific rates that are not available from other sources. Vital registration data suggest that there has been an overall decrease in external causes of death from 1997 to 2009 but the reasons are unclear. In those data, a high proportion of deaths were recorded as ‘other external causes’ of accidental injury – 63% (31 166/49 456) in 2009. The ICD-10 convention to code injury deaths with limited information on intent as accidental (X59) is a common cause of information loss for injury-related mortality data internationally.

We found more than three times as many deaths from homicide and road traffic injury than were recorded by vital registration. Underreporting was also apparent in other official statistics. We recorded significantly more homicides (13% higher) than the 16 834 recorded by the South African Police Service in...
## Table 3. Mortality from homicide, suicide and road-traffic injury for metro and non-metro areas, South Africa, 2009

| External cause of death | Metro areas* | Non-metro areas* | Total* | RR |
|-------------------------|--------------|------------------|--------|----|
| Homicide (X85-Y09)      |              |                  |        |    |
| Male                    | 9846(8328–11364) | 9182(7004–11361) | 19028(16852–21204) | 1.4 |
| Female                  | 8592(7766–9919) | 7652(5794–9521)  | 16245(14339–18151) | 1.3 |
| 0–4 years               | 1232(1025–1440) | 1508(1184–1832)  | 2740(2440–3041) | 1.1 |
| 5–14 years              | 101(80–120) | 185(143–227) | 286(243–328) | 1.0 |
| 15–29 years             | 109(74–180) | 178(64–291) | 287(172–401) | 1.3 |
| 30–44 years             | 4401(3755–5046) | 4130(3074–5187) | 8531(7466–9598) | 1.5 |
| 45–59 years             | 3207(2730–3685) | 2648(2135–3161) | 5855(5346–6363) | 1.3 |
| ≥ 60 years              | 1139(948–1330) | 1156(896–1418) | 2295(2043–2547) | 1.2 |
| Black                   | 403(299–507) | 592(406–758) | 995(822–1169) | 1.1 |
| Coloured                | 8113(6953–9273) | 7974(5836–10113) | 16088(14011–18164) | 1.6 |
| Asian                   | 1080(685–1474) | 848(476–1219) | 1927(1395–2459) | 1.1 |
| White                   | 226(175–276) | 220(145–296) | 316(258–375) | 0.7 |
| Male                    | 534(449–617) | 620(459–802) | 640(485–756) | 1.0 |
| Female                  | 46(35–57) | 82(49–115) | 127(94–160) | 1.2 |
| 0–4 years               | 1181(1001–1362) | 1470(1136–1804) | 2652(2332–2971) | 1.1 |
| 5–14 years              | 1057(880–1233) | 1102(865–1340) | 2159(1919–2399) | 1.0 |
| 15–29 years             | 499(370–629) | 557(446–668) | 1056(910–1203) | 1.1 |
| 30–44 years             | 142(101–194) | 220(160–279) | 361(295–428) | 1.0 |
| 45–59 years             | 1847(1482–2213) | 2757(2054–3460) | 4604(3897–5311) | 1.0 |
| ≥ 60 years              | 533(449–617) | 620(459–802) | 579(475–682) | 1.0 |
| Black                   | 2188(1713–2664) | 2288(1881–2717) | 236(134–338) | 1.0 |
| Male                    | 6875(5582–8167) | 10288(7925–12531) | 10183(8718–12925) | 0.9 |
| Female                  | 5371(4370–6372) | 7571(5909–9233) | 12942(11245–14639) | 0.9 |
| 0–4 years               | 1494(1192–1795) | 2641(1991–3291) | 4135(3492–4778) | 0.8 |
| 5–14 years              | 288(216–360) | 454(342–495) | 741(616–867) | 1.2 |
| 15–29 years             | 391(327–454) | 657(486–829) | 1048(878–1218) | 1.2 |
| 30–44 years             | 2098(1719–2478) | 3355(2594–4116) | 5454(4696–6211) | 0.9 |
| Road-traffic (V00–V89)  | 2188(1713–2664) | 2288(1881–2717) | 5179(4459–5899) | 0.8 |

(continues...)
| External cause of death | Metro areas<sup>a</sup> | Non-metro areas<sup>a</sup> | Total<sup>b</sup> | RR  |
|------------------------|-------------------------|--------------------------|--------------|-----|
|                       | No. (95% CI)            | Mortality rate per 100 000 population (95% CI)<sup>b</sup> | No. (95% CI) | Mortality rate per 100 000 population (95% CI)<sup>b</sup> | Mortality rate per 100 000 population (95% CI)<sup>b</sup> |               |
| 45–59 years            | 1081 (872–1 290)        | 38.0 (30.7–45.4)         | 1 681 (1 321–2 041) | 47.4 (37.3–57.6) | 2 762 (2 396–3 128) | 43.2 (37.5–49.0) | 0.8   |
| ≥ 60 years             | 517 (425–610)           | 34.3 (28.2–40.5)         | 753 (565–941)      | 30.8 (23.1–38.5) | 1 270 (1 089–1 452) | 32.2 (27.6–36.8) | 1.1   |
| Black                  | 5148 (4116–6 180)       | 38.9 (29.9–47.9)         | 8 456 (6 320–10 593) | 37.1 (27.4–46.8) | 13 604 (11 459–15 749) | 37.2 (30.9–43.5) | 1.0   |
| Coloured               | 620 (480–760)           | 27.9 (19.9–35.9)         | 607 (490–724)      | 29.0 (21.9–36.1) | 1 227 (1 052–1 402) | 28.4 (23.0–33.9) | 1.0   |
| Asian                  | 316 (216–416)           | 31.3 (20.0–42.5)         | 167 (106–228)      | 57.3 (27.5–87.9) | 483 (370–599)       | 37.0 (25.7–48.3) | 0.5   |
| White                  | 761 (502–1 020)         | 25.4 (15.7–35.2)         | 975 (694–1 259)    | 58.7 (37.7–79.8) | 1 736 (1 376–2 095) | 32.2 (27.6–36.8) | 1.3   |
| All-injuries (V00–Y34)| 24 584 (20 642–28 526)  | 118.5 (99.0–138.1)       | 27 910 (22 269–33 551) | 125.2 (107.6–142.8) | 52 493 (46 930–58 057) | 121.0 (107.2–134.8) | 1.2   |
| Male                   | 19 999 (16 779–23 219)  | 193.3 (161.5–225.2)      | 21 808 (17 436–26 179) | 172.5 (137.6–207.4) | 41 807 (37 431–46 183) | 181.0 (161.3–200.7) | 1.1   |
| Female                 | 4 512 (3 755–5 269)     | 45.2 (36.7–53.8)         | 6 029 (4752–7306)  | 41.4 (32.0–50.9) | 10 541 (9 306–11 777) | 42.7 (37.1–48.4) | 1.1   |
| 0–4 years              | 991 (806–1 176)         | 51.9 (42.2–61.6)         | 1 256 (992–1 520)  | 51.1 (42.5–60.7) | 2 247 (1 963–2 530) | 41.0 (35.8–46.1) | 1.0   |
| 5–14 years             | 860 (722–998)           | 28.2 (23.7–32.7)         | 1 424 (1 029–1 820) | 22.7 (16.4–29.0) | 2 855 (2 190–3 668) | 24.3 (20.4–28.6) | 1.2   |
| 15–29 years            | 8 871 (7 556–10 186)    | 140.0 (120.0–161.8)      | 10 181 (7 990–12 372) | 116.4 (91.4–141.5) | 19 052 (16 914–21 190) | 126.7 (112.5–140.9) | 1.1   |
| 30–44 years            | 7 636 (6 363–8 908)     | 160.1 (133.4–186.8)      | 7 868 (6 465–9271)  | 151.3 (124.3–178.3) | 15 503 (14 068–16 939) | 155.5 (141.1–169.9) | 1.0   |
| 45–59 years            | 3 394 (2 811–3 978)     | 210.0 (174.6–247.5)      | 4 193 (3 409–4 978) | 118.3 (96.2–140.5) | 7 587 (6 822–8 352) | 118.8 (106.8–130.8) | 1.0   |
| ≥ 60 years             | 1 620 (1 352–1 887)     | 119.4 (98.9–139.9)       | 2 096 (1 623–2 569) | 85.8 (66.5–105.2) | 3 716 (3 260–4 172) | 94.1 (82.6–105.7) | 1.3   |
| Black                  | 18 924 (15 826–22 022)  | 140.9 (120.0–161.8)      | 23 355 (17 895–28 812) | 100.6 (76.7–124.4) | 42 259 (36 893–47 625) | 112.1 (97.1–127.0) | 1.3   |
| Coloured               | 2 414 (1 762–3 065)     | 28.2 (23.7–32.7)         | 2 246 (1 569–2 923) | 107.6 (75.4–139.9) | 4 660 (3 747–5 573) | 106.5 (84.9–128.1) | 1.0   |
| Asian                  | 878 (587–1 169)         | 23.7 (16.9–31.1)         | 2 346 (1 601–3 465) | 115.0 (85.8–172.2) | 1 211 (901–1 521) | 92.6 (65.4–120.2) | 0.8   |
| White                  | 2 236 (1 535–2 936)     | 46.3 (36.1–57.2)         | 1 877 (1 376–2 377) | 108.0 (74.9–141.0) | 4 112 (3 319–4 905) | 83.3 (65.4–101.1) | 0.6   |

<sup>a</sup> CI: confidence interval; RR: rate ratio.
<sup>b</sup> For metro area: unweighted n = 12 037 and weighted n = 21 568. For non-metro areas: unweighted n = 12 160 and weighted n = 30 925. For total: unweighted n = 24 197 and weighted n = 52 493.
<sup>c</sup> Age-standardized to the WHO world standard population.

Note: The categories for race are those used in postmortem and police reports in South Africa.
2009 and significantly more road deaths (24% higher) than the 13 802 recorded by the Road Traffic Management Corporation.18,19

The estimated total number of injury-related deaths in our study did not differ significantly from the 49 456 deaths from external causes recorded in vital registration,15 but better cause-specific detail is required for modelling of burden of disease trends. Previously, the first South African burden of disease study2 provided the only detailed national estimates by age and sex for major causes of injury. There has been an overall decrease in total injury-related deaths from an estimated 59 935 in the year 2000.12 The homicide rate of 38.4 per 100 000 population still places South Africa among the most violent countries, but there has been a significant decrease since 2000 when the national homicide rate was estimated at 64.8 per 100 000 population. This is consistent with national police statistics16 and retrospective national surveys of female homicides that also indicate a decrease.9 According to police statistics, homicide decreased from 18 793 to 15 609 between 2004 and 201118. Two nationally representative retrospective surveys measured a 38% decrease (3793 to 2363 deaths) in female homicide between 1999 and 2009.9

The decrease in female homicide has been attributed partly to the effectiveness of the Firearms Control Act of 2000.9 A recent analysis of homicide across five South African cities from 2001 to 2011 confirms a substantial year-on-year decrease in homicides involving firearms, coinciding with the implementation of the Firearms Control Act, alongside a more modest decrease in other means of homicide.20 We estimate that homicides involving firearms in metro areas accounted for just 38.5% of homicides in 2009, compared to 44% in 2005.20 This suggests that homicide involving firearms has declined more rapidly than homicide by other means, at least in urban areas. The exceptionally high homicide rate among males has been noted previously,2 but the male-to-female ratio has increased since 2000 indicating that the decrease in male homicide has not kept pace with the greater decline among females. After taking into account the overall decrease, the pattern of homicides by age group was similar to that in the year 2000.

Suicide remains an important contributor to injury-related mortality, although our study does suggest a decrease in the female suicide rate from an estimated 6.1 per 100 000 population.
Alcohol consumption is high among racial categories that are, on average, poorer. A previous study recognized the urban bias of mortuary-based surveillance data as well as the poor distinction between deaths of undetermined cause (i.e., whether from natural or external causes) and injury-related deaths of undetermined intent. Our data confirm the incompleteness and misclassification of vital registration data from the Department of Home Affairs, which codes as R99 (i.e., an ill-defined natural cause death) any death that is under investigation at the time of certification. The homicide rate in our study was 5% higher than the 36.4 per 100,000 population in the global burden of disease study, while mortality from road-traffic injury and suicide were approximately fourfold higher than the 8.9 and 3.6 per 100,000, respectively, in the global burden of disease study. We have demonstrated the feasibility and utility of using mortuary-based data to provide timely, accurate and representative injury-related mortality information to monitor major injury trends and to identify at-risk groups.

The study provides empirical evidence of the extent of miscategorization and underreporting that compromises the evaluation of violence and injury prevention efforts. Comparison with several official sources and secondary analyses that rely on these sources suggest that mortuary data can improve estimates of mortality from external causes, and complement national and global burden of disease estimates.

Acknowledgements

We thank Shabeer Wadde, Lilly Seals, Omar Galant, James Such, Martin Fournier, Christa Hattingh, Threnesan Naidoo, Sageren Aiyer, Noreen Udemans, Nazreen Abrahams and Elize de Kock. We gratefully acknowledge the National and Provincial Health Departments for providing access to their facilities and provincial Forensic Pathology Services (FPS) for their assistance during fieldwork. The South African Medical Research Council’s Gender and Health Research Unit provided the sampling frame and methodological assistance to expedite the study. Richard Matzopoulos is a Honorary Research Associate based at the University of Cape Town’s School of Public Health and Family Medicine. Shanaaz Mathews is the Director of the University of Cape Town’s Children’s Institute.

Funding: This work was funded by the South African Medical Research Council, which paid the salaries of the research personnel involved in the study as well as the fieldwork costs.

Competing interests: None declared.
Les dossiers d’autopsie font état de 52 493 décès par traumatisme en 2009 (intervalle de confiance de 95 %, IC : 46 930–58 057). Quasiment la moitié (25 499 décès) correspond à des blessures infligées intentionnellement. Taux de mortalité standardisé selon l’âge, pour les différentes causes externes de décès.

Méthodes
Nous avons réalisé une étude descriptive rétrospective des données de rapports médico-légaux obtenus auprès de morgues, en utilisant une technique d’échantillonnage aléatoire à plusieurs degrés, stratifié en fonction des critères suivants : zone urbaine, zone non urbaine et taille de la morgue. Nous avons calculé les taux de mortalité par âge et les taux de mortalité standardisés selon l’âge, pour les différentes causes externes de décès.

Résultats
Les dossiers d’autopsie font état de 52 493 décès par traumatisme en 2009 (intervalle de confiance de 95 %, IC : 46 930–58 057). Quasiment la moitié (25 499 décès) correspond à des blessures infligées intentionnellement. Taux de mortalité standardisé selon l’âge et les taux de mortalité stratifiés selon des facteurs contextuels de décès.

Conclusion
Il s’agit du premier échantillon nationalement représentatif pour la mortalité par traumatisme en Afrique du Sud. Cette étude offre des estimations plus précises et des profils détaillés par cause, qui ne sont disponibles dans aucune autre source.

Revue de la littérature

La mortalité par traumatisme en Afrique du Sud est un problème majeur, nécessitant une réponse intégrée. Les données de cette étude sont comparables à ceux de l’Afrique du Sud, mais elles sont plus précises et détaillées que les données disponibles auparavant.

Pour une meilleure compréhension de la mortalité par traumatisme en Afrique du Sud, il est nécessaire de développer des politiques et des programmes de santé pour réduire le nombre de décès et de blessures causées par les traumatismes.

Conclusion

La mortalité par traumatisme en Afrique du Sud est un problème majeur, nécessitant une réponse intégrée. Les données de cette étude sont comparables à ceux de l’Afrique du Sud, mais elles sont plus précises et détaillées que les données disponibles auparavant.

Pour une meilleure compréhension de la mortalité par traumatisme en Afrique du Sud, il est nécessaire de développer des politiques et des programmes de santé pour réduire le nombre de décès et de blessures causées par les traumatismes.

Resumen

Mortalidad por traumatisma en África del Sur: estudio descriptivo retrospectivo de informes de autopsia

Objetivo
Enriquecer sobre la mortalidad por traumatisma en África del Sur a partir de un échantillon nacionalmente representativo y comparar los resultados con las estimaciones anteriores.

Métodos
Nosotros realizamos una evaluación descriptiva retrospectiva de los registros de informes médico-legales obtenidos en las morgues, utilizando una técnica de muestreo aleatorio a varios grados, stratificado en función de los criterios siguientes: zona urbana, zona rural y tamaño de la morgue. Nosotros calculamos los tasas de mortalidad por edad y las tasas de mortalidad estandarizadas según la edad, para diferentes causas externas de muerte.

Resultados
Los registros de respuesta incluyen 52 493 decesos por traumatisma en 2009 (intervalo de confianza del 95 %, IC: 46 930–58 057). Quasimente, la mitad (25 499 decesos) corresponde a les lesiones infligidas intencionalmente. Taux de mortalidad estandarizado según la edad y las tasas de mortalidad estandarizadas según la edad, para diferentes causas externas de muerte.

Conclusión
Esta es la primera investigación descriptiva retrospectiva de informes de autopsia para la mortalidad por traumatisma en África del Sur. Esta evaluación ofrece estimaciones más precisas y detalladas por causa, las que no están disponibles en ninguna otra fuente.

Заключение

Исследование смертности от травм в Южной Африке с помощью национально-репрезентативной выборки и сравнение результатов с предыдущими оценками.

Методы
Мы провели ретроспективное описательное исследование данных судебно-медицинских вскрытий, полученных из мorgues, с помощью многокогортной случайной выборки с разбивкой по городским и негородским районам и размеру мorgues. Мы определили возрастозависимый уровень смертности и уровень смертности, стандартизованный по возрасту, для случаев смерти, наступившей от внешних причин.

Результаты
Согласно данным посмертных эпикризов в 2009 году было зарегистрировано 52 493 смерти от травм (доверительный интервал 95 %, ДИ: 46 930–58 057). Почти половина травм (25 499) была нанесена умышленно. Показатели смертности, стандартизованные по возрасту, на 100 000 населения распределились следующим образом: Всевидцы травм: 109,0 (95 % ДИ: 97,1–121,0); убийство: 38,4 (95 % ДИ: 33,8–43); самоубийство: 13,4 (95 % ДИ: 11,6–15,2); травмы, связанные с транспортом: 36,1 (95 % ДИ: 30,9–41,3). Результаты с предыдущими оценками.

Заключение

Это первая национально-репрезентативная выборка смертности от травм в Южной Африке. Она предоставляет более точную оценку и сведения в зависимости от причинного фактора, которые невозможно получить из других источников.
Resumen

Mortalidad relacionada con los traumas en Sudáfrica: un estudio retrospectivo y descriptivo de investigaciones post mortem

Objetivo Investigar la mortalidad relacionada con los traumas en Sudáfrica utilizando una muestra representativa a nivel nacional y comparar los resultados con estimaciones anteriores.

Métodos Se llevó a cabo un estudio retrospectivo y descriptivo de datos médico-legales de investigaciones post mortem utilizando una muestra aleatoria en varias etapas, estratificado por zonas urbanas y zonas no urbanas y el tamaño de la morgue. Se calcularon las tasas de mortalidad específicas y normalizadas por edades de causas de muerte extenuantes.

Resultados Los informes post mortem revelaron 52,493 muertes relacionadas con traumas en 2009 (intervalo de confianza, IC del 95%: 46.930–58.057). Casi la mitad (25,499) fueron infligidas intencionadamente. Las tasas de mortalidad normalizadas por edades por 100,000 residentes fueron las siguientes: todos los traumas: 10.9 (IC del 95%: 9.71–12.10); homicidio 3.84 (IC del 95%: 3.38–4.3); suicidio 13.4 (IC del 95%: 11.6–15.2) y traumas relacionados con el transporte 3.61 (IC del 95%: 3.09–4.13). Utilizando informes post mortem, se observaron tres veces más casos de muertes por homicidio y traumatismos por accidentes de tráfico que la cantidad registrada en el registro de causa de muerte para este periodo. La tasa de homicidio fue similar a la estimación para Sudáfrica desde una perspectiva global, pero las tasas de accidentes de tráfico y suicidios fueron casi cuatro veces superiores.

Conclusión Esta es la primera muestra representativa a nivel nacional de mortalidad relacionada con los traumas en Sudáfrica. Proporciona estimaciones más precisas y perfiles por causas específicas que no pueden obtenerse de otras fuentes.

Referencias

1. Bradshaw D, Groenewald P, Laubscher R, Norman R, et al. Initial burden of disease estimates for South Africa, 2000. Tygerberg: South African Medical Research Council; 2003.
2. Norman R, Matzopoulos R, Groenewald P, Bradshaw D. The high burden of injuries in South Africa. Bull World Health Organ. 2007 Sep;85(9):695–702. doi: http://dx.doi.org/10.2471/BLT.06.037194 PMID: 18026626
3. Altbeker A. Murder and robbery in South Africa: A tale of two trends. In: Van Niekerk A, Suffia S, Seedat M, editors. Data to action: an overview of crime, violence and injury prevention in South Africa. Pretoria: UNISA Press; 2008. pp. 122–49.
4. Chokotho LC, Matzopoulos R, Myers JE. Assessing quality of existing data sources on road traffic injuries (RTIs) and their utility in informing injury prevention in the Western Cape Province, South Africa. Traffic Inj Prev. 2013;14(3):267–73. doi: http://dx.doi.org/10.1080/15389588.2012.706760 PMID: 23441945
5. Lerer LB, Matzopoulos RG, Phillips R. Violence and injury mortality in the Cape Town metropolis. S Afr Med J. 1997 Mar;87(3):296–301. PMID: 9137341
6. Butchart A, Peden M, Matzopoulos R, Phillips R, Burrows S, Bhagwandin N, et al. The South African national non-natural mortality surveillance system—rationale, pilot results and evaluation. S Afr Med J. 2001 May;91(5):408–17. PMID: 11455806
7. Blom L, van Niekerk A, Lafamme L. Epidemiology of fatal burns in rural South Africa: a mortuary register-based study from Mpumalanga Province. Burns. 2011 Dec;37(8):1394–402. doi: http://dx.doi.org/10.1016/j.burns.2011.07.014 PMID: 21855219
8. Inquests Act 58 of 1959. Pretoria: South Africa, 1959.
9. Abrahams N, Mathews S, Martin LJ, Lombard C, Jewkes R. Intimate partner femicide in South Africa in 1999 and 2009. PLoS Med. 2013;10(4):e1001412. doi: http://dx.doi.org/10.1371/journal.pmed.1001412 PMID: 23565064
10. Pillay-Van Wyk V, Msemburn W, Laubscher R, Dorrington RE, Groenewald P, Matzopoulos R, et al. Second National Burden of Disease Study of South Africa: national and subnational mortality trends, 1997–2009. Lancet. 2013;381:5113. doi: http://dx.doi.org/10.1016/S0140-6736(13)61367-7
11. Matzopoulos R, Martin LJ, Wadde S, Thomson V, Primisoo M, Bourne D, et al. The Provincial injury mortality surveillance system (PIMSS): a surveillance tool for the Western Cape. Inj Prev. 2010;16(Supplement 1):A47–8. doi: http://dx.doi.org/10.1136/ijp.2009.029143.172
12. Dorrington R. Alternative South African mid-year estimates, 2013. Cape Town: University of Cape Town; 2013.
13. Ahmad O, Boschi-Pinto C, Lopez A, Murray C, Lozano R, Inoue M. Age standardization of rates: a new WHO standard. [GPE discussion paper series No. 31]. Geneva: World Health Organization; 2001.
14. Mortality and causes of death in South Africa, 1997–2003: findings from death notification. Pretoria: Statistics South Africa, 2005.
15. Mortality and causes of death in South Africa, 2009: findings from death notification [Statistical release PO309.3]. Pretoria: Statistics South Africa, 2011.
16. Bah S. Unnoticed decline in the number of unnatural deaths in South Africa. S Afr Med J. 2004 Jun;94(6):402–3. PMID: 15250456
17. Bhalla K, Harrison JE, Shahzad S, Fingerhut LA; Global Burden of Disease Injury Expert Group. Availability and quality of cause-of-death data for estimating the global burden of injuries. Bull World Health Organ. 2010 Nov 18;88(11):831–838C. doi: http://dx.doi.org/10.2471/BLT.09.068809 PMID: 21076564
18. Crime report 2010-2011. SAPS together squeezing crime to zero. SAPS members, my family – together pushing back the frontiers of evil. Pretoria: South African Police Service; 2011.
19. Road traffic management corporation annual report 2010-2011. Pretoria: Road Traffic Management Corporation; 2011. Available from: http://www. rtmc.co.za/images/docs/RTMCREPORT20102011%20%202011.pdf [cited 2015 Mar 6].
20. Matzopoulos RG, Thompson ML, Myers JE. Firearm and nonfirearm homicide in 5 South African cities: a retrospective population-based study. Am J Public Health. 2014 Mar;104(3):455–60. doi: http://dx.doi.org/10.2105/ AJPH.2013.310650 PMID: 24432917
21. Burrows S, Lafamme L. Suicide mortality in South Africa: a city-level comparison across socio-demographic groups. Soc Psychiatry Psychiatr Epidemiol. 2006 Feb;41(2):108–14. doi: http://dx.doi.org/10.1007/s00212- 005-0004-4 PMID: 16362168
22. Global status report on road safety: time for action [Internet]. Geneva: World Health Organization; 2009. Available from: www.who.int/violence_injury_ prevention/road_safety_status/2009 [cited 2013 Jan 20].
23. GBD Compare [Internet]. Seattle: Institute of Health Metrics and Evaluation; 2013. Available from: http://viz.healthmetricsandevaluation.org/gbdcompare/ [cited 2014 March 27].
24. Peden M, Scurfield R, Sleet D, Mohan D, Hyder AA, Jarawan E, et al. World report on road traffic injury prevention. Geneva: World Health Organization; 2004.
25. Butchart A, Phinneay A, Check P, Villaveces A. Preventing violence: a guide to implementing the recommendations of the World Report on Violence and Health. Geneva: World Health Organization; 2004.
26. Santos SM, Barcellos C, Sá Carvalho M. Ecological analysis of the distribution and socio-spatial context of homicides in Porto Alegre, Brazil. Health Place. 2006 Mar;12(1):38–47. doi: http://dx.doi.org/10.1016/j. healthplace.2004.08.009 PMID: 16243679
27. Poverty trends in South Africa: an examination of absolute poverty between 2006 and 2011. Pretoria: Statistics South Africa, 2014.