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SEASONAL VARIATION IN DIRECT OBSTETRIC MORTALITY IN RURAL SENEGAL: ROLE OF MALARIA?

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Abstract. We explore a possible link between malaria and maternal death in a rural area of Senegal by assessing the seasonal pattern of maternal mortality by cause and examining whether this pattern coincides with the malaria season. Overall mortality in women 15–49 years of age did not differ by season, while maternal and direct obstetric deaths were significantly more frequent during the rainy/malaria season than during the rest of the year, even after adjusting for place of delivery.

INTRODUCTION

Malaria in pregnancy is associated with maternal anemia, stillbirth, intra-uterine growth retardation, and low birth weight. Whether malaria is a cause of maternal death is less certain. In this study, we explore a possible link between malaria and maternal death in a rural area of Senegal by assessing the seasonal pattern of maternal mortality by cause and examining whether this pattern coincides with the malaria season.

METHODS

The rural study area of Niakhar, Senegal has been under demographic surveillance since 1983. It has a population of approximately 30,000 and is located in the region of Fatick, 135 km southeast of Dakar.[1] The rainy season begins in June, reaches a peak in August, and end by October. In this area, malaria is endemic with a low and stable transmission (9–12 infected mosquito bites per person-year, mainly between August and October).[2] Deaths due to malaria tend to peak in September and October, but malaria is an uncommon cause of death in adults.[3] The population subsists mainly on agriculture and cattle raising, is largely illiterate, fertility is high, and access to obstetric care is poor. Three health centers provide antenatal and delivery services, and the hospital at Kaolack, 70 km away, provides surgical procedures.

To ascertain the number and causes of maternal deaths, the relatives of all women 15–49 years of age who died between 1984 and 1997 were interviewed about the circumstances of these deaths by a physician in 1996 and 1997. Two obstetricians independently assigned the causes of death, and another physician was consulted in case of disagreement. Deaths were defined as maternal if they occurred during pregnancy or within 42 days of its termination, and excluded deaths from injuries. Maternal deaths were classified as direct or indirect and the most likely cause of direct obstetric deaths was assigned. We report female death rates per 100,000 women-years and the maternal mortality ratio per 100,000 live births by cause in July–August, September–October, and November–June.

We also conducted a nested case-control study using all 57 maternal deaths from direct obstetric causes between 1984 and 1995 as cases. We matched them by year of birth or death to three controls that were randomly chosen from the demographic database. Controls were women who were still alive one year after delivery. Relatives of cases and controls were interviewed about demographic factors and health care use for birth. The relative odds of dying during the rainy season was examined using logistic regression

RESULTS

Overall female and maternal mortality were higher in September–October than in July–August, but these differences were not statistically significant (Table 1). We therefore pooled the months of July–October, which represented the rainy season, and compared these to the dry season (November–June). Overall female mortality did not differ by season. However, the proportion of maternal deaths among all deaths was significantly higher during the rainy season (36% versus 23%; $P = 0.01$). The highest proportion was observed in September (43%). Maternal mortality from all causes and from direct obstetric causes was 1.6-fold and 1.9-fold higher during the rainy season, and the difference was three-fold and four-fold for deaths due to eclampsia and dystocia, respectively (one-sided $P = 0.03$ and 0.04, respectively). No deaths could be directly attributed to malaria. There was no significant difference in the age and parity distributions of the deceased women between the two seasons. Birth in health facilities was uncommon, but in the rainy season fewer births took place in any health facility ($P < 0.01$) or a hospital ($P = 0.04$). After adjustments for age, parity, antenatal follow-up, and place of delivery in the logistic regression analysis using the case-control data, the rainy season was still associated with death from direct obstetric causes (adjusted odds ratio = 3.0, 95% confidence interval = 1.4–6.6).

DISCUSSION

There are many reasons why direct obstetric mortality may be higher in the rainy season. These include late referral to life-saving obstetric care when roads are impracticable, hard physical work and poor nutritional status during the months of intense farming, misclassification of causes of death, and malaria. The persistence of seasonal patterns after adjusting for place of delivery suggests that differential access to care is unlikely to explain the findings, although late arrival at the health facility may partly account for the excess dystocia deaths. However, in a hospital-based study in Dakar, the higher risk of maternal death during the rainy season persisted even after adjusting for later referral.[4] Nutritional deprivation in women is substantial between September and November, but nutritional deficiencies have not been un-

TABLE 1
Female mortality rate, maternal mortality ratio, and use of obstetric services by season in Niakhar, Senegal, 1984–1997

	Months				Ratio July–October/November–June [95% confidence interval]
	July–August	September–October	July–October	November–June	
Deaths in women 15–49 years old per 100,000 women-years (number of deaths)					
	403 (49)	542 (66)	473 (115)	415 (202)	1.1 [0.9–1.4]
Maternal deaths per 100,000 live births (number of deaths)					
All causes of maternal death	578 (15)	765 (26)	684 (41)	426 (46)	1.6 [1.0–2.5]*
Direct obstetric deaths	462 (12)	559 (19)	517 (31)	259 (28)	1.9 [1.1–3.4]†
Hemorrhage	154 (4)	206 (7)	184 (11)	120 (13)	1.5 [0.6–3.7]
Eclampsia	116 (3)	118 (4)	117 (7)	37 (4)	3.1 [0.8–14.7]‡
Dystocia	39 (1)	147 (5)	100 (6)	28 (3)	3.6 [0.8–22.3]‡
Other direct causes	154 (4)	88 (3)	117 (7)	74 (8)	1.6 [0.5–4.9]
Other causes	116 (3)	206 (7)	167 (10)	167 (18)	1.0 [0.4–2.3]
Percent in births in					
Health facility	12.0	13.2	12.0	13.5	0.9†
Hospital	1.8	2.0	1.6	2.1	0.8‡

* $P < 0.05$.
† $P < 0.01$.
‡ One-sided $P < 0.05$.

equivocally linked to the incidence or severity of obstetric complications. Deaths may also have been misclassified. The convulsions and coma preceding death from cerebral malaria may have been erroneously attributed to eclampsia, or the verbal autopsy may have failed to correctly classify deaths due to anemia. However, diagnostic specificity is unlikely to vary by period, and the relative risks should not have been affected.

The coinciding peaks of malaria and maternal or direct obstetric mortality are unlikely to be due to chance. Recently, in The Gambia, pregnant women attracted twice the number of *Anopheles gambiae* complex mosquitoes than non-pregnant women.[5] Sequestration of malaria parasites in the placenta may contribute to hypertensive diseases of pregnancy by reducing placental perfusion and oxidative stress, and exacerbating the placental changes associated with pre-eclampsia.[6] A hospital study in Dakar also suggested a causal link between malaria and hypertensive diseases of pregnancy; pre-eclampsia was more common in the rainy season, and women presenting with a malaria-infected placenta had a three-fold increase in the risk of pre-eclampsia compared with women whose placenta was not infected.[7] However, severe anemia during the rainy season due to nutritional deficiencies but also malaria could contribute to direct maternal mortality by complicating an obstetrical condition. A meta-analysis estimated that 6.4% of both direct and indirect maternal deaths in Africa could be related to anemia, irrespective of its origin,[8] and a review of published studies in stable malaria transmission settings in sub-Saharan Africa showed that the median prevalence of severe anemia among pregnant women reached 8%.[9] Our results are also consistent with the hypothesis that maternal malaria-associated mortality is believed to be a particular problem in areas of low malaria transmission.

Given the high level of maternal mortality and resurgence of malaria in west Africa, the possible causal pathway linking malaria, hypertensive diseases of pregnancy, and maternal deaths warrants further scrutiny.

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