Mortality among twins and singletons in sub-Saharan Africa between 1995 and 2014: a pooled analysis of data from 90 Demographic and Health Surveys in 30 countries

Christiaan W S Monden, Jeroen Smits

Summary
Background Sub-Saharan Africa has the world’s highest under-5 and neonatal mortality rates as well as the highest naturally occurring twin rates. Twin pregnancies carry high risk for children and mothers. Under-5 mortality has declined in sub-Saharan Africa over the last decades. It is unknown whether twins have shared in this reduction.

Methods We pooled data from 90 Demographic and Health Surveys for 30 sub-Saharan Africa countries on births reported between 1995 and 2014. We used information on 1685110 singleton and 56 597 twin livebirths to compute trends in mortality rates for singletons and twins. We examined whether the twin–singleton rate ratio can be attributed to biological, socioeconomic, care-related factors, or birth size, and estimated the mortality burden among sub-Saharan African twins.

Findings Under-5 mortality among twins has declined from 327·7 (95% CI 312·0–343·5) per 1000 livebirths in 1995–2001 to 213·0 (196·7–229·2) in 2009–14. This decline of 35·0% was much less steep than the 50·6% reduction among singletons (from 128·6 [95% CI 126·4–130·8] per 1000 livebirths in 1995–2001 to 63·5 [61·6–65·3] in 2009–14). Twins account for an increasing share of under-5 deaths in sub-Saharan Africa: currently 10·7% of under-5 mortality, including 15·1% of neonatal mortality. We estimated that about 315 000 twins (uncertainty interval 289 000–343 000) die in sub-Saharan African each year. Excess twin mortality cannot be explained by common risk factors for under-5 mortality, including birthweight. The difference with singletons was especially stark for neonatal mortality (rate ratio 5·0, 95% CI 4·5–5·6). 51·7% of women pregnant with twins reported receiving medical assistance at birth.

Interpretation The fate of twins in sub-Saharan Africa is lagging behind that of singletons. An alarming one-fifth of twins in the region dies before age 5 years, three times the mortality rate among singletons. Twins account for a substantial and growing share of under-5 and neonatal mortality, but they are largely neglected in the literature. Coordinated action is required to improve the situation of this extremely vulnerable group.

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Introduction Sub-Saharan Africa has the highest rate of naturally occurring twin births in the world.1 Whereas natural twinning rates are about six to nine twin births per 1000 maternities in east Asia and Latin America, and eight to 16 in Europe, North America, and the Middle East, they are as high as 18 per 1000 or more in the central African twinning zone that runs from Guinea, Liberia, and Côte d’Ivoire in the west of Africa to Tanzania, Mozambique, and the Comoros in the east.1 About 3–4% of children born in sub-Saharan Africa are members of a twin pair.

Twins are extremely vulnerable and twin pregnancies have a high risk of complications for mother and child. Twins suffer from lower birthweight and preterm delivery. Twin pregnancies and births are associated with obstetric complications such as anemia, post-partum haemorrhage, hypertensive disorders, and increased maternal mortality.2,3 Under-5 and neonatal mortality rates are two to five times higher than among twins compared with the largest relative differences found in regions with the lowest mortality rates.2–50 For example, in Finland, which has one of the lowest infant mortality rates in the world, infant mortality among multiple births is considerably higher than among singletons (11·1 versus 1·9 deaths per 1000 livebirths in the period 2010–15; Ahokas E, Population Statistics, Statistics Finland, personal communication). Twins suffer more from congenital malformations and could also therefore be more vulnerable after the first year of life.7

The fate of twins might be particularly precarious in sub-Saharan Africa where child mortality rates are the highest in the world,12 where maternal and newborn care is weak,13–17 and where the absolute number of children under 5 years, including twins, will increase by about 20% over the next decades.12 High mortality rates among twins have been documented for many sub-Saharan sites or countries, with under-5 mortality rates ranging from over 200 to almost 400 deaths per 1000 livebirths.1,12,13,15,16

Also, maternal mortality and morbidity associated with
twin pregnancies are very high in sub-Saharan Africa. Although effective guidelines are available for antenatal and delivery care for twins, many women in the region receive little antenatal care at all and deliver in a non-medical setting. Given the high absolute number of twin births in sub-Saharan Africa, in combination with the high perinatal and maternal mortality surrounding these births, it might be difficult, without special attention to this vulnerable group, to achieve the Every Newborn 2035 target regarding neonatal and under-5 mortality among twins, it will be difficult to achieve the Every Newborn 2035 target and the Sustainable Development Goal target regarding neonatal and under-5 mortality without special attention to this highly vulnerable group.

Methods

Study design

The data are derived from the DHS Program. Each DHS survey consists of a household survey and separate women’s survey. In the latter, all usual resident women aged 15–49 years are invited for an interview, which includes a complete birth history collecting information on all livebirths of the women, including date of birth, sex of the child, whether it was a singleton or multiple birth, and whether and when a child died. The team executing the DHS survey ensures protection of participants in agreement with local and international laws.

Procedures

We pooled 90 standard DHS surveys done between 1995 and 2015 in 30 sub-Saharan African countries: Benin, Burkina Faso, Burundi, Cameroon, Chad, Comoros, Democratic Republic of Congo, Republic of Congo, Côte d’Ivoire, Ethiopia, Gabon, Ghana, Guinea, Kenya, Lesotho, Liberia, Malawi, Mali, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Tanzania, Togo, Uganda, Zambia, and Zimbabwe. These countries were selected because their DHS survey provided sufficient numbers of births in the following periods: 1995–2001, 2002–08, and 2009–14. These 30 countries account for 83% of all under-5 mortality in sub-Saharan Africa (appendix). We selected all children born in the period 1995–2014. DHS do not record stillborn children.
All figures refer to livebirths and for twins this means only those cases where both twins were liveborn. Triplets and other higher order multiple births were excluded. Marital status, place of residence, and wealth were measured at the time of interview. Household wealth was measured by the International Wealth Index, which is a cross-nationally comparable index based on the household’s possession of consumer durables, housing quality, and access to basic amenities.

Statistical analysis
To assess to what extent excess twin mortality can be accounted for by differences in biological and socioeconomic factors, medical assistance, and birth size, the 2009–14 mortality rate ratios were adjusted in a series of regression models. We included the following variables: maternal age at birth (in years), birth order, length of the preceding birth interval (in months), mother’s marital status, urban or rural residence, household wealth, place of delivery (in a medical facility or clinic versus at home or other non-medical location), and assistance of a nurse, medically trained midwife, or doctor during delivery. Women were asked to report whether their child’s size at birth was very small, small, average, large, or very large. This metric has been shown to be a good proxy for birthweight. For the case of a 54% reduction in overall under-5 mortality between 1990 and 2015 for sub-Saharan Africa as a whole.

Among twins, the reduction in under-5 mortality from 327·7 to 213·0 per 1000 is much larger than among singletons in absolute terms (a reduction of 114·5 vs 65·5 deaths per 1000), but it is smaller in relative terms (35% vs 51%). Twins experienced 198·8 more deaths per 1000 livebirths than singletons in 1995–2001, but this excess mortality decreased to 149·5 per 1000 in the 2009–14 period. So, the absolute difference in mortality rates between twins and singletons has fallen by a quarter.

The rate for the difference in under-5 mortality between twins and singletons increased over the study period from 2·5 (95% CI 2·4–2·7) to 3·4 (3·1–3·6), an increase of 32%. Also, the share of twins in total under-5 mortality has increased substantively. Whereas in 1995–2001, 8·1% (95% CI 7·6–8·5) of under-5 mortality was due to mortality among twins, in 2009–14 this was 10·7% (9·8–11·6) of total mortality. The number of singletons

Table 1: Under-5 mortality among singletons and twins in 30 countries in sub-Saharan Africa 1995–2014

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Singletons</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Livebirths</td>
<td>735·849</td>
<td>641·995</td>
<td>250·669</td>
<td>-</td>
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<tr>
<td>Deaths</td>
<td>94·601</td>
<td>63·731</td>
<td>15·912</td>
<td>-</td>
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<tr>
<td>Mortality rate per 1000 (95% CI)</td>
<td>(126·4–130·8)</td>
<td>(97·5–101·0)</td>
<td>(61·6–65·3)</td>
<td>-50·6%</td>
</tr>
<tr>
<td>Twins</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Livebirths</td>
<td>25·324</td>
<td>22·349</td>
<td>8924</td>
<td>-</td>
</tr>
<tr>
<td>Deaths</td>
<td>8299</td>
<td>6199</td>
<td>1900</td>
<td>-</td>
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<tr>
<td>Mortality rate per 1000 (95% CI)</td>
<td>(312·0–343·5)</td>
<td>(264·8–290·0)</td>
<td>(196·7–229·2)</td>
<td>-35·0%</td>
</tr>
<tr>
<td>Absolute twin-singleton difference</td>
<td>199·2</td>
<td>178·1</td>
<td>149·5</td>
<td>-24·9%</td>
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<tr>
<td>Twin–singleton rate ratio (95% CI)</td>
<td>2·5</td>
<td>2·8</td>
<td>3·4</td>
<td>31·6%</td>
</tr>
<tr>
<td>Share of twins in total under-5 mortality (95% CI)</td>
<td>8·1%</td>
<td>8·9%</td>
<td>10·7%</td>
<td>32·3%</td>
</tr>
</tbody>
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Results
The total 1995–2014 sample included information on 1685·110 children, of which 56·597 were twins. 190·642 children died before age 5 years, of which 16·399 were twins. Table 1 presents crude under-5 mortality rates for singletons and twins for the three periods, 1995–2001, 2002–08, and 2009–14. There was a reduction in under-5 mortality for both singletons and twins between 1995 and 2014. For singletons, under-5 mortality decreased by 51%, from 128·6 to 63·5 per 1000 livebirths. This result is similar to the UN estimate of a 54% reduction in overall under-5 mortality between 1990 and 2015 for sub-Saharan Africa as a whole.

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Articles

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under-5 deaths in sub-Saharan Africa in 2015 was estimated at 2·9 million by the UN Inter-agency Group for Child Mortality Estimation.\textsuperscript{11,27} This number translates to about 315,000 twins (uncertainty interval 289,000–343,000) dying before their fifth birthday (appendix).

In table 2 we break down under-5 mortality into mortality at different stages (conditional on survival to that age). The major difference in mortality between singletons and twins occurred in the first days and month of life. In the most recent period, the twin–singleton rate ratio for neonatal mortality was 3·0 (95% CI 3·4–5–6, whereas it was 2·6 (2·2–3·1) for post-neonatal mortality (1–11 months) and 2·1 (1·6–2·7) for child mortality (12–59 months). The neonatal mortality rate has decreased for both twins and singletons, but for twins is still exceptionally high (137·0 per 1000). Although the biggest difference between twins and singletons was observed in the first month of life, the rate ratio for child mortality implies that after 12 months—and presumably highly selective mortality—twins still experienced a mortality rate twice as high as singletons.

Among both twins and singletons, the share of neonatal mortality in total under-5 mortality increased over the three periods. By 2009–14, neonatal mortality was responsible for 43% (27·5 of 63·5 per 1000) of under-5 mortality among singletons and for 64% (137·0 of 213·0 per 1000) among twins. Our figures show that in the 2009–14 period, as much as 15·1% (95% CI 13·5–16·8) of all neonatal deaths in sub-Saharan Africa were accounted for by twins.

Table 3 shows the distribution by twins and singletons of common demographic, socioeconomic, and medical care factors that are associated with under-5 mortality. Twins and singletons did not differ much in household wealth, maternal education, or marital status of the mother. Due to the large sample size all of the above differences are significant at the 5% level but none of them are substantial in absolute size. This result was also true for the difference in sex of the child and mother’s urban or rural place of residence.

Larger differences were found with birth order and mother’s age at birth (table 3). Twin births were less frequent among first births (6·8% vs 20·9%) and more frequent among high parity births of four or more (66·6% vs 45·4%). They were also less frequent among mothers aged 12–19 years (7·9% vs 18·9%) and more frequent among mothers in their 30s (35·0% vs 25·2%). In multivariate models, parity and maternal age have independent positive associations with twin births (appendix). These results are in agreement with findings from studies in more developed countries.\textsuperscript{11}

Twins were more likely than singletons to have been born in a medical setting (62·5% vs 52·7%) and to have had some medical assistance at birth (51·7% vs 40·4%). These associations might have been to the benefit of twins, but with regard to birth size they were disadvantaged. More than one in three (35·6%) twins was reported to be smaller than average, compared with only one in six singletons (16·8%).

Of the 259,593 observations in the 2009–14 period for which multivariate analyses were done, 33,228 (12·8%) of the case observations had missing information for one or more variables of interest. Missing information on marital status (17·846 [6·9%]) or on child’s size at birth (25·186 [9·7%]) were most common. Results estimated with multiple imputations are similar to those of the complete case analysis (appendix). In the base model, which included only the fixed effects, the twin–singleton rate ratios for under-5 and neonatal mortality were 3·4 (95% CI 3·1–3·7) and 5·0 (4·5–5·7), respectively (table 4). After adjusting for demographic and socioeconomic factors, these rate ratios increased to 3·6 (95% CI 3·3–3·9) and 5·6 (4·9–6·3). Additional controls for medical assistance showed little change in rate ratios, but additional adjustment for birth size reduced the twin–singleton rate ratios back to base level for both under-5 mortality (rate ratio 3·4, 95% CI 3·1–3·7) and neonatal mortality (rate ratio 5·0, 4·4–5·7).

Although table 3 shows that twins were much more likely to have small birth size, this could not explain excess mortality among twins. The twin–singleton rate ratio for under-5 mortality rate ranged from 2·9 (95% CI 2·3–3·7) among very small children to 3·7 (2·8–5·0) among very large ones (appendix). This result is in line with the so-called birthweight paradox, the finding that babies with low birthweight in high-risk populations, such as twins, have lower mortality than babies with low birthweight in more favourable populations.\textsuperscript{12,13} Among
twins of average size or larger, the under-5 mortality rate was still 186·1 per 1000.

### Discussion

This study is the first comprehensive analysis on trends in twin mortality in sub-Saharan Africa. Under-5 mortality has decreased substantially in this region over the past decades. Nevertheless, the UN Inter-agency Group for Child Mortality Estimation has estimated that 2·9 million children in the region died before the age of 5 years in 2015.12 Our analysis indicates that almost 11% (about 315,000) of these deaths occurred among twins. This proportion has risen from 8% in 1995–2001. The differences are even larger for neonatal mortality. In
Before discussing the practical implications of our findings, we should address some data limitations. Our estimates of twin mortality are likely to be lower bound estimates. The main limitation of the DHS for this study is possible under-reporting of twin births and twin deaths. Women who died during or since childbirth cannot be interviewed. Since the probability of maternal mortality is higher with twin births, it is likely that DHS data underestimate the number of twin births and deaths. Moreover, there might be further under-reporting of twin births and twin mortality because only livebirths are registered in the DHS surveys and all twin births in the data consist of two liveborn children. Where one of the twins was stillborn, the surviving co-twin has most likely been registered as a singleton. Because of the higher mortality risk inherent in twins, it is likely that the surviving co-twin faces a higher mortality risk than singletons (as has been reported for Burkina Faso). Sear and colleagues report higher stillbirth rates among twins in Gambia and higher neonatal mortality among liveborn twins. DHS data are based on recall information, which makes them potentially susceptible to recall bias. However, births and deaths of children are among the most salient and emotional life events in women’s lives and therefore recall bias is unlikely to be high. Again, recall bias is more likely to suppress rather than increase estimates of twin mortality.

To reduce twin mortality in sub-Saharan Africa, improvements in health-care services are needed in all three phases of the process: during pregnancy, at delivery, and post partum. First, early detection of twin pregnancies, good antenatal care tailored towards the needs of mothers pregnant with twins, and timely referral for hospital delivery are important preconditions for twin survival and maternal health during and after delivery. However, still too few women pregnant with twins in the region receive appropriate medical care. For example, almost half of the women giving birth to twins in a Nigerian tertiary hospital did not receive antenatal care and of the mothers who delivered twins in a study hospital in Guinea Bissau, as many as 65% were not aware that they were pregnant with twins. A first recommendation therefore is to strengthen antenatal care services and train providers of this care in recognising twin pregnancies. If ultrasound is lacking, most twin cases can be identified by clinical examination. When twin pregnancies are identified, the mothers should receive antenatal care that, given the often resource poor environments they live in, is as much as possible in line with existing guidelines for twin pregnancies.

Second, it is important that delivery should take place in a hospital setting with staff trained in twin deliveries and with facilities for interventions, including caesarean section. Twins are a high-risk group, associated with preterm delivery and complications such as post-partum haemorrhage and increased maternal mortality. Twin deliveries have a substantially increased risk of caesarean section. In our data for the 2009–14 period, the crude under-5 mortality rate for twins was 178.2 per 1000 among deliveries that took place in a medical setting compared with 250.9 per 1000 among deliveries at home. Given that almost half of these twin births took place without assistance of a medically trained person, and that many hospital deliveries in sub-Saharan Africa are last minute or emergency cases, there is still much to gain.

Third, special attention for twin births in sub-Saharan Africa should continue after a safe delivery. Mortality rates of twins remain high after the perinatal period and twins have increased risk of other complications, such as neurodevelopmental disabilities and congenital malformations. Therefore, it would be advisable to monitor these children in their first years of life. Particularly vulnerable are twins born after a short birth interval, from poor families, with an older mother, or when one child of a twin pair has died.

If the care for twins and women pregnant with twins does not improve considerably in the coming years, the absolute numbers of twin deaths will hardly decrease. At the current speed of improved survival among twins, the reduction in the number of deaths will be compensated to a large extent by the growth in the under-5 population in the region, which is expected to increase by about 20% until 2030. To achieve the SDG and Every Newborn targets regarding neonatal and under-5 mortality, more attention will have to be paid to twin pregnancies and twin births. Despite twins’ higher vulnerability, it is possible to achieve high survival and, as the Finnish case shows (Ahokas E, Population Statistics, Statistics Finland, personal communication), a high twin–singleton mortality ratio can co-exist with small absolute mortality differences between twins and singletons. Although it is unrealistic to expect Finnish mortality rates for sub-Saharan Africa anytime soon, the positive message is that improvements in care for twin pregnancies and twin births do not require unusual or new measures or technology. The potential for improvements in the survival of this forgotten group of vulnerable newborns is large and starts with increasing awareness of its plight.

Contributors
CWSM and JS conceived the study, made equal contributions to the study, analysed the data, wrote, and approved the final manuscript.

Declaration of interests
We declare no competing interests.

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2009–14, the rate ratio of twin versus singleton neonatal mortality was 5.0 and the share of twins in total neonatal mortality was 15%.
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