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Perinatal Outcomes of Multiple-Gestation Pregnancies in Kenya, Zambia, Pakistan, India, Guatemala, and Argentina: A Global Network Study

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Abstract

Aim To determine the rates of multiple gestation, stillbirth, and perinatal and neonatal mortality and to determine health care system characteristics related to perinatal mortality of these pregnancies in low- and middle-income countries.

Methods Pregnant women residing within defined geographic boundaries located in six countries were enrolled and followed to 42 days postpartum.

Results Multiple gestations were 0.9% of births. Multiple gestations were more likely to deliver in a health care facility compared with singletons (70 and 66%, respectively,

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- multiples gestation
- twins
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$p < 0.001$), to be attended by skilled health personnel (71 and 67%, $p < 0.001$), and to be delivered by cesarean (18 versus 9%, $p < 0.001$). Multiple-gestation fetuses had a relative risk (RR) for stillbirth of 2.65 (95% confidence interval [CI] 2.06, 3.41) and for perinatal mortality rate (PMR) a RR of 3.98 (95% CI 3.40, 4.65) relative to singletons (both $p < 0.0001$). Neither delivery in a health facility nor the cesarean delivery rate was associated with decreased PMR. Among multiple-gestation deliveries, physician-attended delivery relative to delivery by other health providers was associated with a decreased risk of perinatal mortality.

Conclusions Multiple gestations contribute disproportionately to PMR in low-resource countries. Neither delivery in a health facility nor the cesarean delivery rate is associated with improved PMR.

Multiple gestation, defined as the carriage of more than one fetus in a single pregnancy, is a leading risk factor for poor pregnancy outcome.[1–6] The incidence of multiple-gestation pregnancies has been on the rise in developed countries, with twins accounting for more than 3% of all births.[1,2,7] The incidence of multiple gestation is lower in developing countries, generally 1 to 2% of all births.[8] However, the risk of neonatal death of twins in developing countries is significantly higher than the risk of death for singletons. Several studies have suggested that the risk of perinatal death may be 10-fold for multiple births compared with singleton birth, with increased risk for maternal morbidity and mortality as well.[3,5]

Even with optimal care, including both prenatal and perinatal care, the risk of maternal as well as neonatal morbidity and mortality for multiple gestations is increased compared with singleton births. In many developing countries, antenatal clinic attendance is poor,[6] skilled birth attendants are often unavailable, and nearly half of all births occur in the home or otherwise outside of health facilities.[9] Compared with women carrying a singleton, women with a multiple-gestation pregnancy are at increased risk for conditions including preeclampsia, anemia, gestational diabetes, premature rupture of membranes, and postpartum hemorrhage. Many of these are risk factors that require cesarean delivery to improve outcomes.[10] In the United States, cesarean delivery is performed for more than half of twin pregnancies and is almost always performed for higher-order gestations.[11,12] Even in developed countries, the risk of death for twins and higher multiples is significantly greater than singletons.[5] Nevertheless, significant disparities in maternal and perinatal outcomes associated with multiple births exist between developed and developing countries, with risk of adverse outcome severalfold higher in developing countries compared with developed countries.[13,14]

The increasing rates of ovarian stimulation and assisted reproductive techniques are associated with increased rates of multiple births. Many other factors may contribute to a woman conceiving multiple fetuses, including risk factors such as genetics and advanced maternal age.[9,12–14]

Despite its importance as a risk for adverse pregnancy outcomes, few studies have prospectively evaluated the prevalence and outcome of multiple-gestation pregnancies in the rural community setting of developing countries. We sought to describe multiple-gestation pregnancies in rural settings of resource poor countries in Asia, Africa, and Central America as well as an upper middle-income country in South America. Our specific objectives were to determine the incidence of multiple births, describe relevant health demographic profiles of mothers with multiple-gestation pregnancies, describe the neonatal outcomes of these pregnancies, and compare them to those of singleton pregnancies among the participating countries.

Methods

The Global Network for Women and Children's Health Research Maternal Newborn Health registry study is a prospective multicenter study conducted in Kenya, Zambia Pakistan, Guatemala, Argentina, and India.[9] The registry prospectively collects data on all pregnancies occurring within 106 geographically defined areas, called *study clusters*. The birth registry methods and initial data have been described in detail elsewhere.[9] Briefly, in all study clusters, registry administrators who are study staff enroll pregnant mothers as early as 20 weeks of gestation and follow them through delivery and to 42 days postpartum. Maternal and neonatal outcomes are recorded. At the time of delivery, pregnancies were noted to be singleton or multiple. There were no documented episodes of a multiple gestation with loss of one fetus early in pregnancy with carriage of the remaining fetus to viable delivery.

For the present study, mothers enrolled from January 2010 to December 2010 were included in the final analyses. Adjusted relative risks (RRs) and 95% confidence intervals (CIs) from generalized estimating equation (GEE) extensions of log-binomial regression models adjusting for cluster were reported for twin fetal and neonatal outcomes by gender. Multivariate logistic, proportional odds regression models and mixed regression models with GEE adjusting for cluster were used to determine differences in pregnancy and infant outcomes between multiple- and single-gestation pregnancies. Adjusted RRs and 95% CIs from GEE extensions of a log-

Table 1 Rates of multiple-gestation pregnancies by study site

	Total	Argentina	Guatemala	Kenya	Zambia	Belgaum, India	Nagpur, India	Pakistan
Pregnant women (*n*)	69,706	2,840	5,979	8,953	7,093	20,547	10,006	14,288
Multiple gestation pregnancies, *n* (rate/1,000)	637 (9.1)	21 (7.4)	48 (8.0)	131 (14.6)	65 (9.2)	134 (6.5)	85 (8.5)	153 (10.7)
Twin pregnancies, *n* (rate/1,000)	630 (9.0)	21 (7.4)	48 (8.0)	128 (14.3)	64 (9.0)	133 (6.5)	85 (8.5)	151 (10.6)
Triplet pregnancies, *n* (rate/1,000)	7 (0.1)	0 (0.0)	0 (0.0)	3 (0.3)	1 (0.1)	1 (0.0)	0 (0.0)	2 (0.1)

binomial regression model adjusting for clustering of multiples were reported for perinatal mortality as a function of site and the average cluster rates of physician deliveries, hospital deliveries, and cesarean deliveries. Data were analyzed using SAS software version 9.2 (Cary, NC).

Ethical Considerations

Institutional review board approval was obtained from all involved institutions, including local ethics review boards in each of the countries. Consent was obtained from all participants. Subject identification numbers were used to ensure confidentiality. Subject information and records were kept confidentially.

Results

The total number of pregnant women enrolled was 69,706 (►**Table 1**). The Belgaum (India) site had the highest number of deliveries, and Argentina had the lowest. Multiple births accounted for approximately 1% of all of the pregnancies, with twins contributing 0.9% and triplets 0.01%. The incidence of multiple-gestation pregnancy varied by site; Kenya and Pakistan had the highest rates of multiple-gestation deliveries with rates of 14.6/1,000 and 10.7/1,000 live births, respectively. Kenyan multiple-gestation rates were almost twice that of Argentina. Kenya also reported the highest rate of triplets (0.3/1,000 live births). Zambia, Belgaum, and Pakistan also reported triplets during this study period.

►**Table 2** summarizes the characteristics of the mothers, location and mode of delivery, presence of birth attendant, and maternal outcomes, compared by study site. The mean maternal age was higher among mothers with multiple-gestation pregnancies compared with mothers with singleton pregnancies (26 ± 5 years versus 24 ± 5 years, respectively). Similarly, mothers with multiple-gestation pregnancies had a higher median parity ($p < 0.001$). The mothers with multiple-gestation pregnancies were more likely to have delivered in a health care facility as compared with mothers of singleton pregnancies (70.3% versus 66.2% respectively, $p < 0.001$) and were more likely to be attended by skilled health personnel (70.8% versus 66.6%, $p < 0.001$). Likewise, they were more likely to be delivered by cesarean delivery (18.1% versus 9.5%, $p < 0.001$).

►**Tables 3** and **4** provide the fetal and infant outcomes by singleton versus multiple-gestation status. Compared with singletons, multiple-gestation pregnancies were at significantly higher risk of stillbirth, neonatal mortality, and perinatal mortality (►**Fig. 1**). The mean gestational age, determined by last menstrual period or best obstetric estimate,[9] for those with multiple-gestation pregnancies was 35.8 weeks compared with those with singleton of 38.7 weeks. Birth weight was also significantly lower. Of the twin infants, 287 (47%) were male and 326 (53%) were female. Males were at higher risk for all measures of mortality, although stillbirth was not statistically significant (►**Table 4**). ►**Table 5** shows the gender concordance of twins by site. Overall, 235 (38%) of the twins pairs were gender discordant, and 378 (62%) were gender concordant.

Finally, we developed a model to evaluate the association of several aspects of the health care system with outcomes of multiple gestations. This model predicts the change in relative risk of perinatal mortality as the percent of deliveries accomplished in a facility, attended by a physician, or delivered by cesarean section increases. An increased rate of twin deliveries in health facilities was not associated with a statistically significant decreased risk of perinatal mortality (►**Table 6**). On the other hand, an increased rate of physician-attended deliveries of twins was associated with a slightly decreased perinatal mortality risk (RR 0.9 [CI 0.8, 1.0], $p < 0.05$).

Discussion

Our study is among the first prospective, population-based studies to examine the rates of multiple birth and their outcomes in low-resource settings. We enrolled approximately 70,000 pregnant women, of whom 1% had a multiple-gestation pregnancy. The frequency of multiple births was high in Kenya, but not in Zambia, which is in agreement with previous studies showing large variations in twinning rates with in Africa.[15] As expected, mothers with multiple-gestation pregnancies were older and of higher parity than mothers of singletons.[15] We found significantly higher risks of stillbirth, neonatal death, and perinatal mortality among multiples. As previously described in some studies, we found that mortality was higher among males than among females.[15]

Table 2 Maternal demographic by gestational status

	Multiple gestation	Single gestation	Overall	*p* value
Total deliveries, *n*	637	68,987	69,624	
Status at enrollment, *n* (%)	637	68,930	69,567	
Pregnant	499 (78.3)	57,071 (82.8)	57,570 (82.8)	
Delivered	138 (21.7)	11,859 (17.2)	11,997 (17.2)	
Maternal age, *n*	636	68,793	69,429	
Mean ± SD	26.1 ± 5.4	24.5 ± 5.1	24.5 ± 5.1	<0.0001
< 20	43 (6.8)	8,102 (11.8)	8,145 (11.7)	<0.0001
20–35	552 (86.8)	58,117 (84.5)	58,669 (84.5)	
> 35	41 (6.4)	2,574 (3.7)	2,615 (3.8)	
Parity, *n*	637	68,816	69,453	
Median (P25, P75)	2.0 (0.0, 3.0)	1.0 (0.0, 3.0)	1.0 (0.0, 3.0)	<0.0001
0	160 (25.1)	22,348 (32.5)	22,508 (32.4)	<0.0001
1–4	360 (56.5)	38,913 (56.5)	39,273 (56.5)	
> 4	117 (18.4)	7,555 (11.0)	7,672 (11.0)	
Delivery location, *n* (%)	636	68,921	69,557	<0.0001
Hospital	335 (52.7)	28,114 (40.8)	28,449 (40.9)	
Clinic	112 (17.6)	17,502 (25.4)	17,614 (25.3)	
Home/other	189 (29.7)	23,305 (33.8)	23,494 (33.8)	
Delivery attendant, *n* (%)	637	68,977	69,614	<0.0001
Physician	304 (47.7)	24,288 (35.2)	24,592 (35.3)	
Nurse/nurse midwife/LHW/HW	147 (23.1)	21,659 (31.4)	21,806 (31.3)	
TBA	148 (23.2)	19,313 (28.0)	19,461 (28.0)	
Family	38 (6.0)	3,717 (5.4)	3,755 (5.4)	
Delivery mode, *n* (%)	637	68,972	69,609	<0.0001
Vaginal/vaginal assisted	522 (81.9)	62,429 (90.5)	62,951 (90.4)	
Cesarean section	115 (18.1)	6,543 (9.5)	6,658 (9.6)	
Maternal outcome at 6 wk, *n* (%)	598	67,005	67,603	0.2057
Dead	3 (0.5)	93 (0.1)	96 (0.1)	
Alive	595 (99.5)	66,912 (99.9)	67,507 (99.9)	
Mother hospitalized after last visit, *n* (%)	630	67,901	68,531	0.1438
Yes	5 (0.8)	174 (0.3)	179 (0.3)	
No	625 (99.2)	67,727 (99.7)	68,352 (99.7)	

Abbreviations: HW, health worker; LHW, lady health worker; SD, standard deviation; TBA, traditional birthing attendant.

Many complications occurring in multiple-gestation pregnancies might be prevented with proper utilization of antenatal services, early diagnosis of multiple-gestation pregnancies, and utilization of health services for delivery.[16] However, in low-income countries, many women, especially in rural settings, do not attend antenatal clinic throughout pregnancy.[6,17,18] In these geographic areas, there are also few ultrasound facilities that would facilitate early detection of multifetal pregnancies.

In this study, one-third of mothers delivered at home with the help of unskilled birth attendants. At the time of delivery (the intrapartum period) most of these pregnancies are first diagnosed as multiple gestation. There is an increasing emphasis on discouraging deliveries in the home for all births, especially when delivery is accomplished by unskilled birth attendants.[19,20] The two Indian sites had much higher rates of hospital delivery and skilled attendants than did either of the two African sites (data not shown). Despite this, the perinatal and neonatal mortality rates for twins were higher in the Indian sites than in either Kenya or Zambia (data not shown). These data suggest that merely moving twin deliveries from homes into facilities is unlikely to reduce perinatal mortality

Table 3 Perinatal outcomes for multiple versus singleton gestation

	Multiple gestation	Single gestation	RR (95% CI)[a]	*p* value
Total infants, *n*	1,268	68,988		
Stillbirths, *n* (rate/1,000)	99 (78.1)	2,008 (29.1)	2.65 (2.06, 3.41)	<0.0001
≤ Neonatal mortality ≤ 7 days, *n* (rate/1,000)	150 (130.7)	1,371 (20.7)	6.29 (5.10, 7.75)	<0.0001
Neonatal mortality ≤ 28 days, *n* (rate/1,000)	194 (169.0)	1,719 (26.0)	6.45 (5.38, 7.74)	<0.0001
Perinatal mortality, *n* (rate/1,000)	249 (196.4)	3,379 (49.0)	3.98 (3.40, 4.65)	<0.0001
Gestational age, *n*[b]	1,129	62,830		
Mean ± SD	35.8 ± 5.2	38.7 ± 4.4		<0.0001
Measured birth weight, *n*	1,155	67,139		
Mean ± SD	2,156.4 ± 620.4	2,918.5 ± 540.0		<0.0001

Abbreviations: CI, confidence interval; RR, relative risk; SD, standard deviation.
Note: Stillbirth = infant with no signs of life at birth; early neonatal mortality = live-born infants who died ≤ 7 days of life; neonatal mortality =live-born infants who died ≤ 28 days of life; perinatal mortality = stillbirths plus early neonatal mortality.
[a]Adjusted for site.
[b]Determined by last menstrual period.

Table 4 Twin fetal and neonatal outcomes by gender

	Gender		
Outcome	**Male**	**Female**	**RR (95% CI)[a]**
Stillbirths, *n* (rate/1,000)	51 (79.7)	41 (67.9)	1.17 (0.74, 1.86)
Neonatal mortality < 7 days, *n* (rate/1,000)	89 (152.4)	59 (107.9)	1.40 (1.06, 1.84)
Neonatal mortality < 28 days, *n* (rate/1,000)	112 (191.8)	79 (144.4)	1.33 (1.02, 1.72)
Perinatal mortality < 7 days, *n* (rate/1,000)	140 (218.8)	100 (165.6)	1.32 (1.04, 1.67)

Abbreviations: CI, confidence interval; RR, relative risk.
[a]Adjusted for site.

sufficiently to help reach the Millennium Development Goal 4 of reducing childhood mortality. Rather, increased attention, resources, and training may need to be focused on the obstetric and neonatal care provided within health facilities if we are to achieve these goals. This is clearly a hypothesis that needs further, well-controlled study.

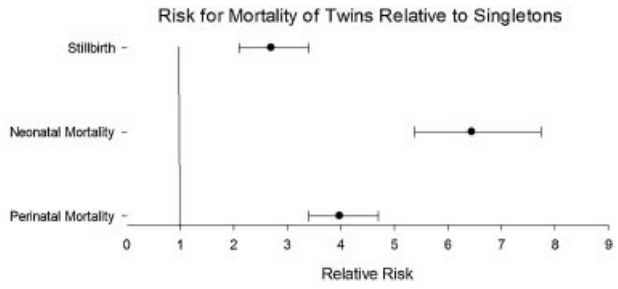

Fig. 1 Odds ratio for mortality of twins relative to singletons. Odds ratios were estimated by generalized estimating equation binomial models adjusting for multiple gestation and site.

Multiple-gestation pregnancies are an important risk factor for neonatal mortality in low-income countries. Identification of multiple fetuses early in pregnancy to enhance planning for delivery and postnatal care may be important to reduce neonatal mortality.

Table 5 Concordance of twin gender by sites[a]

GN site	Gender concordant	Gender discordant	Total
Argentina	15 (71.4)	6 (28.6)	21
Guatemala	24 (66.7)	12 (33.3)	36
Kenya	66 (53.2)	58 (46.8)	124
Zambia	36 (56.3)	28 (43.8)	64
India (Belgaum)	83 (62.4)	50 (37.6)	133
India (Nagpur)	55 (64.7)	30 (35.3)	85
Pakistan	99 (66.0)	51 (34.0)	150
Overall total	378 (61.7)	235 (38.3)	613

Abbreviations: GN, global network.
[a]Data are provided as number of twin dyads (%).

Table 6 Reduction of RR in perinatal mortality for delivery characteristics[a]

Explanatory variables	*p* value (Wald)	Relative risk for a 10% increase RR (CL)
Study site	0.07	–
% physician deliveries	0.04	0.9 (0.8, 1.0)
% hospital deliveries	0.7	1.0 (0.9, 1.1)
% cesarean section deliveries	0.4	1.1 (0.8, 1.6)

Abbreviations: CL, confidence limit; RR, relative risk.
[a]For each 10% increase in the rate of the explanatory variable, the third column indicates the RR associated with the change.

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References

1 Public Health Agency of Canada. Canadian Perinatal Health Report, 2008 Edition. Minister of Health, Government of Canada, Ottawa, Ontario, Canada 2008
2 US Department of Commerce. United States Census Bureau: Statistical Abstract of the United States. The National Data Book: The 2007 Statistical Abstract. 2007:1–60
3 Doyle P. The outcome of multiple pregnancy. Hum Reprod 1996;11 (Suppl 4):110–117, discussion 118–120
4 Mathews TJ, Miniño AM, Osterman MJ, Strobino DM, Guyer B. Annual summary of vital statistics: 2008. Pediatrics 2011;127: 146–157
5 Powers WF, Kiely JL. The risks confronting twins: a national perspective. Am J Obstet Gynecol 1994;170:456–461
6 van Eijk AM, Bles HM, Odhiambo F, et al. Use of antenatal services and delivery care among women in rural western Kenya: a community based survey. Reprod Health 2006;3:2
7 Mathews TJ, Miniño AM, Osterman MJK, Strobino DM, Guyer B. Annual summary of vital statistics: 2008. Pediatrics 2011;127: 146–157

8 Lee HC, Gould JB, Boscardin WJ, El-Sayed YY, Blumenfeld YJ. Trends in cesarean delivery for twin births in the United States: 1995–2008. Obstet Gynecol 2011;118:1095–1101
9 Belizán JM, McClure EM, Goudar SS, et al. Neonatal death in low- to middle-income countries: a global network study. Am J Perinatol 2012;29:649–656
10 Kogan MD, Alexander GR, Kotelchuck M, et al. Trends in twin birth outcomes and prenatal care utilization in the United States, 1981–1997. JAMA 2000;284:335–341
11 Vintzileos AM, Ananth CV, Kontopoulos E, Smulian JC. Mode of delivery and risk of stillbirth and infant mortality in triplet gestations: United States, 1995 through 1998. Am J Obstet Gynecol 2005;192:464–469
12 Suri K, Bhandari V, Lerer T, Rosenkrantz TS, Hussain N. Morbidity and mortality of preterm twins and higher-order multiple births. J Perinatol 2001;21:293–299
13 Mathews TJ, MacDorman MF. Infant mortality statistics from the 2004 period linked birth/infant death data set. National vital statistics reports: from the Centers for Disease Control and Prevention, National Center for Health Statistics. National Vital Statistics System. 2007;55:1–32
14 Habib NA, Dalveit AK, Mlay J, et al. Birthweight and perinatal mortality among singletons and twins in north-eastern Tanzania. Scand J Public Health 2008;36:761–768
15 MacGillivray I, Campbell DM, Thompson B. Twinning and Twins. Wiley, New York, NY 1988
16 Chamberlain G. ABC of antenatal care. Multiple pregnancy. BMJ 1991;303:111–115
17 Ornella Lincetto SM-A, Gomez P, Munjanja S. Antenatal care. In: Lawn J, Kerber K, eds. Opportunities for Africa's Newborns: Practical Data, Policy and Programmatic Support for Newborn Care in Africa. Capetown, South Africa: WHO; 2006:51–62
18 Mwaniki PK, Kabiru EW, Mbugua GG. Utilisation of antenatal and maternity services by mothers seeking child welfare services in Mbeere District, Eastern Province, Kenya. East Afr Med J 2002;79: 184–187
19 Stanton C. Steps towards achieving skilled attendance at birth. Bull World Health Organ 2008;86:242–242A
20 World Health Organization, National Child Health Resource Centre (NCHRC). Department of Reproductive Health and Research. Making pregnancy safer: the critical role of the skilled attendant. A joint statement by WHO, ICM and FIGO. World Health Organization. Geneva, Switzerland 2004