Adolescents' use of health care services and risk for maternal morbidity in West Africa: the MOMA study

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Abstract

Young age is a risk factor for poor maternal and infant outcomes, thus a direct relationship between adolescents and poor maternal outcomes is often presumed. This study tests two related hypotheses: that pregnant adolescents are less likely to seek care compared with older pregnant women, and that poor outcomes are more likely due to a lack of appropriate delivery care. This study uses data from the prospective population-based MOMA study conducted in six West African countries. Bivariate and multivariate models analyze the relationship between independent variables and two dependent variables, delivery with trained attendant and severe maternal morbidity. Age is negatively associated with the probability of delivery with a trained attendant after controlling for background, reproductive health, and previous care use factors. However, controlling for background, clinical, and delivery care factors reveals that maternal age is not directly associated with morbidity. Since correct and timely treatment of obstetric complications is the best method to prevent or minimize pregnancy complications, these results suggest that better access to reproductive health care for adolescents will improve pregnancy outcomes.

Introduction

The World Health Organization (WHO) considers pregnancy during adolescence be to a time of high risk for poor maternal and infant outcomes (WHO, 1996a). Although teenagers suffer more complications of pregnancy (Hobcroft et al., 1985; Hoffman, 1998; Senderowitz, 1995), there is evidence that maternal age may indirectly influence these outcomes. Rather, the social context in which childbearing occurs, such as a lack of access to care and social support, may have a large effect in moderating the relationship between age and pregnancy outcome (Makinson, 1985; Zabin and Kiragu, 1998). Since adolescence is a concept that is socially rather than biologically constructed, adolescents' increased risk of poor childbearing outcomes is more likely to be modified by social factors than as a direct result of immature physiology. We need a better understanding of how maternal age may operate directly and indirectly to influence pregnancy outcomes to inform policy and programs.

Demographic and Health Surveys suggest that childbearing before age 20 in Sub-Saharan African countries is common. Between 27% and 75% of women aged 20 to 24 reported a birth before age 20

(Singh, 1998). Most childbearing that occurs before the age of 20 does so within the context of marriage, especially in African countries where Islam predominates as the religious philosophy. Of women in countries such as Burkina Faso (1992-93 DHS), Mali (1987 DHS), or Niger (1992 DHS), where there is a significant Muslim influence, 6% to 11% had a first birth that occurred before marriage compared to other West African nations such as Cameroon, Ghana or Senegal where 20 to 23% of births occurred outside marriage. Although married marital status is generally protective of pregnancy outcomes independent of maternal age, in many African cultures premarital childbearing may be a healthy strategy in terms of gaining financial resources from the father, a first step in the marital process, or in terms of gaining respect within the community for demonstrated fertility (Bah et al., 1991). Increasing attention is being paid to the fact that marriage in some contexts may not be a clearly defined event and actions such as childbearing may be one step in sealing the union between mother and father. Early marriage or proof of fertility at young ages may be acceptable and even desirable (Bledsoe and Cohen, 1993). In general, it has been observed that the percentage of women who have a child outside of marriage increasing because the age at marriage is increasing (Meekers, 1994).

The study of adolescent pregnancy outcomes in developing countries is limited by the paucity of data other than hospital-based studies or descriptive studies that fail to appropriately control for confounding. Hospital-based data especially in developing countries is limited in its representativeness because most deliveries occur outside the facility. Nonetheless, the trend in the literature of developing countries is for poorer infant and maternal outcomes among younger adolescents. One longitudinal study conducted in Bamako, Mali and Bobo-Dioulasso, Burkina Faso found that after controlling for certain background and reproductive status variables, women under 18 were significantly more likely to deliver low birth weight infants and to experience infant mortality (LeGrand and Mbacké, 1993). However, the loss of participants on follow-up was a major limitation of this study.

Fewer studies, even those hospital-based, have looked at maternal outcomes among adolescents. One longitudinal study conducted in Bangladesh where study participants were identified within randomly selected geographical areas found that toxemia during pregnancy was more common among

women 13 to 17 than women aged 18 to 23 (Rahman et al., 1989). Further, maternal mortality was three times higher for the younger women, although the causes of death were different. However, in this study no multivariate analyses to control for confounding factors were presented. A meta analysis of studies that included a control or comparison group when looking at adolescent pregnancy outcomes in developing countries found modest non-significant evidence for an increased risk of pregnancy induced hypertension among women under 16 (Scholl, et al., 1994). This study also found a significant association between young maternal age and anemia and cesarean section. No known studies have analyzed adolescents' risk for maternal morbidity based on a more comprehensive definition.

Whether early childbearing is really a "problem" in the African context either in terms of social acceptability or immature physiology is unclear, although poor outcomes are likely the result of an interaction between the two (Zabin and Kiragu, 1998). In many contexts where large family sizes and early marriage or early childbearing is the norm and young women and men assume adult roles at relatively young ages social factors may have less of a effect on pregnancy outcomes. In these societies, especially in the more rural areas, the concept of adolescence may exist only for a short period of time because the onset of puberty marks the termination of childhood and may signal readiness for marriage or a transition into the adult work world (Caldwell et al., 1998; Crockett, 1995).

The move toward more industrialized economies in developing countries is creating a more distinct period of adolescence, increasing secondary education attendance and employment seeking, and extending the amount of time teenagers are dependent on their parents, especially in the urban areas. The existence of secondary education in a society has been suggested as the strongest indicator of a period of adolescence or at least serving as the core of adolescence (Fasick, 1994). Education promotes age-specific peer groups, and urban settings encourage interaction among adolescents. Boy-girl friendships and sexual relationships by the mid-teens are also associated with this period. The urban setting also provides a market for products of teenage culture and organizations oriented toward youths. It is feared that the loss of cultural traditions occurring simultaneously with industrialization and the importation of western culture may be to the detriment of adolescent behavior since the usual life lessons are imparted

during this time (Bah et al., 1991). As there is an increasing perception of adolescent pregnancy, especially for unmarried adolescents, as a problem coinciding with this phenomenon, social factors may have a larger influence on poor adolescent pregnancy outcomes. More research is needed to understand how social factors may intervene to result in increased risk of poor pregnancy outcomes among adolescents.

For lack of better indicators, most studies have relied on chronologic age to represent the period of adolescence. Gynecologic age has been proposed as a better indicator of biologic immaturity (Scholl, 2000), but collecting data on age at menarche has its own methodological challenges and is often excluded from questionnaires. The use of chronologic age to represent adolescence is also influenced by measurement error associated with lack of birth date knowledge, especially in developing countries. Maternal age is regularly represented in data analysis using a set of binary variables commonly separated into 5-year age groups, e.g., 15-19, 20-24, 25-29, 30-35, etc., to deal with measurement error associated with lack of birth date knowledge (Shryock et al., 1976). This method requires that the results of the categories in the regression be interpreted with respect to a reference category (Greene, 1997). Alternatively, one group of teenagers may be compared to a group of women in their 20s. When this method is employed there has been little effort to match the two groups of women on other characteristics. The use dummy variables or age groups neglect the continuity of the underlying continuous distribution of age. In studying adolescent outcomes it may be important to differentiate from year to year since adolescence is a period of rapid transitions, growth, and experiences. It may not be realistic in terms of interpreting the results to consider a 15 year-old similar to a 19 year-old.

The paper of childbearing outcomes during adolescence in developing countries is further complicated by a lack of clarity regarding the population of interest. The existing literature reveals a lack of consensus on the appropriate age range in which to study outcomes. In the literature, the age cut-off ranges anywhere from 14 to 19 years of age (see, for example, Lankoande et al., 1999; Lao and Ho, 1997; LeGrand and Mbacké, 1993; Letamo and Majelantle, 2001; Mahomed et al., 1989; Ncayiyana and Ter Haar, 1989; WHO, 1996a).

This study attempts to deal with several limitations found in previous studies. The data are from a multi-center, prospective, population-based study conducted in seven West African urban areas that experienced low loss to follow-up. Further, there are various background, reproductive health factors, access to health factors, and clinical factors available from this study, and a comprehensive definition of maternal morbidity was created. Understanding the prevalence, incidence, and determinants of maternal morbidity allows researchers, program planners, and policy makers to prioritize problems, understand their causes, and plan and evaluate programs. Although maternal age is used to represent adolescence and measurement problems remain, maternal age was allowed to take different forms in the analysis to identify the best fit for the data.

The first objective of this paper is to study whether pregnant adolescents are less likely to use reproductive health care. Since delivery with a trained attendant is one aspect crucial to improving maternal health (UN, 1996), this study will test the hypothesis that adolescents are less likely to delivery with trained attendants even after considering variables that moderate the association such as socio-economic and previous health care use factors. Previous studies conducted in similar populations suggest that adolescents 17 and younger are less likely to seek any prenatal care or timely PNC (LeGrand and Mbacké, 1993). If adolescents are less likely to seek care with trained practitioners, this may increase their risk of poor outcomes.

The second objective of this study is to test the hypothesis that age has an indirect effect, rather than a direct effect on maternal outcomes, specifically maternal morbidity and mortality. Maternal health is of interest in this study because of the paucity of studies focusing on maternal outcomes outside of maternal mortality. Furthermore, the study of morbidity is important from the concept of the life-cycle and how severe pregnancy complications among young women will have longer and perhaps more serious consequences over their life span. Patterns of behavior that are formed and physical insults that occur during these years will influence overall health and longevity (Ozcebe, 1995). Analyses will test whether maternal age indirectly influences maternal health by operating through more proximate determinants of health, such as access to care.

Methods

Study population

The MOMA study (MOrbidité MAternelle en Afrique) was conducted from December 1994 to June 1996 in six urban areas: Ouagadougou, Burkina-Faso; Abidjan, Cote d'Ivoire; Bamako, Mali; Nouackchott, Mauritania; Niamey, Niger; and Saint-Louis and one semi-urban town, Kaolack, Senegal (see Bouvier-Colle et al., 1997 for detailed study methodology). At least two study zones with in each city were selected to represent the diverse socio-economic circumstances found each city. Each zone was chosen according to contrasting social criteria (an area of newer, less stable dwellings and an area of older, more permanent ones) to obtain a heterogeneous sample of the city's residents, the presence of health centers, and the permission of local officials. Although there was at least access to a health center, each zone differed substantially on their access to higher-level health facilities.

Survey methodology

The number of births for the area and time period was estimated to achieve the appropriate sample size. Interviewers conducted a door-to-door census of all pregnant women in each study zone and passed each household at intervals of one to two months to identify new pregnancies until the desired sample size was reached.

All pregnant women declaring their pregnancy up until the 36^{th} week of amenorrhea and residing in the study area were identified at the population and household level, asked to participate during a one year period of time, and administered a questionnaire on their socio-demographic characteristics. Subsequent interviews took place between 32 and 36 weeks of amenorrhea, at the time of delivery, and 60 days postpartum.

- At first contact, women were interviewed on their socio-demographic information, obstetric history, previous contraceptive use, and anticipated use of health services during the current pregnancy.

- At the second contact, which could be the same time as the first interview if the woman was identified between 32 and 36 weeks of amenorrhea, a basic physical examination was performed for each woman at home and information was obtained on the pregnancy by interview. In the case where the woman reported any illnesses resulting in a hospitalization or consultation, prescriptions and the woman's pregnancy notebook (if available) were consulted to substantiate her reports.
- The third contact occurred at delivery and focused on delivery complications. Questionnaires were completed by the delivery attendant and verified upon interview with the attendant and the woman. In the case of home delivery (18.5% of participants), the interview was conducted with the woman within a few days of her delivery and included her relatives and birth attendant if there was one.
- The fourth contact was a home visit at 60 days postpartum. Information was collected on any postpartum hospitalizations or consultations, a basic physical exam occurred, and family planning intentions were ascertained. If a consultation occurred during the postpartum period, women's reports of problems were checked against any prescriptions, written instructions, or information in the woman's personal pregnancy notebook (if available). In the case of a postpartum hospitalization, women's reports were verified with hospital staff during a visit to the facility if judged necessary following a discussion by the local coordinating team. At this visit a physical examination was performed and if any problem was reported by the woman a gynecological examination occurred.

In the case that the study participant did not continue because of abortion, premature delivery and date, change of address, travel, or death, the interviewer noted the reasons in the questionnaire. When a death occurred, a specific study was conducted lead by the supervisor and the coordinator of the interviewers.

Conceptual model

This paper uses a conceptual framework to show the distance and relationship between background factors, proximate factors, clinical factors, and maternal morbidity and mortality. It is based on one influential work by McCarthy and Maine (1992), but has been modified to place greater emphasis

on those factors directly or causally related to maternal morbidity (Figure 1). McCarthy and Maine (1992) employ approaches to analyzing the determinants of pregnancy, maternal morbidity, and mortality with roots in the work of Mosley and Chen (1984) and Davis and Blake (1956). The premise of their framework is that the 'distant determinants' of socioeconomic factors must operate through biological/health status and other 'proximate determinants' such as health behaviors and access to health care factors to influence morbidity and mortality outcomes.

The conceptual framework in Figure 1 aids in selection of appropriate independent variables for this study that are available in the MOMA data, and it also helps to elucidate the direct and indirect nature of the independent variables on the dependent variables of interest, delivery with a trained attendant and maternal morbidity. Located at the top of the model are the background factors associated with maternal morbidity and include influential women's, family, and community factors. The proximate factors are situated closer to the outcomes of interest and include reproductive status, access to health services, health care use and behavior factors, nutritional status and obstetric factors. McCarthy and Maine's (1992) contribution of "unknown and unpredicted factors" reminds us that some women develop pregnancy complications for no apparent reason. Finally, although the framework proposed in Figure 1 takes into account the distant and proximate determinants as described by McCarthy and Maine (1992), a third tier, "clinical factors", has been added at the bottom of the figure to highlight the important factors during pregnancy that may cause pregnancy complications.

The circle in the bottom right part of figure 1 represents detection of complications and appropriate and timely receipt of treatment. In developing countries, medical management and, more specifically, timely and appropriate care may have wider implications for discriminating between morbidity and the degree of severity than in developed countries where most women receive timely, appropriate care (Fortney and Smith, 1999). For this study, it is important to consider the role that timely and appropriate treatment—or lack thereof—plays in defining cases of maternal morbidity.

Good measures of the clinical or proximate factors should highlight the indirect relationship of some proximate and background factors with the dependent variables of interest during multivariate

analysis. Since adolescence is a social concept, it is hypothesized that maternal age will have direct relationship on use of health care, but an indirect relationship with maternal morbidity and mortality. A better understanding of the factors that directly contribute to poorer adolescent outcomes will help identify more precise areas for intervention.

Study constructs and data analysis

The conceptual framework in Figure 1 identifies the specific variables from the MOMA study that represent the larger concepts. The position of the variables in the framwork suggest a direct or indirect relationship with maternal morbidity and mortality (i.e., proximate determinants and clinical factors are more directly related to morbidity and background and relevant proximate determinants are related to trained attendant). Bivariate analyses between independent variables and the two dependent variables were conducted.

To detect a trend in adolescents' use of health care services, bivariate associations between maternal age and those health care use variables available in the MOMA data (family planning use, PNC attendance, type of PNC attendant, PNC treatments, referral for delivery, delivery with a trained attendant, and place of delivery) were explored. Family planning use refers to use prior to the current pregnancy and is categorized into modern (sterilization, pill, implant or injectable), natural (abstinence, traditional methods, natural methods, breastfeeding, or other) and no use. PNC attendance is categorized into entry after the 4th month of pregnancy, entry prior to the 4th month, and no PNC. Timely entry into PNC is based on recommendations by WHO (1996b). PNC treatments are considered as receipt of at least iron or chloroquine during pregnancy. Iron and chloroquine are standard PNC treatments in West Africa, thus any women attending PNC should have received them as a preventive measure. Referral for delivers refers to any woman who was asked during a consultation or hospitalization to deliver in an equipped facility, i.e., maternity or hospital.

Prenatal care provider was considered an important predictor of type of delivery attendant because it is assumed that women who have PNC with a trained attendant will be more likely to deliver with a trained attendant. The type of PNC provider for analyses was created as a two-level dummy

variable. Women who had at least one visit with a nurse, midwife or doctor (n=18,676) were in one group. Women who had a visit with a TBA or "other" or had no PNC visits were coded together in the other group. There were 106 women who reported a PNC visit but for whom the type of provider was missing. These women were coded in the latter group, no PNC or TBA or "other" provider. Two other type of data inconsistencies are noted: There were 12 women who reported no PNC visits yet reported a PNC provider as midwife or doctor, and there were 37 women where the number of PNC visits were missing yet they had named a PNC provider. In both cases, the type of provider served as the indication for coding over number of visits.

The functional form of the main independent variable of interest, maternal age, was allowed to take different forms for each multivariate regression according the distribution of age and the dependent variable of interest. The use of linear splines for the age variable was explored. Splines make the function continuous, but allows the slope of the function to vary by meaningful changes in age and allows researchers to estimate the relationship between the independent and dependent variables as a piecewise linear function (StataCorp, 1999). This method is more flexible than using age as a continuous variable because it allows for the slope of the variable to vary, but knots can still be placed to account for measurement error associated with age heaping.

The dependent variable of interest for the first multivariate analysis, delivery with a trained attendant, was also defined as a dichotomous (yes/no) variable. Women who delivered alone or with family or a traditional birth attendant were considered as having delivered with an untrained birth attendant. Women delivering with a nurse, trained auxiliary attendant, midwife, or doctor were considered as having delivered with a trained attendant.

The second dependent variable of interest, severe maternal morbidity, was an indicator constructed by the MOMA group and defined as:

- *Obstructed Labor* – mechanical or dynamic dystocia resulting in a cesarean section, instrumental delivery, other complications of prolonged labor including uterine rupture, hysterectomy, compression syndrome, or vesico-vaginal fistula, or death.

- *Hemorrhage* – prepartum, peripartum or postpartum hemorrhage leading to blood transfusion or a hospitalization of more than four days, or to a cesarean section, facility transfer, hysterectomy, or death.
- *Hypertension* – eclampsia, clinically diagnosed pre-eclampsia and hypertension (diastolic >89mmHg) leading to a caesarean section, hospitalization or death.
- *Sepsis* – peritonitis, septicemia, or infections leading to a hospitalization or death.
- *Another precise complication* leading to a caesarean, transfusion, hysterectomy, or death.

The advantage of this definition is that it also included death as an extreme morbidity.

Two multivariate analyses were conducted. All variables having a significant bivariate association with the dependent variable of interest and/or proximally situated from the dependent variable of interest were included in the initial multivariate logit regression model. The best fit of PNC visits, parity, level of education, marital status, and maternal age was tested using a Wald test (Greene, 1997). Any variable that was found to be non-significant and was a distal determinant of the outcome (according to figure 1) was removed to achieve a parsimonious final model. Both multivariate models were estimated by logit regression using Huber-White robust standard errors to correct for heteroscedasticity of unknown form. The advantage of robust variance estimators is that it is robust to the assumption that the logit function is correct, that the model is correctly specified, and is recommended for use with clustered data (Sribney, 1998). City of residence dummy variables were included in multivariate analyses to correct for any unmeasured variation associated with place of residence. All analyses were conducted using STATA 6.0 (College Station, TX).

Results

Overall, the rate of retention in the MOMA study was favorable even following a study to determine the level of inclusion in the study area (Bouvier-Colle et al., 1997). Of the 21,506 women contacted and meeting the inclusion criteria, 20,326 (94.5%) were included in the study. Further, of those women contacted 19,545 (90.9%) completed all four interviews. Not shown in this paper is that there is

substantial heaping on ages 18, 20, 25, 30, and 35 suggesting measurement error associated with the age variables. The fact that only 23% of women reported their birth dates in the sample is further suggestive of measurement error, and it should be noted that younger women were no more likely than older women to report their date of birth. There were 6.1% of women with severe maternal morbidity and 86.1% of women who delivered with a trained attendant. Descriptive statistics of the study population are available elsewhere (Bouvier-Colle et al., 1997).

Trends in adolescents use of health care

Table 1 presents the bivariate relationships between maternal age and some indicators of use of health care. Across several indicators, young adolescents ages 11 to 15 are consistently less likely to use or receive services than women aged 16 to 19 or 20 to 30. Adolescents 11 to 15 are significantly less likely to use any family planning, to have had PNC, to have received preventive iron or chloroquine prophylaxis, or to deliver with a trained attendant. Interestingly, adolescents 11 to 15 are more likely than older women to use natural family planning methods suggesting an unmet need for more modern methods. Women 20 to 30 are four times more likely than women 16 to 19 to use modern methods. There is also a trend for adolescents 11 to 15 when they seek PNC to frequent an untrained provider. Although adolescents are less likely to see PNC, those who do are much more likely to be referred to a maternity or hospital for delivery. Women 11 to 15 are slightly less likely as women 20 to 30 to deliver with a trained attendant, although significantly less so than women 16 to 19. The fact that women 20 to 30 are less likely to deliver with a trained attendant than women 16 to 19 is probably an effect of parity. Older women are more likely to be multiparous and have successfully delivered previously, therefore are less likely to seek delivery care. Place of delivery at home or a hospital is also more similar for women 15 to 19 and 20 to 30, while women 16 to 19 are more likely to deliver in a maternity or health center. These bivariate results suggest a lack of access to care trend especially for the youngest adolescents aged 11 to 15. The same analyses were conducted comparing women 16 to 17 and 18 to 19, but their results were similar so they were combined for brevity.

Delivery with a trained attendant

Prior to conducting a multivariate analysis of the relationship between maternal age and delivery with a trained attendant, the bivariate associations between women's characteristics and delivery with a trained attendant were examined (Table 2). From the background factors, women without revenues from the father and those who are employed in small commerce or farming are significantly less likely to deliver with a trained attendant. Women with more education are more likely to delivery with a trained attendant. As expected, delivery with a trained attendant varies widely by place of residence. Women in Abidjan, Niamey, and Kaolack are less likely to deliver with a trained attendant. Among the more proximate determinants, women in monogamous marriages, nulliparious women, women with obstetrical antecedents, women who sought PNC with trained providers, women with less than two years separating the previous and current pregnancy, and women with referral for delivery were more likely to deliver with a trained attendant. However, there was no difference for women based on access to potable water or maternal height. Women who did not use family planning prior to the current pregnancy were more likely to deliver with a trained attendant.

Graphic 1 is another means of representing the unadjusted relationship between maternal age and delivery with a trained attendant. Rather than linear, this relationship appears to be more s-shaped. Women 18 to 25 are the most likely to deliver with a trained attendant while the youngest women are the least likely and the oldest women are the most likely.

Table 3 presents the multivariate regression results of delivery with a trained attendant. Different representations of maternal age were tested in this model to find the one that best corresponds to the nonlinearity of the relationship. Neither age as a continuous variable nor the addition of age squared were statistically significant. Age splines with knots at 5-year intervals 14, 19, 24, 29, 34, and 39 were tested and were statistically significant (chi2=25.71, p<=0.000) in the model. However, splines knots at 24, 29 and 34 were preferred over the previous intervals because a test of significant differences between the slope coefficients suggested that the slope was not different from ages 11 to 24 and above 34. A Wald test of the combination of the age splines was statistically significant (chi2=22.75, p=.0001). Age

remains significantly associated with the dependent variable suggesting a direct effect of maternal age on delivery with a trained attendant after controlling for other use of care variables such as referral for delivery and other confounders such as marital status and parity. For each additional year until age 24, the average marginal effect is 0.0136. Similarly, between 24 and 29 there is a 0.0161 decrease in the probability of delivery with a trained attendant, between 29 and 34 a 0.0139 increase, and for over 34 years of age there is a 0.0034 decrease in the probability of delivery with a trained attendant.

This result suggests that there is some effect of young age independent of other background and proximate factors that results in delivery with untrained attendants. Of the background factors, women with access to potable water and women with no education or more that six years of education were more likely to deliver with a trained attendant. Although there was no difference for single women relative to monogamously married women, women in polygamous marriages were significantly less likely to deliver with a trained attendant. Of the proximate factors, nulliparious women, women who were referred for delivery, women with a previous c-section, women who previously used modern family planning, and women who had PNC with a skilled professional were more likely to deliver with a trained attendant.

Inclusion of background factors, women's source of revenues and occupation, were not statistically significant in the multivariate model, and since there were other indicators of socio-economic status that were significant in the model, these variables were excluded. Two proximate factors that did not reach statistical significance in the multivariate model, intergestational spacing less than 24 months and maternal height, were also excluded. Intergestational spacing is highly correlated with parity (since nulliparae have no spacing) and is also a variable that is missing several observations. Maternal height was not associated with the dependent variable in bivariate analyses. Other clinical factors such as high blood pressure and infant presentation also were not found to have a significant association in the analysis. This result provides support for their position in the conceptual framework relative to use of health services.

Of the 20,362 women included in the MOMA study, 19,091 (93.8%) were included in the multivariate analysis of delivery with a trained attendant. However, 1508 (7.4%) of the 20,326 women

included in the study were missing information on the dependent variable, type of birth attendant. Women with multiple pregnancy (n=324) and women with late abortion (n=129) were excluded from analyses. For those 1508 women who had information on the place of delivery (but not type of attendant), women who delivered at home or in transport were coded as delivering with untrained attendant (n=42). Similarly, those women delivered in a public maternity, private maternity, or hospital were coded as delivery with a trained attendant (n=68). After the recoding, of those 1398 women still missing type of delivery attendant information, 1338 (96%) were missing all information on the third interview. Generally, measurement error on the dependent variable can be ignored because it is absorbed in the error term of the regression (Greene, 1997).

Severe maternal morbidity

Table 4 presents the bivariate relationship between women's characteristics and severe maternal morbidity. In an unadjusted relationship, women 15 years and younger are significantly more likely to have morbidity. Graph 2 provides a visual picture of how the risk associated with maternal morbidity is markedly increased for women under 16 and over 35. Of women 15 and younger, 9% had morbidity compared to 5.2% of women aged 16 to 20. Among the background factors, women with more education and women who had no source of revenues from the father are significantly more likely to have maternal morbidity. Women in Saint Louis and Nouakchott are much more likely to have morbidity compared to women in Bamako and Kaolack. Women in polygamous marriages were significantly less likely to have morbidity than either married women or single women. Of the more proximate determinants, nulliparity or grand multiparity, obstetric history risk, short pregnancy interval, short maternal height, four or more PNC visits, illness during pregnancy, non-cephalic infant presentation, and high blood pressure are all significantly associated with maternal morbidity. By the nature the of the severe maternal morbidity definition, i.e., it included obstetric interventions, women who delivered in a hospital setting or were referred to a higher level of care are much more likely to have morbidity.

To test whether maternal age has a direct association with morbidity after controlling for background, proximate and clinical factors, Table 5 presents the results from the multivariate analysis of

maternal age and severe maternal morbidity. The final model contains age as a continuous variable because neither age represented in splines nor dummy variables resulted in significant coefficients for maternal age, thus age was left as continuous for parsimony. Background factors such as education, occupation, potable water, and marital status were not significant in the model suggesting an indirect effect of those variables on morbidity. The strongest associations were found between type of delivery attendant (specially doctor) and referral for delivery. Doctors then midwives are probably more likely to detect and treat complications compared to other types of birth attendants. In another study using the MOMA data, de Bernis et al. (2000) found that in Saint Louis, where most women gave birth in the regional hospital, morbidity was higher than for women in Kaolack, where women gave birth mainly in health centers. However mortality was higher in Kaolack than in Saint Louis. The authors concluded that the higher morbidity and lower mortality found in Saint Louis compared to Kaolack was a function of better diagnosis and treatment of complications by the staff of the regional hospital. Additionally, in this analysis women who delivered with family or untrained attendants were also significantly more likely to have morbidity.

In general, those factors that are statistically significant in the multivariate model are those that are clinically related to maternal morbidity or have been identified in previous studies as risk factors. Certain risk factors such as nulliparity, obstetric antecedents, and four or more PNC visits are probably proxy variables for unmeasured biological factors or poorer previous health status. High diastolic ($\geq$ 90mmHg) and abnormal infant presentation were both statistically significant, while high systolic ($\geq$14mmHg) was borderline significant at the 0.05 level. Protienuria, a condition related to preeclampsia and eclampsia, was not found to be significant in this relationship, although this was probably due to problems with measurement that were noted during data collection, a limitation of this analysis. Of the proximate determinants, type of PNC provider and maternal height failed to reach statistical significance. Modern family planning use was not included in the model because it was not associated with morbidity in the bivariate analysis. Intergestational spacing, although statistically significant in the bivariate

analysis, failed to reach statistical significance in the multivariate analyses. It was not included in the final model because it is highly correlated with parity and it is missing several observations.

Of the 20,362 women included in the study 13.3% (2698) were dropped from the multivariate analysis due to missing data. Most of these missing data were a result of missing information on infant presentation (9.1% of the sample) and blood pressure (10.9% each diastolic and systolic). Missing data limits the generalizability of the results because it is likely that this information is not missing at random, rather it is associated with certain characteristics.

Discussion

The results of this study support the hypothesis that with younger maternal age women are less likely to seek reproductive health care or to deliver with a trained attendant. The results suggest that previous use of health care has an important direct association with subsequent delivery with a trained attendant, independent of maternal age. Further, after controlling for health care factors and other background factors, adolescents remained significantly less likely to deliver with a train attendant. This suggests young maternal age independent of previous health care use acts as a barrier to delivery with a trained attendant.

The second hypothesis that age has an indirect rather than direct effect on maternal morbidity and mortality was supported. Type of delivery attendant was the strongest mediator of this effect, although other clinical factors such as illness during pregnancy, non-cephalic presentation of the infant, high parity, obstetric antecedents, and high blood pressure were significantly associated with morbidity. The fact that receipt of revenues from the father of the baby was significantly associated with a decreased likelihood of maternal morbidity is further suggestive of a strong social component that is important to prevent maternal morbidity. The results suggest that primary prevention programs such as family planning designed to delay first births will only be partially successful to improve maternal health if other more intermediate determinants of maternal health such as access to quality health care or treatment of clinical complications of pregnancy are not improved. Targeting young people with family planning will be

inadequate if adolescents are not educated about the risks associated with sexuality and childbearing and the health and family planning services available to them. Specifically, sexuality education needs to be introduced young, that is before most adolescents have initiated sexual activity. Health and family planning services should have welcoming environments for adolescents.

Social norms that limit the status of women such as the practice of relationships with "sugar daddies", the pressure to prove fertility before marriage, the practice of marriage upon menarche, or regulations that prohibit pregnant girls from attending school also limit women's ability to safe childbearing. Improving the status of women in societies is the foundation to support women to make healthy decisions. The imbalance of roles between women and men is also reflected in the ability to negotiate safe sex or even to abstain from sex. Part of sexuality education should include the skills to help young women avoid coercive situations or to negotiate safe sex (Pachauri, 1998). Since adolescents are in a period of developing these skills, these social imbalances can be exaggerated at their ages.

These analyses warrant discussion of certain limitations. Both multivariate analyses are probably subject to bias due to omitted variables. Although there are some variables to control for previous health care use, health care use prior to the current pregnancy (other than family planning use prior to the index pregnancy) was not measured. An important limitation of the maternal morbidity analyses is that there are no good measures of previous health care status. Although there is some control for obstetrical antecedents, it may be that the women most likely to have morbidity are also those women who are less likely to marry or attend school because they are less healthy. Although no variables will be truly exogenous, important omitted variables may bias the estimated coefficients in indeterminable directions (Greene, 1997).

There are also conceptual limitations related to the dependent variables. In this study those attendants considered 'trained' varied widely on their skills and abilities and the resources available to them. That which is most important to preventing maternal morbidity and mortality is the availability of the skills to prevent, detect and manage any complications that arise combined with the equipment, drugs and supplies to treat those complications (UN, 1996). Thus, use of the dichotomous dependent variable

'delivery with a trained attendant' in this study is only one element necessary to prevent morbidity and mortality. It cannot be assumed that delivery with a trained attendant means all attendants had the same level of skill nor does it imply access to quality obstetric care.

Although the definition of severe maternal morbidity was created by the MOMA group with the intention to capture all those women who would have died (or did die) if they had not otherwise received treatment, it is likely that some women with very severe morbidities were not included and that some women with less severe morbidities were. Misclassification of women who should have been coded as having severe maternal morbidity but were not probably occurred more frequently with adolescents because they were less likely to seek care and more likely to deliver at home.

The generalizability of this study is somewhat limited due to absence of random selection of study participants or areas and missing data in the multivariate analyses, although the overall rate of study retention is quite high for a study of this type. Since the study participants were identified from specific zones in West African urban areas, the generalizability of these results to the whole of West Africa, or even urban West Africa, is limited. Although the MOMA study was population-based, adolescents probably were more likely to be excluded from the study than older pregnant women if they were more likely to hide their pregnancies or seek early abortions. However, this is the first study of its kind to attempt to measure morbidity in multiple settings in West Africa using a common study protocol. The advantage of this study is that it has a large sample size to allow for the study of outcomes among women of very young age, an aspect that has been previously neglected (Bledsoe and Cohen, 1998). Even when adolescents have been included in previous studies, years of maternal age were rarely disaggregated in analyses or reports. Results are usually presented in arbitrary five- or ten-year age increments obscuring more subtle age effects and prejudge meaningful cutoffs. In addition to excluding women under 15, many surveys (including some Demographic and Health Surveys) interview only married women and fail to procure information on socioeconomic or education status.

Although infant outcomes were not explored in this paper, more research is needed on the relationship between adolescents and such outcomes as low birth weight and infant mortality and the

proximate and clinical factors that may intervene to moderate this relationship. For example, inadequate maternal weigh gain and short cervixes have been implicated as intervening factors between adolescents and low birth weight and preterm delivery (Cherry et al., 1991; Stevens-Simon et al., 2000). Other authors have proposed that differing underlying prevalences of low gynecological age (i.e., time between onset of menses and delivery) may explain the conflicting results of those studies that found an of increase risk of preterm labor and delivery among adolescents and those that did not (Scholl, 2000). If more precise clinical factors are identified that increase the risk of poor outcomes, these clinical factors can be treated in health services.

To determine whether early childbearing is a problem for women's long-term health, it is important to consider the context in which young women engage in sexual activity and become pregnant. There may be other social and biological factors combine to make childbearing a risky proposition in the long-run. Maternal morbidities may be exacerbated or increase her risk for additional problems in future pregnancies. Young maternal age has been found to have a negative effect on child health care (LeGrand and Mbacké, 1993). Her education or employment opportunities may be limited by the presence of a newborn, or her psychological immaturity may impair her ability to care for her infant (WHO, 1996a). Further, the discussion of adolescent pregnancy naturally lies within the domain of adolescent sexuality, which has serious consequences in terms of sexually transmitted infections and HIV/AIDS.

Abortion is one of the major consequences of teenage pregnancy (Cunningham and Boult, 1996), which has both significant short-term and long-term health consequences for adolescents. Since women in the MOMA study were identified after they had declared their pregnancy, any complications of adolescents seeking abortion would have been missed in this study. In contexts where access to safe abortion is limited or there are barriers to access by adolescents, unsafe abortion is likely to result high rates of abortion complications including pain, infection, infertility or even death for adolescents. Several studies have found that the majority of women seeking abortion in developing countries where access to safe abortion services are severely limited are adolescents who are still in school (Zabin and Kiragu, 1998). Further, adolescents are more likely to seek abortion later in their pregnancy putting them at

higher risk for complications or death. One probability housing survey in Addis Ababa where abortion accounted for 54% of the direct obstetric deaths, women who were single, nulliparous, aged 15 to 19, and employed as maids/janitresses, or students were at the highest risk of abortion-related death (Kwast and Rochat, 1986). Thus, secondary prevention activities may include safe and appropriate abortion services for adolescents.

It is not clear that—at least in terms of maternal and infant outcomes excluding abortion—that adolescent pregnancy and childbearing is a problem in these West African contexts. Often these pregnancies occur within marriage or are socially acceptable and wanted. Although adolescents are usually thought of to be one of the healthiest age groups in society, negative patterns of behavior and insults to health that develop during this period are going to have the largest future repercussions. In general, more research is needed to identify the factors that cause maternal morbidity, such as high blood pressure, for a better understanding of which women are likely to develop complications. The results of this study suggest that further research is needed where the clinical and proximate factors of maternal and infant health are better measured before it can be concluded that childbearing during adolescence is dangerous to either the mother or the infant.

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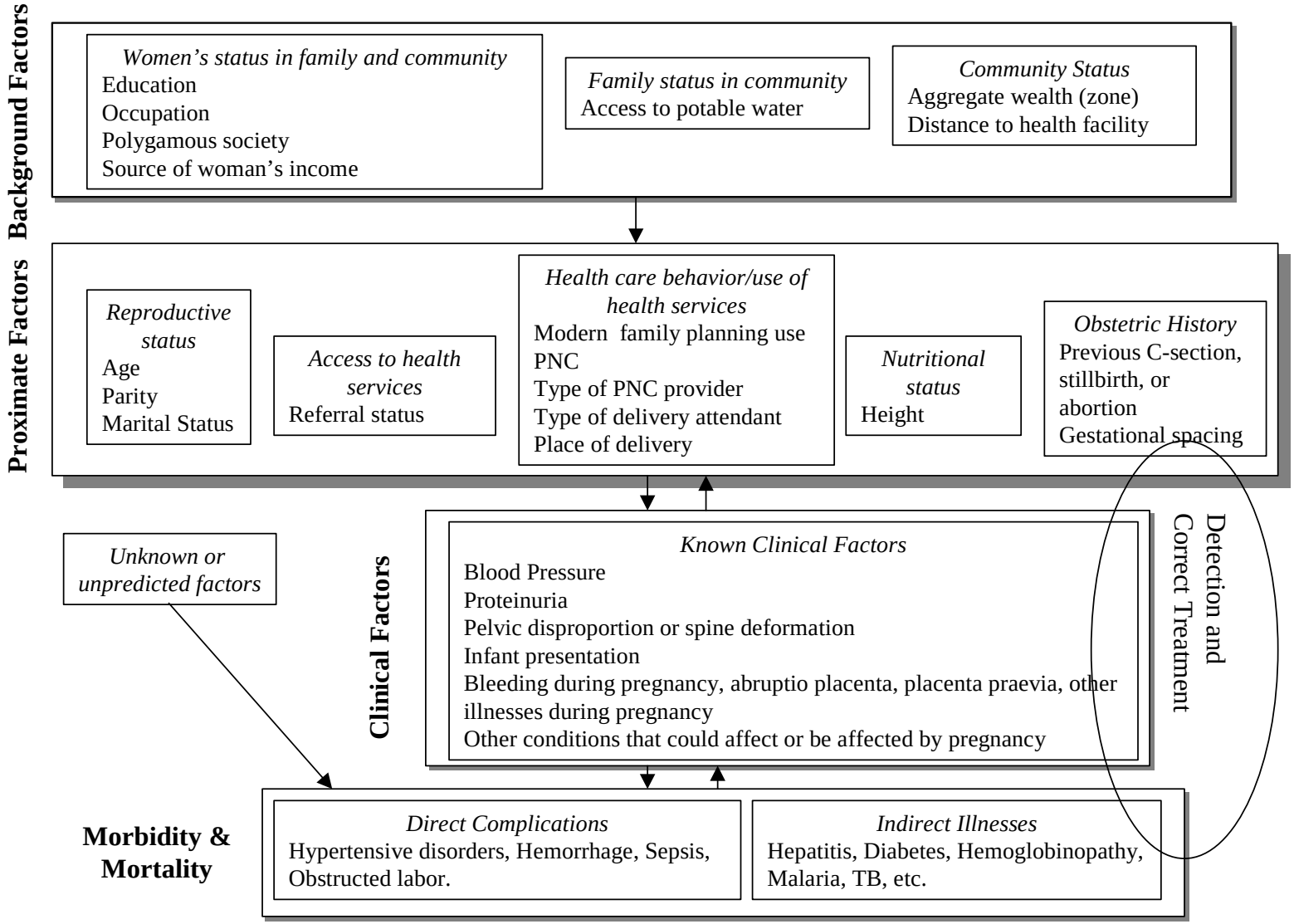
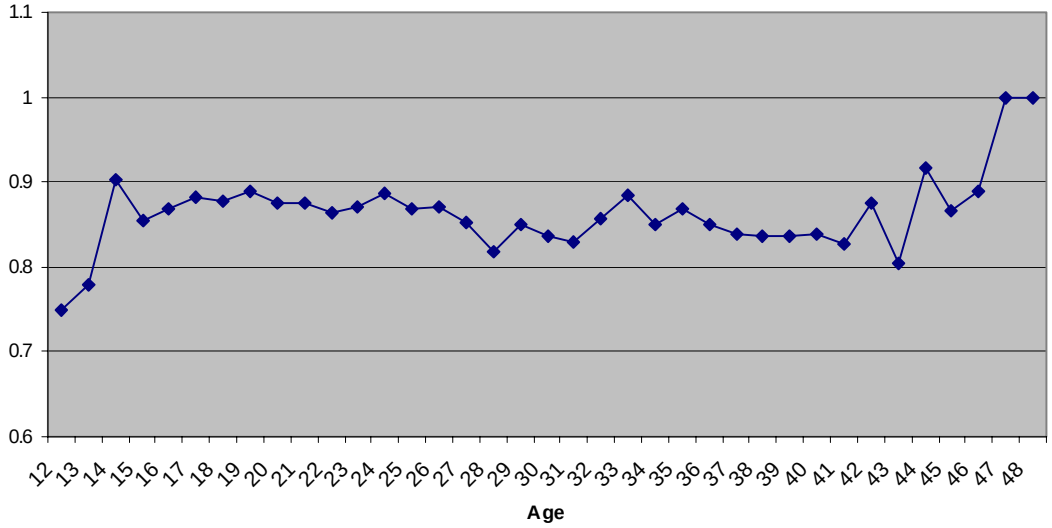
Figure 1. Conceptual Model of Maternal Morbidity



Graph 1 Proportion of Women Delivering with a Trained Attendant, by Age



Graph 2 Proportion of Women with Severe Maternal Morbidity, by Age

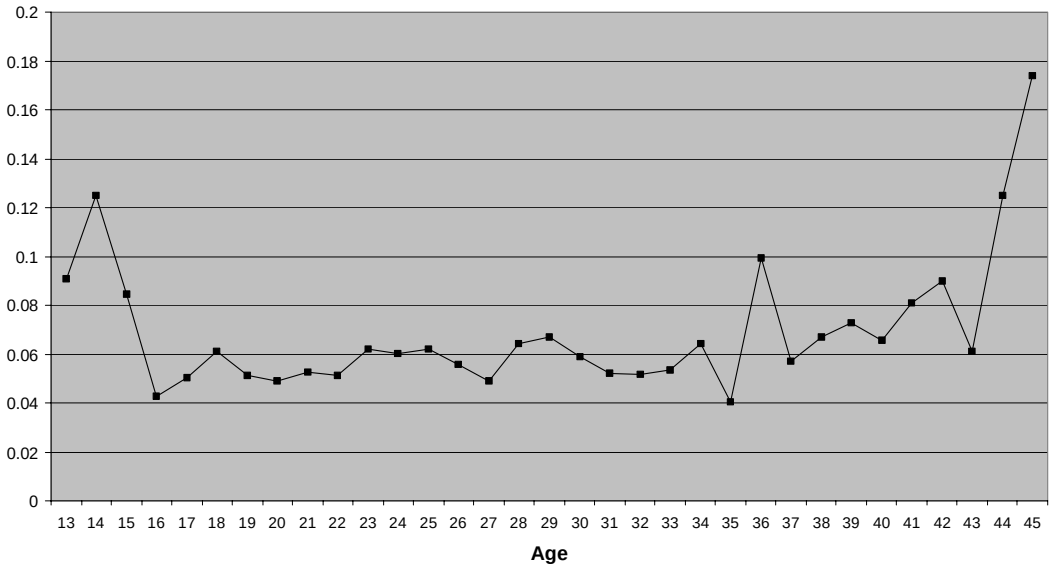


Table 1 Bivariate analysis of maternal age and use of reproductive health services.

	11-15	16-19	20-30
Family planning use to space current pregnancy**			
Modern (Sterile, pill, injectable, implant)	7 (2.0%)	192 (5.3%)	2548 (20.0%)
Natural (Abstinence, traditional, natural, breastfeed, other)	68 (19.1)	556 (15.3)	1785 (14.0)
No	281 (78.9)	2882 (79.4)	8433 (66.1)
Prenatal care**			
None	36 (11.4)	308 (9.4)	1004 (8.4)
Late entry PNC	199 (63.0)	2149 (65.5)	7568 (63.2)
1st PNC visit w/in 4 months of pregnancy	81 (25.6)	823 (25.1)	3395 (28.4)
Type of PNC attendant (p=.08)			
TBA/other or none	38 (11.5)	341 (10.0)	1106 (9.0)
Trained (nurse, midwife, or MD)	293 (88.5)	3086 (90.1))	11211 (91.0)
Any iron and/or chloroquine during pregnancy**			
Yes	153 (46.2)	1945 (56.9)	6824 (55.5)
Referral for delivery**			
Yes	25 (7.8)	110 (3.4)	355 (3.0)
Delivery with a trained attendant**			
Yes	275 (85.7)	2899 (88.0)	10310 (86.0)
Place of delivery**			
Home, attendant's home, or transport	60 (18.7)	479 (15.0)	2377 (19.9)
Maternity or health center	216 (67.3)	2357 (71.7)	7615 (63.6)
Hospital	45 (14.0)	450 (13.6)	1981 (16.6)

Table 2 Bivariate analysis of delivery with a trained attendant by women's characteristics.

	Delivery with a Trained Attendant	
	Yes	No
Age**		
11-15	275 (85.7)	46 (14.3)
16-20	4169 (87.8)	578 (12.2)
21-25	4924 (87.1)	732 (12.9)
26-30	4116 (84.3)	769 (15.7)
31-35	2483 (85.7)	409 (14.1)
36-40	1084 (83.8)	210 (16.2)
41-45	218 (84.8)	39 (15.2)
46-51	19 (82.6)	4 (17.4)
Education **		
None	7676 (82.5)	1628 (17.5)
1-5 years	4806 (88.1)	649 (11.9)
6 or more	4825 (90.4)	510 (9.6)
Principal occupation**		
Without	11843 (86.7)	1819 (13.3)
Small commerce or farmer	4920 (84.5)	904 (15.5)
Salaried, professional or state employee	594 (89.0)	68 (11.0)
Source of Revenues**		
None or personal only	2956 (90.2)	324 (9.9)
Father and personal	14309 (86.1)	2458 (14.7)
Potable water		
Yes	16094 (86.2)	2584 (13.8)
No	1167 (85.4)	199 (14.6)
City of Residence**		
Abidjan	2540 (74.9)	851 (25.1)
Bamako	3161 (92.8)	246 (7.2)
Niamey	2449 (78.0)	691 (22.0)
Nouakchott	3013 (90.9)	302 (9.1)
Ouagadougou	2884 (92.8)	225 (7.2)
Saint Louis	2100 (98.5)	32 (1.5)
Kaolack	1170 (72.5)	444 (27.5)
Parity**		
Nulliparous	4104 (91.3)	393 (8.7)
1-6	11737 (84.9)	2088 (15.1)
7 or more	1456 (82.1)	309 (17.5)
Marital status**		
Single, widowed, or divorced	1250 (85.1)	219 (14.9)
Married monogamous or living as	12378 (87.4)	1826 (12.9)
Married polygamous or living as	3689 (83.2)	291 (14.9)
Referral for delivery**		
Yes	648 (98.0)	13 (2.0)
No	16616 (85.8)	2756 (14.2)

Family planning used to space current pregnancy**		
Yes	5364 (83.6)	1053 (16.4)
No	11936 (87.3)	1735 (12.7)
Prenatal care provider (highest level)**		
TBA, other or no PNC	1471 (76.3)	457 (23.7)
Nurse, midwife, or doctor	15641 (87.3)	2278 (12.7)
Height		
150cm or less	460 (85.8)	76 (14.2)
Greater than 150cm	16550 (86.2)	2650 (13.8)
Antecedent cesarean section**		
Yes	320 (93.8)	21 (6.2)
No	16376 (85.8)	2714 (14.2)
Intergestational spacing**		
2 or more years	9841 (83.5)	1943 (16.5)
less that 2 years	1941 (86.3)	307 (13.7)

**p<0.01 *p<0.05

Table 3 Logit regression results [a] of delivery with a trained attendant.

N=19,091	Coefficient	Robust Standard Error	*P*
Constant	−.255	.320	.426
Age**			.000
spline knot 24**	.057	.014	
spline knot 29**	−.067	.017	.000
spline knot 34**	.058	.020	.004
Rest	−.014	.019	.442
Potable water**	.282	.090	.002
Single, widowed or divorced	−.096	.090	.289
Monogamous married	(ref.)		
Polygamous married*	−.115	.053	.029
No Education**	.253	.058	.000
Education 6 or more years **	.324	.072	.000
Nulliparity**	.810	.081	.000
Previous c-section**	.714	.241	.003
Previous modern family planning use**	.295	.063	.000
Trained PNC provider**	.953	.068	.000
Referral for delivery**	1.78	.292	.000

Log likelihood = -6668.9043
**p<0.01 *p<0.05
[a] Results adjusted for place of residence

Table 4 Bivariate analysis of severe maternal morbidity by women's characteristics.

Variable	Severe Maternal Morbidity Yes	No
Age**		
11-15	32 (9.0)	325 (91.0)
16-20	270 (5.2)	4919 (94.8)
21-25	349 (5.7)	5689 (94.2)
26-30	304 (5.9)	4894 (94.2)
31-35	154 (5.1)	2888 (94.9)
36-40	99 (7.3)	1251 (92.7)
41-45	27 (10.0)	244 (90.0)
46-51	1 (4.2)	23 (95.8)
Education **		
None	492 (4.9)	9535 (95.1)
1 to 9 years	631 (6.3)	9472 (93.6)
10 or more years	111 (8.2)	1247 (91.8)
Source of Revenues**		
None or personal only	248 (7.1)	3265 (92.9)
Father only and personal	987 (5.5)	16949 (94.5)
Principal occupation**		
Without	803 (5.5)	13830 (94.5)
Small commerce or farmer	370 (6.0)	5843 (94.0)
Salaried, professional or state employee	63 (9.6)	591 (90.4)
Potable water		
Yes	1164 (5.8)	18823 (94.2)
No	69 (4.8)	1375 (95.2)
City of Residence**		
Abidjan	249 (6.6)	3554 (93.5)
Bamako	103 (2.9)	3418 (97.1)
Niamey	169 (4.7)	3435 (95.3)
Nouakchott	250 (7.3)	3157 (92.7)
Ouagadougou	185 (5.5)	3182 (94.5)
Saint Louis	191 (8.8)	1978 (91.2)
Kaolack	89 (5.4)	1546 (94.6)
Parity**		
Nullparity	357 (7.2)	4617 (92.8)
1 to 6	746 (5.1)	13922 (94.9)
7 or more	130 (7.1)	1710 (92.9)
Marital Status**		
Single, widowed or divorced	106 (6.4)	1554 (93.6)
Monogamous married or living as	900 (6.0)	14202 (94.0)
Polygamous married or living as	229 (4.8)	4513 (95.2)
Referral for Delivery**		
Yes	298 (45.1)	363 (54.9)
No	924 (4.77)	18460 (95.2)
Family planning use to space current pregnancy		
Yes	368 (5.3)	6604 (94.7)
No	866 (6.0)	13647 (94.0)
Prenatal care provider (highest level)*		
TBA, other or no PNC	92 (4.6)	1191 (95.4)
Nurse, midwife, or doctor	1121 (6.0)	17555 (94.0)

Place of delivery**		
Home or during Transport	169 (4.3)	3737 (95.7)
Health Center or Maternity	485 (3.8)	12405 (96.2)
Hospital	576 (17.6)	2701 (82.4)
Height greater than 150cm**		
Yes	1136 (5.7)	18875 (94.3)
No	64 (11.4)	496 (88.6)
History of Abortion, Stillbirth, or C-section**		
Yes	207 (11.7)	1569 (88.3)
No	1020 (5.3)	18219 (94.7)
Intergestational spacing*		
2 or more years	647 (5.5)	11160 (94.5)
less than 2 years	147 (6.5)	2104 (93.5)
Illness during pregnancy**		
Yes	462 (6.9)	6257 (93.1)
No	746 (5.4)	13195 (94.7)
Infant Presentation**		
Cephalic	1019 (5.4)	18027 (94.7)
Face/Forehead/Seat/Transverse	107 (21.4)	394 (78.6)
High Diastolic Blood Pressure**		
Yes	126 (10.3)	1096 (89.7)
No	959 (5.4)	16972 (94.7)
High Systolic Blood Pressure**		
Yes	101 (13.9)	628 (86.2)
No	984 (5.3)	17447 (94.7)
Scoliosis or pelvic deformation**		
Yes	18 (11.8)	135 (88.2)
No	1193 (5.8)	19325 (94.2)

**p<.01 *p<.05

Table 5 Logit regression results [a] of severe maternal morbidity.

N=17,664	Coefficient	Robust Standard Error	*P*
Constant	−2.07	.334	.000
Age	−.0099	.0069	.206
Revenues from father**	−.269	.100	.007
Parity >5	.273	.142	.054
Trained PNC provider	.119	.147	.419
Maternal height > 150cm	−.167	.176	.343
Illness during pregnancy*	.188	.082	.022
Cephalic presentation**	−.910	.175	.000
History of abortion, stillbirth or c-section**	.326	.115	.005
Diastolic blood pressure >=90*	.464	.148	.002
Systolic blood pressure >=140**	.301	.169	.075
Referral for delivery**	1.84	.133	.000
Delivery with family, TBA**	.481	.151	.001
Nurse or trained auxiliary	(ref.)		
Delivery with midwife**	.503	.113	.000
Delivery with doctor**	4.70	.195	.000

Log likelihood = -2872.0437
**p<.01 *p<.05
[a] Results adjusted for place of residence