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Postneonatal and child mortality among twins in Southern and Eastern Africa

Aafke Justesen and Anton Kunst

Background Few studies have evaluated the difference in mortality between twins and singleton children during the postneonatal and childhood period in sub-Saharan Africa. The aim of this study was to quantify the excess mortality of twins during the postneonatal and childhood period and to identify factors that contribute to the excess mortality among twins. The different use made of health care services was hypothesized to contribute to the increased mortality.

Methods The Demographic and Health Survey data on Malawi, Tanzania and Zambia were pooled. Logistic regression was used to estimate twin/singleton differences for the combined postneonatal and child mortality and to study the role of intermediate factors and effect modifiers.

Results The study was based on 18 214 singleton children and 706 twins. The twin/singleton odds ratio (OR) of the combined postneonatal and child mortality was 2.33 (95% CI : 1.85–2.93). This excess mortality was largest during the first year of life. Control for intermediate factors (preventive health care and breastfeeding) did not sizeably diminish the mortality difference. Effect modifiers that were associated with increased twin/singleton OR were male sex, unwanted child, short birth interval and low socioeconomic status.

Conclusions The excess mortality of twins compared to singletons is considerable. A difference in use of preventive health care or in breastfeeding cannot explain the increased mortality. Males, unwanted children, those born after a short birth interval and the socioeconomically disadvantaged are at special risk. The generally good attendance at under-5 clinics gives health care providers the opportunity for increased surveillance of these high-risk groups.

Keywords Twins, postneonatal mortality, child mortality, preventive services, sub-Saharan Africa

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Multiple pregnancy and delivery constitute a higher risk for morbidity and mortality for both mother and babies in comparison to singleton births.[1–6] Studies from the industrialized world have shown that the increased mortality continues into the postneonatal period and into childhood.[5,6] There is, however, a paucity of information from sub-Saharan African countries on the outcome of twin children after the neonatal period. Exceptions are the studies brought together by Pison,[7] which were reported before the 1980s and some other small, but more recent studies.[3,8] Pison extracted from studies in West Africa risk ratios of postneonatal mortality of twins versus singletons of between 1.98 and 3.11. For the risk ratio of child mortality he found values between 1.07 and 1.72. The disproportional mortality of twin children justifies further study.

Department of Public Health, Erasmus University, Rotterdam, The Netherlands.

The most important causes of postneonatal and child mortality in developing countries are malnutrition and infections. Common infections contributing to high mortality are acute respiratory infections, diarrhoeal diseases and measles, which are all highly contagious.[9,10] There are several reasons why children from twin births might suffer more from these diseases than singleton children: (1) Breast milk falls short earlier, resulting in early weaning of at least one baby. This increases the risk for malnutrition and infections.[10,11] (2) Close contact between twin babies increases the chance of cross-infections. In addition, twins are born more commonly to mothers of high parity, which induces more cross-infections among siblings. (3) Monetary need is higher in the care of twins. A low budget might affect the care for one or both children, for instance, through insufficient consultations with health providers or a decrease in the quality and quantity of supplementary food. (4) The use of health services is logistically more complicated with twin children and this could influence both curative and preventive health care. (5) The high demand in time and energy made on the mother by two small children, additional to obligations to the already existing family, can influence the care of twins. (6) There are additional risks specific to the twin status. The cultural beliefs attached to twins can influence the care. One of the twin babies could get preferential treatment, i.e. according to their gender or birth order. Such practices are known from West Africa[12] and Asia.[13]

The present study is concerned with twins in eastern and southern Africa. The aim of the study was, first, to quantify the excess mortality of twins during the postneonatal and childhood period and, second, to identify factors that contribute to the increased mortality of twins. Our special interest was in the possible contribution of inadequate use made of health facilities by mothers of twins. In addition we studied whether the mortality difference between twins and singletons varied according to gender, birth order, birth interval, and socioeconomic factors.

Material and Methods

Database

The study was performed on data from the eastern and southern African countries Malawi, Tanzania and Zambia. All three were under British control until they became independent in the early 1960s. These three countries were chosen, first, because of their close position in ranking in the basic health indicator listing[9] and in the human development index[14] and, second, because relevant data were available from the Demographic and Health Survey (DHS), round II. A countrywide random sample of households identified women aged 15–49, who were interviewed using structured questionnaires. For this study information was obtained from the demographic and birth history data, including: date of birth, age at death, gender, birth interval and desirability of all children born to each woman who was interviewed. In addition to these data, information on breastfeeding, under-5 clinic attendance and vaccinations was available for the children born during the 5 years prior to the survey.

The analysis in this study was performed on data from the DHS, round II. The database consisted of all singletons and twins born during the 5 years prior to the survey. Higher order multiple births were excluded. The data from the three countries were pooled. Round II of the DHS, which was conducted in 1991–1992, was used because it contains information on under-5 clinic attendance and vaccination status of all children. This information was not collected for the deceased children in the later round III of the DHS.

Statistical analysis

SPSS 8.0 for Windows was used for logistic regression analysis. The dependent variable was death of a child during the combined postneonatal and childhood period and the main independent variable was twin status. For the logistic regression analysis the dependent variable was dichotomized as present or absent. In the DHS age at death was expressed in completed months. The postneonatal period was defined as 2–11 completed months and childhood as 12–59 completed months. In the remainder of the text the term mortality will be used to mean the combined postneonatal and child mortality unless stated otherwise. The variables subsequently added to the logistic model were divided into three groups: confounders, intermediate factors and effect modifiers. The computations were done including all cases for which the necessary variables were available.

Confounders

The confounders considered in the computations were maternal age, putative age of the child and the number of live-born children. Maternal age indicates the age of the mother in years on the date of birth of the child. The child's putative age is expressed in months. It is a measure of the time interval between its birth and the survey, irrespective of its survival. The number of live births is used as proxy for parity, because the registration of stillbirths in the DHS data is incomplete. The twins are counted as two live births. The index child, or children in the case of twins, is included in the total number of live-born children. Maternal age, putative age of the child and number of live births were all entered as continuous variables into the regression model, together with their squares.

Intermediate factors

We considered preventive health measures, represented by the variables under-5 card availability, vaccination status and breastfeeding, as intermediate factors through which twin status could exercise its influence on mortality. Breastfeeding was defined as being insufficient when a child was breastfed for $\leqslant 6$ months. The use of supplementary food was not included in the definition. The availability of the under-5 card, which is a proxy for under-5 clinic attendance, was defined as present, when the mother indicated that she had obtained a card from the under-5 clinic at the child's age of 2 months. The BCG, DPT, polio and measles vaccinations were defined as adequate if they were given before the age of 2, 8 and 12 months respectively. The four vaccinations were then combined and vaccination was considered as incomplete if one or more vaccinations was inadequate. When the odds ratios (OR) for twin status were adjusted for preventive health measures all three intermediate factors were entered together into the regression model.

Effect modifiers

Effect modification was examined in order to identify twin subgroups at increased risk of death. First the mortality rate for twins and singletons was calculated for the subgroups of the considered effect modifiers, then the effect modifiers were added singly to the logistic regression model to obtain the twin/singleton OR for the different subgroups.

As possible effect modifiers we investigated gender, birth order, unwanted child, short birth interval and some socioeconomic indicators, i.e. place of residence, maternal education and cleanliness of drinking water. A child was defined as unwanted if the mother indicated that the child was unwanted at the time of birth. The birth interval was considered short if the previous child had been born $\leqslant 2$ years prior to the index child. Here children from first pregnancies were excluded. Maternal education was divided into three groups: those with no education, those with incomplete primary education and those who had completed their primary education. Piped drinking water available either inside or outside the house was coded as treated drinking water. Water from wells, boreholes, or brought by tanker truck, and collected rainwater or surface water was coded as untreated.

Results

The Demographic and Health Surveys of Malawi, Tanzania and Zambia cover a total of 18 920 children, of which 706 are twins (Table 1). In the combined data the twin prevalence is 3.7% of all children or 1.9% of deliveries.

Table 2 compares twins and singleton children with respect to a number of preventive health care measures and possible effect modifiers. The two major differences between twins and singletons are, as expected, maternal age and family size. Considerably more twins were born to mothers over the age of 25 years and to those with ⩾5 live births. The other variables did not show distinct differences.

The mortality of twins is higher than that of singletons in all age ranges under the age of 5 years (Table 3). The adjusted twin/singleton OR is 2.33 (95% CI : 1.85–2.93) for the combined postneonatal and childhood period, but the difference between twins and singletons decreases with increasing age. Additional analysis showed that this OR varied from 1.66 (95% CI : 1.07–2.56) in Tanzania to 2.10 (95% CI : 1.39–3.16) in Zambia and 3.47 (95% CI : 2.36–5.10) in Malawi.

In Table 4 the contribution of preventive health care and breastfeeding to the excess mortality of twins is evaluated. The duration of breastfeeding, under-5 clinic attendance and vaccination status were added first separately and then together to the regression model. They have only a marginal effect on the twin/singleton OR. This result was similar in each of the three countries.

Table 5 shows the mortality rate according to the different effect modifiers, while Table 6 shows their effect on the twin/singleton OR. The OR for male children (2.92) is twice as high as for female children (1.88), although the difference is not statistically significant. The OR for the first born twin is 3.16, about three times higher than for the second born (1.62). Adjustment for preventive health measures has no substantial impact on variations in the OR by gender or birth order.

The twin/singleton OR of unwanted children (3.21) shows a non-significant increase in comparison with wanted children (2.03). Preventive health care measures have no influence on this variation in the OR. Children born after a short birth interval show a larger twin/singleton OR than children born after a longer interval. This difference can be explained by adjustment for the preventive health measures.

Place of residence, maternal education and cleanliness of the drinking water can all be considered as factors related to socioeconomic status. All these factors show only a small difference in mortality rate among the singleton children and a

Table 1 Number of children included from each country

	Twins	Singletons	Twins (%)[a]
Malawi	180	4312	4.0
Tanzania	280	7852	3.4
Zambia	246	6050	3.9
Total	706	18 214	3.7

[a] Per cent of total number of live-born children.

Table 2 Selected baseline characteristics of twins and singletons

	Twins	Singletons	Difference
Maternal age ⩾25 years (%)	71.7	53.3	+18.4
No. of live births ⩾5 (%)	64.3	35.4	+28.9
Born <3 years prior to DHS[a] (%)	62.3	63.4	–1.1
Breastfeeding insufficient (%)	1.6	1.6	0.0
Under-5 card not available (%)	4.9	3.8	+1.1
Vaccinations incomplete (%)	21.4	22.1	–0.7
Male (%)	47.0	50.4	–3.4
Child unwanted (%)	33.7	29.4	+4.5
Prior birth interval ⩽2 years (%)	18.2	17.6	+0.6
Rural residence (%)	73.1	73.0	+0.1
No education (%)	34.8	31.7	+3.1
Drinking water untreated (%)	66.3	64.9	+1.4

[a] Demographic and Health Survey.

Table 3 Mortality rate at different ages for twins and singletons

	No. of deaths/1000 live children[b]		OR[a] twin/singleton (95% CI)	
	Twins	Singletons	Crude	Adjusted[c]
Neonatal deaths	180	40	5.23	6.24
(0–1 months)			(4.26–6.43)	(5.02–7.77)
Postneonatal deaths	134	53	2.74	3.05
(2–11 months)			(2.14–3.53)	(2.36–3.95)
Childhood deaths	61	50	1.25	1.29
(12–59 months)			(0.82–1.90)	(0.84–1.94)
Combined postneonatal and childhood deaths	176	91	2.14	2.33
(2–59 months)			(1.71–2.67)	(1.85–2.93)
Under-5 deaths	322	125	3.32	3.73
(0–59 months)			(2.82–3.92)	(3.14–4.42)

[a] Odds ratio.

[b] Children alive at the beginning of each interval.

[c] Adjusted to the confounders maternal age, number of live births and year of birth.

Table 4 The influence of breastfeeding and preventive health care on the difference in postneonatal and child mortality between twin and singleton children

	Odds ratio mortality twin/singleton[a] (95% CI)		
	Postneonatal	Childhood	Combined postneonatal and childhood
None	3.05 (2.36–3.95)	1.29 (0.83–1.98)	2.33 (1.85–2.93)
Breastfeeding	3.12 (2.39–4.09)	1.27 (0.82–1.97)	2.34 (1.85–2.96)
Under-5 card availability	2.96 (2.26–3.87)	1.09 (0.69–1.74)	2.17 (1.71–2.75)
Vaccination status	3.08 (2.37–4.00)	1.35 (0.87–2.07)	2.40 (1.90–3.03)
All	3.02 (2.29–3.99)	1.17 (0.73–1.87)	2.26 (1.77–2.88)

[a] Adjusted for the confounders maternal age, number of live births and year of birth.

Table 5 The combined postneonatal and child mortality among twin and singleton children according to possible effect modifiers

	Twins		Singletons	
	N	No. of deaths/1000 children[a]	N	No. of deaths/1000 children[a]
Gender				
Male	255	216	8484	93
Female	312	144	8444	88
Birth order				
First	275	225		
Second	292	130	16 928	91
Child wanted				
No	194	180	4973	75
Yes	370	168	11 891	95
Prior birth interval ⩽2 years				
Yes	80	288	2952	112
No	469	162	13 976	86
Place of residence				
Rural	414	200	2952	112
Urban	153	111	13 976	86
Education mother				
None	202	223	5375	92
Incomplete primary	134	187	4789	108
Complete primary or more	231	130	6762	78
Drinking water				
Untreated	375	205	10 834	94
Treated	192	120	5916	85

[a] Children alive at 2 months of age.

larger difference among the twins. The twin/singleton OR trebles for the disadvantaged children. Again, preventive health indicators cannot explain this pattern.

Discussion

Our study shows that the mortality is more than twice as high for twins as for singletons in the combined postneonatal and childhood period. This is due to a marked increase in mortality during the postneonatal period, while in the age group 1–5 years the difference in mortality for twins and singletons is small. Inadequate preventive health care and breastfeeding among twins cannot explain this difference in mortality. The excess mortality of twins is marked, especially among male children and in children of families in poor socioeconomic circumstances, although none of these effect modifications were statistically significant.

Table 6 The influence of possible effect modifiers on the difference in combined postneonatal and child mortality between twin and singleton children

	Odds ratio twin/singleton (95% CI)	
	Adjusted for confounders[a]	Adjusted for confounders and intermediates[b]
Gender		
Male	2.92 (2.12–4.02)	2.92 (2.08–4.10)
Female	1.88 (1.34–2.62)	1.75 (1.22–2.51)
Birth order		
First	3.16 (2.36–4.26)	3.03 (2.20–4.17)
Second	1.62 (1.14–2.31)	1.63 (1.13–2.35)
Child wanted		
No	3.21 (2.14–4.81)	3.12 (2.03–4.80)
Yes	2.03 (1.52–2.70)	2.00 (1.48–2.70)
Prior birth interval ⩽2 years		
Yes	3.14 (1.87–5.27)	2.42 (1.34–4.36)
No	2.40 (1.84–3.12)	2.46 (1.87–3.24)
Place of residence		
Rural	2.74 (2.11–3.54)	2.68 (2.04–3.53)
Urban	1.35 (0.80–2.29)	1.23 (0.69–2.20)
Education mother		
None	3.05 (2.13–4.36)	2.75 (1.87–4.06)
Incomplete primary	2.35 (1.48–3.73)	2.67 (1.64–4.35)
Complete primary or more	1.84 (1.22–2.77)	1.79 (1.16–2.75)
Drinking water		
Untreated	2.87 (2.19–3.76)	2.72 (2.08–3.69)
Treated	1.46 (0.93–2.31)	1.36 (0.83–2.24)

[a] Confounders: maternal age, number of live-born children and year of birth.
[b] Intermediates: breastfeeding, under-5 card availability and vaccination status.

There have been few studies on mortality after the neonatal period in developing countries that made a comparison between twins and singletons. Pison[7] reported a number of studies from West Africa and Kenya and Lesotho based on the

World Fertility Survey, using data collected before 1985. The twin/singleton risk ratio for mortality from 1 to 12 months in these studies varied between 1.98 and 3.11, while the risk ratio for the age group 1–5 years ranged from 1.07 to 1.72. Our findings are within these margins (OR of 2.74 and 1.25 respectively, Table 3). Similarly, in a more recent study, Aaby *et al.*[8] reported that the rate of the combined postneonatal and child mortality for twins was about twice the rate for singletons in rural Senegal. McDermott *et al.*[3] found a twin/singleton risk ratio for postperinatal mortality of 1.53 in rural Malawi. In the US the rate ratio for postneonatal mortality for blacks was 2.87.[5] The figures are obtained in different ways, but they are roughly comparable.

Evaluation of potential data problems

All twin pairs in the DHS consist of two live-born children. This implies that twins with one live birth and one stillbirth must have been registered as a singleton birth. If a single live born child of a twin pair has the same probability of dying as other twins, then the twin/singleton OR calculated in this study are an underestimation of the true values. Factors such as chorionicity, congenital anomalies, maternal complications of pregnancy affect both twins and these factors can, therefore, put a single live born twin at a higher risk of death than a singleton. We, therefore, expect an underestimation of the calculated OR. However, this underestimation is probably small.

There is the possibility of underreporting and recall bias in the data of the DHS. Underreporting of fetal loss, but also of live births, is a recognized problem, even in industrialized countries.[15] It is likely that this happens especially in the case of children who die at a young age. The chance that the death of one of twins is not reported, when the co-twin survives, could well be higher than the chance of underreporting in singletons. The effect of such underreporting would be an underestimation of the excess mortality of twins. However, recall is probably a minor problem because the presented data concern the children born in the 5 years prior to the survey and this study is restricted to deaths occurring after the first month of life.

Use of preventive health care and breastfeeding

The hypothesis that preventive health care and breastfeeding are insufficient in the care of twin children and thus contribute to the excess mortality of twins, is not confirmed in this study. As shown in Table 4, adjustment for these factors changes the excess mortality of twins minimally. Table 2 already suggests this result: the under-5 clinic attendance is high and nearly everybody, mothers of twins and singletons alike, breastfeed their children at least for 6 months.

The protective effect of breastfeeding against infectious diseases is well documented.[10,11,16] Exclusive breastfeeding, as opposed to partial breastfeeding, gives extra protection against infectious morbidity and mortality, especially in developing countries where there are inadequacies in health-related provisions and services.[10,17] Exclusive breastfeeding for at least 4–6 months is recommended strongly in developing countries for these reasons. In additional analyses, we therefore substituted (exclusive or partial) breastfeeding for 6 months with a new variable, exclusive breastfeeding for 4 months. Addition of this new variable hardly changed the mortality difference between twins and singletons: the twin/singleton OR of 2.26 reported in Table 4 changed to 2.19 (95% CI : 1.71–2.81).

Under-5 card availability and vaccination status indicate the use made of preventive health services. These services were well attended. Over 95% of mothers had an under-5 clinic card. Moreover, among the 22% of children whose vaccination schedule was incomplete, only 12.2% of singletons and 12.8% of twins were not vaccinated at all. The preventive health services we investigated were provided equally to twins and singletons. However, it is possible that the use made of preventive health services, which can be planned in advance, is better than the use made of curative services, which are needed in emergency situations. Emergencies cause organizational difficulties, especially in households with several small children and a tight budget. Twins could then be at an increased disadvantage. However, the data in the DHS are insufficient to investigate the effect of the use of curative health services on mortality.

Effect modifiers

Table 3 shows that the excess mortality of twins is dependent upon age. This phenomenon has been observed by others.[7,8] The high mortality of twins during the neonatal period is to a large extent due to the high prevalence of preterm birth and low birthweight among twins.[1,2,4] The increased susceptibility for infections and the more serious course of an infectious disease in such vulnerable infants could cause the excess mortality in twins during the early postneonatal period. The importance of this combination of factors diminishes with age. The extent to which preterm birth and low birthweight were responsible for the high mortality of twins in the postneonatal period and later is difficult to say. Data on preterm birth were unreliable, while the birthweight of 48% of singletons and 43% of twins was not available due to the high incidence of home deliveries.

A high mortality among male singletons has been found in many studies.[8,18,19] Our finding that the excess mortality of twins is higher among boys than among girls is surprising. A recall bias in favour of deceased twin boys compared to deceased twin girls can play a role, but a relatively low proportion of males among the live-born twins in the data (47%) makes this explanation unlikely. However, it is probably related to the same unknown factor(s) that cause the higher mortality of males among singletons.

There are reports from Senegal[20] and Bangladesh[21] that girls have a lower mortality from infectious causes after measles vaccination than boys, although the mechanism is uncertain and could lie beyond the immunity for measles alone.[20] This phenomenon could also play a role in our data. An increased infection rate among twins, for instance through a higher rate of cross-infections, could result in a higher mortality among boys based the pattern described above.

Mortality of first-born twins was nearly twice as high as mortality of second-born twins (Table 5). This is contradictory to other publications from developing and industrialized countries.[7,19] The percentage of males among first-born twins (51%) and singletons (50%) is higher than the males among second-born twins (43%), but adjustment for gender did not change the outcome substantially. Confusion between the first and second born twin at the time of the interview could weaken the observed association, but it cannot explain a reversal of the expected association.

Another possible explanation refers to the HIV pandemic. All three countries of the study area have a high prevalence of HIV infection.[22] Vertical transmission of the infection is higher to the first twin than to the second.[23] Most deaths due to HIV infection occur during the first or second year of life.[24] This can explain, at least in part, the observed difference in postneonatal and child mortality between the first and second born twins. HIV infection plays a less important role as primary cause of death in the neonatal period. However, the neonatal mortality of the first twin is also higher than that of the second twin in our data (204 and 156 per 1000 live births respectively, Table 5), which cannot be explained by HIV infection.

Place of residence, cleanliness of drinking water and maternal education are all related to the socioeconomic status. The excess mortality of twins trebles in the socioeconomically disadvantaged groups, although the difference compared with the advantaged groups does not reach statistical significance (Table 6). This pattern is influenced only minimally by a difference in under-5 clinic attendance, vaccination and breastfeeding. Many other factors related to a low socioeconomic status, such as poor nutrition, insufficient maternal care, poor living conditions could affect twins especially. The synergistic effect of poverty and twin status may be related to financial demands, demands on the time and energy of the mother and a higher rate of cross-infections.

Implications

Twin births constitute 3.7% of all children born in this study from three eastern and southern African countries. This is a sizeable group of children, who contribute disproportionately to under-5 deaths. The perinatal period has long been recognized as a period of increased risk for twins. However, the increased mortality risk extends into the postneonatal and childhood period, when the mortality of twins is more than twice the value of the mortality of singletons.

Under-5 clinic attendance, vaccination status and duration of breastfeeding among twins are not different from singletons. On the other hand, twins born after a short birth interval and unwanted twins have a substantially increased mortality risk. Therefore, family planning and child spacing will benefit twins even more than singletons. The almost universal attendance at under-5 clinics gives health personnel an excellent opportunity to monitor twins as a special at risk group.

Because twins born in socioeconomically disadvantaged families have the largest excess mortality, the most impressive impact might be expected from an improvement in the socioeconomic circumstances of the population. However, this change is beyond the influence of the health services.

It is possible that the use of the curative services, which are needed in emergency situations, could be under-utilized by mothers of twins. This possibility needs further exploration.

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