The Relationship between Female Genital Cutting and Fertility in Kassena-Nankana District of Northern Ghana

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Abstract: *There is a growing body of literature on the impact of the practice of female genital cutting (FGC) on fertility. To date, no study has found an association between reproductive capability and FGC, and findings about the association between FGC and obstetric complications have been mixed. The purposes of this analysis are to measure the fertility effects of genital cutting and to increase understanding of the differential fertility patterns of cut and uncut women in a rural traditional setting where excision, an FGC form of intermediate severity, is prevalent. Baseline data on FGC status was collected in a 1995 panel survey of women aged 15-49. A subset of currently married women aged 20-49 were selected and matched with demographic surveillance data collected to determine their probability of having a live birth in three month intervals from 1996 to 2003. FGC was found to affect parity progression differently by a woman's current parity level. Nulliparous women who had been cut experienced delays in first live birth. Other cut women of low and highest parity were less likely to experience a live birth event relative to uncut women. Cut women with parities of 3, 4, and 5 had greater risk of parity progression relative to uncut women. Comparisons of background characteristics and fertility patterns and behaviors among circumcised and uncircumcised women are discussed.*

Introduction and Background

Female genital cutting (FGC) is a social tradition that cuts across religious, racial, ethnic and socioeconomic lines. This procedure, which involves the removal of all or part of the clitoris and the external genitalia, is generally performed by traditional birthing attendants or elderly women in the community, although in many countries, the proportion of girls that are circumcised by a doctor or trained midwife has grown considerably in recent years (WHO 1998). The cutting is often achieved using a sharp instrument, such as a stone or a razor, and is rarely accompanied by an anesthetic. In cases in which the procedure is performed on a number of girls, one after the other, the same unsterilized blade may be used on all of the children. Local herbs, dirt, or ashes may be applied to the wound in an attempt to stop bleeding and enhance healing following the procedure (Mann et al. 1999).

The ritual of FGC, which is deeply rooted in cultural tradition, often symbolizes the rite of passage from childhood to adulthood and is usually performed on girls between the ages of four and fourteen years. There is, however, wide variability in terms of age between countries, with some tribes performing circumcision in the early postnatal period and others waiting until the young woman is ready to be married. The World Health Organization estimates that between 100 and 140 million women worldwide have already experienced some form of female genital cutting, and more than two million girls and young women at risk every year (Toubia 1998). Although until the 1990s, Sudan was the only country with reliable and comprehensive data tracking prevalence over time, many countries now incorporate a basic module questionnaire on FGC in their National Demographic and Health Surveys. While the practice of female genital cutting is concentrated primarily in 28 countries in the sub-Saharan and Northeastern regions of Africa, it is also found in some parts of the Middle East and Asia, and increasingly among immigrant populations in Europe, North America, and Australia.

Those who support the elimination of FGC point to its harmful and often irreversible consequences; aside from the immediate pain and trauma associated with prolonged bleeding, severe infection and neurogenic shock, women who have been cut must endure the often debilitating long-term physical and psychosocial pain associated with urination, dysmenorrhoea, keloid and dermoid cysts, fistula, pelvic inflammatory disease, dyspareunia, and childbirth (Toubia 1994; Toubia and Izett 1998). Although research that has focused on psychological trauma has been primarily qualitative and is based largely on anecdotal data and individual testimonies, these findings suggest that the psychological sequelae associated with FGC include anxiety, chronic or acute depression, behavior changes in children, constant fear of monthly menstruation, insomnia, post-traumatic stress disorder, loss of self-esteem, and in some cases, psychopathology (Abdalla 1982).

Girls and women who have undergone infibulation experience a heightened risk of prolonged obstructed labor, which may result in both maternal and perinatal distress. Acute fetal asphyxia may occur, ultimately resulting in either death or significant brain damage in the newborn. In addition, in the case of severe perineal lacerations during delivery, the mother's risk of hemorrhage, sepsis, and damage to neighboring tissues is significant. Women are traditionally re-infibulated following each childbirth; the raw edges of the labia majora are sewn back together using thread, paste, thorns, or staples to ensure that the posterior opening is tiny (WHO/UNICEF/UNFPA 1997). Despite mounting concern regarding the reproductive health consequences of FGC, there is limited understanding both of the occurrence of specific obstetric complications and of their severity by type of circumcision (Jones et al. 1999; Larsen and Okonofua, 2002; Obermeyer and Reynolds 1999). Evidence of these health effects is often anecdotal and based on case reports rather than population-relevant measures of risk (Slanger et al. 2002; Obermeyer 2003). The limited empirical evidence that exists is mixed. A study conducted in Burkina Faso found that uncut women were significantly less likely to have delivery complications and significantly less likely to have a genital infection (Jones et al. 1999). However, a study in Nigeria found that when social class and birth conditions were controlled for, there was no association between FGC and morbidity during first delivery (Slanger et al. 2002).

To date, no study has found an association between reproductive capability and FGC. While the Jones et al. study in Burkina Faso found that women who have been cut are more likely to experience obstetric complications, a 1998-1999 NHRC study found that women who were circumcised married earlier than uncircumcised women, and that circumcised women had greater total fertility than uncircumcised women (Reason 2004). Another study based on DHS surveys in the Central African Republic, Côte d'Ivoire, and Tanzania found that, when controlling for confounding socioeconomic, demographic and cultural variables, circumcised women, grouped by age at circumcision, did not have significantly different odds of infertility nor of childbearing than uncut women (Larsen and Yan, 2000). However, given the central importance of motherhood in many societies in which FGC is prevalent, further investigation of the effects of this practice on women's ability to reproduce is warranted. In particular, rigorous longitudinal appraisal of the age and parity specific impact of FGC on fertility dynamics is completely lacking. The present study aims to address this gap.

Study Context

Prevalence of FGC in Ghana has been estimated at 30 percent (Toubia 1995). Studies, however, have shown that the practice is concentrated among ethnic groups in the far northern part of the country (U.S. State Department). In southern Ghana, FGC reportedly continues only among migrant communities from northern Ghana and neighboring countries (WHO 1998).

In 1995, the Navrongo Health Research Centre (NHRC), in collaboration with the Ghana Health Service, began a program of research to understand female genital cutting as it is practiced in the rural Kassena-Nankana District of the Upper East Region. Findings indicated that FGC was practiced among all predominant ethnic groups of the district, in spite of 1994 national legislation outlawing its practice.

Qualitative research findings indicate that the practice of FGC is embedded in Kassena and Nankana culture in complex ways. FGC is an important part of gender identity, status as a respected adult woman, purification, preparation for marriage, and fulfillment of cultural responsibility. A woman's eldest daughter is expected to undergo circumcision so that she can play a crucial role in her mother's funeral rites. FGC is also performed in an effort to curb female sexuality, improve hygiene and aesthetic appeal, and demonstrate courage in the face of pain. Pressure from co-wives and the desire to be accepted by adolescent peers also contribute to the continuation of the practice (Akweongo et al. 2001; Adongo et al. 1998).

Since 1993, a Demographic Surveillance System has recorded demographic events among the entire district population (Binka et al., 1998). Yearly panel surveys collect detailed information on a population subset. A module on FGC was first included in the yearly panel in 1995. The results of this survey indicated that FGC was practiced throughout the district in varying levels by both of the predominant local ethnic groups. The overall prevalence among women 15-49 in the district was found to be 77 percent. Among older women, the practice was almost universal, with a prevalence of 94 percent among women aged 35 years and older. Among the youngest women surveyed, prevalence was much lower, at 26 percent among women 15-19 years old (Mbacké et al. 1998). A subsequent clinic-based study of pregnant women seeking prenatal care found that women in the district had experienced all three of the major types of FGC – clitoridectomy, excision, and infibulation. This study classified most women who had been cut as having had *excision*, the form of intermediate severity. One third of cut women had been circumcised with the milder *clitoridectomy* procedure. Only 8% had been infibulated. Of the women who had been cut, 62 percent were circumcised between 15 and 19 years of age, and by age 20, 80 percent had already undergone the procedure (Mbacke et al., 1998). In Kassena-Nankana District, young women are generally circumcised along with peers in their age cohort. All circumcisions are performed by traditional practitioners.

A study conducted in 1998-1999 in the district found that women exposed to FGC had an earlier age at marriage and experienced their first pregnancy earlier than those who had not been cut (Reason 2004). This study concluded that the reproductive fitness of cut women was enhanced relative to uncut women, who had a lower total parity, and that the cost to fertility of not practicing FGC was greater than the possible health risks associated with FGC within this cultural setting. Our study examines the issue from a different perspective made possible by the use of longitudinal data;

rather than determine the population level effects of FGC on fertility, we seek to determine the effect of FGC on reproductive capability by assessing the risk of having a live birth event among cut and uncut women who are already married.

Hypotheses

This paper investigates the hypothesis that exposure to FGC will decrease the probability of having a live birth. The analysis also investigates the hypothesis that fertility effects of FGC will be conditional on parity. The posited fertility effects of FGC may arise from the physiological impact of the procedure on spontaneous pregnancy loss or other determinants of reduced fecundability related to reproductive morbidity. An effect of FGC on fertility that is conditional on parity is posited to reflect physiological impact. Achieved cumulative parity is conditional on the pace of prior child bearing, and effects on fecundability would therefore be more evident among low parity women who fail to produce children owing to FGC-induced reproductive disability.

Evidence for an effect of FGC could be observed at various points in a woman's reproductive career. In some cut women, we would expect to see an effect of FGC early on in their fertility history, when the FGC procedure has more recently taken place. Effects may arise through difficulty of sexual intercourse or through complications such as infections resulting from the procedure. Infection could also lead to longer term effects. Clinical evidence indicates that women who have been cut experience a heightened risk of pelvic inflammatory disease (PID), which is a known risk factor for infertility. Since risks of PID are additive, advancing age may expose women to progressively greater cumulative risks of FGC effects on fertility. Direct evidence of such a relationship has not been documented in the literature, however. FGC may also have behavioral effects on sexual practice through the association of FGC with reproductive norms that influence coital exposure.

If fertility effects are demonstrated, the relative roles of physiological and behavioral determinants cannot be ascertained with socio-demographic data. However, physiological effects would be suggested by evidence that the onset of fertility or pace of childbearing at low parities is reduced among circumcised women relative to uncircumcised women. Behavioral determinants would be suggested by interactions demonstrating that age and parity effects are conditional on social, economic, or educational characteristics of women. Behavioral effects could occur at all parities and ages. Qualitative data from Kassena-Nankana district suggests that circumcised women are believed to experience reduced sexual desire (Akweongo et al. 2001, Adongo et al. 1998), which may, in turn, lead to less frequent intercourse. However, there is no empirical data on the effect of FGC on sexuality in this setting.[1] Moreover, if circumcised women who deliver children experience excessive pain and complications relative to uncircumcised women, they may seek to limit or space childbearing as a consequence of the effects of FGC. While disentangling behavioral and physiological effects is not possible, the fertility impact of these two sets of FGC consequences is posited to be additive rather than offsetting.

Methods

This analysis applies a generalized logistic model of the form:

$$\ln[P/(1-P_{t/x,z})] = \alpha + \beta X_{it} + \sum_{j=1}^{J} \gamma Z_{i_t,j} + \delta_i C_i + \sum_{j=1}^{J} \xi jj Z_j C_i + \sum_{k=1}^{K} \eta_k U_k + \varepsilon i_i + \varepsilon_{it} \qquad (1)$$

where,

P	is the probability that a woman has a live birth in quarter t over 72,384 quarter years of person time observed and 2,572 live singleton births (representing 98.7 percent of the total of 2,605 live births) and 33 live twin births (1.3 percent), such that intervals with no live birth are 0.
t	is the t^{th} 90 round of observation from the baseline line (January, 1996) to the index 90 observation round where T= 24, corresponding to December 31, 2003.
X_{it}	is the age of woman i at time t
Z_{ijt}	is parity j for woman i as of time t
C_i	defines circumcision status of individual i as of the 1995 panel survey; and
U_k	represents the k^{th} background characteristics,

and where unknown parameters to be estimated by the STATA "Generalized Estimating Equation" (GEE) procedure (Zeger et al. 1988) are

α	an intercept,
β	estimates the effect of age,
γ_j	estimates the effect of parity j,
ξ_j	estimates the conditional effect of FGC at parity j, and
η	estimates the effect of background characteristic k
ε_{ijk}	defines error arising from within individual effects, and
ε_{ij}	defines error arising from between individual effects.

To clarify the effect of FGC on timing of first live birth, we have estimated Cox models for the hazard of first live birth for nulliparous women.

$$h(t / xzcu) = h_0(t) + \delta_i C_i + \sum_{k=1}^{K} \eta_k U_k + \varepsilon i_i + \varepsilon_{it} \qquad (2)$$

h(t/x,z,c,u) is the hazard function for bith at time *t* conditional on the set of characteristics X, Z, C, and U, as in equation (1) and

$h_0(t)$ is a function of time representing the underlying hazard of first birth since age 14 years.

The Data

Data for this analysis were collected by two research projects of the NHRC; the Navrongo Community Health and Family Planning Project (CHFP) and the Navrongo Demographic Surveillance System (NDSS). The Navrongo CHFP experiment began in 1993 as a program of social research to develop and test culturally sensitive and operationally feasible service delivery strategies for fostering reproductive change and improved community health (Binka et al. 1995). The impact of CHFP strategies is monitored by demographic surveillance and in yearly panel surveys which monitor background characteristics and reproductive preferences and behavior of women in a subset of family compounds in the study district. Intermittently, surveys have included modules on topics such as knowledge about HIV/AIDS transmission and female genital cutting (FGC). FGC prevalence was measured for the first time in the 1995 survey and again in 2000. FGC status measured in the 1995 panel survey is used in this analysis because it allows for five more years of follow-up time in which to monitor parity progression. The demographic impact of the CHFP is monitored by the NDSS, which continuously assesses population size and composition, and fertility, mortality, and migration rates. Every three months, interviewers visit each compound within the study district to register pregnancies, births, deaths, and in and out migrations from the district.

Data used in this analysis are a subset of the 1995 panel survey of 5,288 women aged 15 to 49. Because the only assessment of exposure to FGC for this analysis occurred in 1995, it was important that we select women whose exposure status was unlikely to change. Once a woman has been exposed to FGC, her status is irreversible, but women who had not been exposed to FGC by 1995 could be circumcised subsequently. However, in the study population, nearly all

FGC takes place among women under age 20 and most commonly among unmarried women as a key cultural rite in the transition to adulthood. In 1995, the mean age of FGC incidence was 15 years. Therefore, we limited our analysis to women who were currently married in 1995 and who were at least 20 years old. Women who were not currently married were excluded because it was assumed that they would have a lower underlying risk of pregnancy than currently married women. For these reasons, 1,362 women who were not currently married and 161 currently married women under 20 years of age in the 1995 panel survey were excluded from analysis. Of the remaining 3,765 women, five (0.13 percent) who didn't report their FGC status were excluded. An additional 17 women who reported that they had been sterilized were also excluded, leaving a total of 3,743 women. All but one of these women had been exposed to FGC.

Records of these 3,743 women from the 1995 panel were matched with the demographic surveillance data for women aged 20 to 49 who had been married for nine months or more as of January 1, 1996. Women were followed until they were permanently lost to follow-up or until December 31, 2003, the latest date for which demographic surveillance data was available. The records of 2,758 women from the survey (73.7 percent of the 3,743 women selected for analysis) were found in the NDSS dataset. High levels of in and out migration in the district are mainly responsible for the 26.3 percent of women whose survey responses could not be matched with surveillance data. The 2,758 women who were matched with NDSS data were observed for a total of 73,708 three-month intervals, or a total of 18,427 person years. Individual women were observed between three months and eight years, with an average of 6.7 person years each. In all, 64.21 percent of women were observed without interruption for the entire eight year period.

Women were not considered lost to follow-up if they were observed until December 31, 2003 or if they were observed until they were 49 years of age. By these criteria, 529 women (19.18 percent of the 2,758 total women) were lost to follow-up. The odds of exposure to FGC, education, polygamy, and marriage to an educated husband were compared among women who were lost to follow-up and women who were not lost to follow-up. There was no significant association with loss to follow-up and any of these exposures. Associations between loss to follow-up and continuous or multi category covariates were assessed using logistic regression. No association was found between loss to follow-up and a woman's ethnicity or religion. Women who were lost to follow-up were significantly younger and had significantly fewer children than those who remained under observation in the study area. This is probably because younger women with fewer children are more likely to migrate away from the district.

Under surveillance system definitions, women absent for 180 days are "out-migrants." Births occurring to out-migrants are not recorded as births in a compound, even if the mother subsequently returns as an in-migrant. However, data tracking procedures have been instituted to locate out-migrants and maintain their identification. In this manner, births are linked to mothers if the birth occurs in the study district. However, practical problems in maintaining record linkage are suggested by the fact that returning migrants experience lower fertility in the period before moving than non-migrants. Although it is possible that these women simply had a low birth rate during their absences, we assume that data during these times were less accurate than information compiled among women who were under continuous observation. We have censored 151 (5.5 percent or the 2758 women in the dataset) of the cases with absent time of one year or more from the analysis. These women did not differ from other women in terms of their education, religion or husband's education. However, they were more likely to be in a polygamous marriage (odds ratio of 1.68, chi-square p-value of 0.00) and less likely to have been exposed to FGC (odds ratio of 0.63, chi-square p-value of 0.046). Logistic regression revealed that they were significantly younger and had lower parity relative to women who were not absent for one or more years and that they were significantly more likely to be of Nankam or other ethnicity relative to Kassim ethnicity. Removing the person-time of these 151 women from the analysis during their long absences resulted in a loss of 1,324 three month intervals, or 1.80 percent of remaining person time, and a total of five live birth events. These women were re-entered into the study as soon as their location became known again. In order to include as many birth events as possible, data about health care services that women may or may not have received in their absence will not be measured correctly in the first three quarters of their return to known location status. Removing these 1,324 quarters of observation time from the dataset leaves a total of 72,384 observations of person quarter years for 2,758 women.

Because our data were from a cohort study, we modeled the effect of FGC exposure on live birth outcome using risk ratios. A log linear model was used to estimate risk. Because the dataset included multiple observations of individuals over time, we used a cross-sectional time-series model to account for correlations within multiple observations of individuals in calculations of standard errors and variance. The estimation of the model in equation (1) used the STATA xtgee procedure with the family(binomial) and link(log) options. The estimation of the model in equation (2) utilized the STATA procedure stcox.

Variables used in the analysis included FGC, education, religion, ethnicity, and polygamy. Variables from the demographic surveillance system included parity, age, polygamy, compound population, health service, and calendar time. FGC status was measured with a binomial variable. Women who reported that they were not cut in 1995 were assigned a value of 0 and women who reported that they were cut in 1995 were assigned a value of 1. Women's educational status is also a binomial variable from the 1995 survey question: "Have you ever attended school?". Women who reported that they had never been to school are assigned a value of 0 and women who reported that they had been to school are assigned a value of 1. Ethnicity is a four level nominal categorical variable defined as Kassem, Nankam, Bulsa, and Other. Religion is also a four level nominal categorical variable with possible values of Traditional, Christian, Muslim, and Other. Parity is a categorical variable based on a continuous variable from the demographic surveillance dataset, updated every three months, that represents the total number of live births that a woman has ever had. In this study population, parity ranges from zero to 12 births. For our analysis, we defined parity in 8 categories of 0, 1, 2, 3, 4, 5, 6, or 7 or more births. Age is a continuous variable from the demographic surveillance dataset that represents current age in years of each woman, updated for each quarter (every three months) of observation. Polygamous marital status for currently married women in the GEE analysis was assessed in the 1995 survey with the question, "Does your husband/partner have any other wives besides yourself?". Possible responses are Yes, No, Don't Know, and Not Applicable (for women who don't have a husband or partner). Because only currently married women are included in the analysis dataset (see above) there are no "Not Applicable" responses. However, 0.14 percent of women answered "Don't Know"; these responses were treated as missing data. For the time series portion of our analysis of women with parity zero, marital and polygamous status were assessed by the demographic surveillance system in three month intervals so that we could include nulliparous women regardless of baseline marital status. Husband's education was assessed with the question, "Has your husband/partner ever attended school?". Possible responses are Yes, No, Don't Know, and Not Applicable (for women who don't have a husband or partner). Even though only currently married women are included in the analysis dataset (see above), 3.04 percent of responses are "Not Applicable" and 1.05 women answered "Don't

Know". These responses were treated as missing data. Compound population was measured during demographic surveillance and represents the population of each extended family compound, updated for each quarter of observation. This variable remains a continuous variable for this analysis; no coding changes are made. Health service was defined by location recorded in demographic surveillance. The district is divided into four service areas to test alternate methods of health care service delivery in the Navrongo Community Health and Family Planning Project. One area receives regular clinic-based services provided by the Ministry of Health. A second "community volunteer" area relies on community members who can give medicine for illnesses such as malaria, dispense contraceptive pills, and provide referrals for other serious health issues. In a third area, resident nurses provide immunization services, injection contraceptives, contraceptive pills, and basic health needs for community members in 90 day house-visit rounds. In the final area, both nurse and volunteer services are offered. Lastly, calendar time is included in the model as an important covariate for capturing the general trend of fertility decline present in the district (Debpuur et al. 2002). It is included as a continuous variable beginning with the first quarter in which women are observed in 1996 and continuing through the end of 2003, measuring time in quarter years.

Results

Table 1 presents a multiple logistic regression analysis of the background characteristics that are associated with FGC. Relative to other women, residents of traditional compounds are more likely to be polygamous, uneducated, married to an uneducated husband, members of the Nankam ethnic group, traditional in religion, members of a more traditional and thus larger extended family compound, and to have had a larger total parity because of traditional beliefs in the importance of expanding the family lineage. As the odds ratios in column 1 of Table 1 show, such women are also more likely to have been genitally cut, although compound population was found to have little association with FGC. These same seven covariates also influence contraceptive use, which in turn influences whether or not a live birth takes place (column 4, Table 1). Odds ratios in column four attest to the influence of polygamy, educational attainment, religion, ethnicity, and compound size[2] on contraception, for example; the more traditional a woman is, or the more traditional her husband and his family are, the more likely she is to *not* use a modern method of contraception (Debpuur, et al, 2002). Since the indicators of traditionalism in Table 1 are co-determinants of fertility and FGC, they are appropriate elements of the vector *U* in equation 1.

Table 1: Multivariate logistic regression models of the odds ratio that a woman has experienced FGC or has ever used modern contraception (pill, IUD, injection, diaphragm, foam, condom, or male sterilization) by selected covariates of 2,641 currently married women , 1995 Navrongo Panel Survey

		FGC			Ever Used Modern Contraceptive	
	OR	(95% CI)	p-value	OR	(95% CI)	p-value
Ever used modern contraception	0.59	(0.43, 0.83)	0.00			
Exposed to FGC				0.60	(0.43, 0.84)	0.00
Attended school	0.46	(0.34, 0.63)	0.00	1.91	(1.50, 2.43)	0.00
Polygamous marriage	1.33	(0.98, 1.81)	0.07	0.85	(0.68, 1.08)	0.19
Christian$^{\pm}$	0.63	(0.46, 0.86)	0.00	1.97	(1.55, 2.51)	0.00
Muslim$^{\pm}$	0.75	(0.38, 1.47)	0.40	1.45	(0.86, 2.47)	0.17
Other$^{\pm}$	1.07	(0.12, 9.53)	0.95	2.83	(0.64, 12.50)	0.17
Nankam$^{\nabla}$	0.81	(0.58, 1.14)	0.23	0.54	(0.41, 0.71)	0.00
Bulsa$^{\nabla}$	0.74	(0.38, 1.46)	0.39	0.66	(0.38, 1.14)	0.14
Other_ethnicity$^{\nabla}$	0.10	(0.05, 0.21)	0.00	0.70	(0.31, 1.61)	0.41
Age-20	1.14	(1.05, 1.23)	0.00	1.09	(1.02, 1.17)	0.01
(Age-20) squared	1.00	(0.99, 1.00)	0.06	1.00	(0.99, 1.00)	0.00
Volunteer$^{\lozenge}$	0.84	(0.53, 1.32)	0.45	1.52	(1.09, 2.11)	0.01
Nurse$^{\lozenge}$	2.32	(1.21, 4.46)	0.01	1.11	(0.76, 1.62)	0.59
Nurse & Volunteer$^{\lozenge}$	0.52	(0.36, 0.74)	0.00	1.17	(0.86, 1.60)	0.32
Compound Population 1-9$^{\phi}$	0.98	(0.64, 1.50)	0.92	0.93	(0.64, 1.34)	0.69
Compound Population 20-39$^{\phi}$	0.90	(0.65, 1.26)	0.55	1.22	(0.94, 1.58)	0.13
Compound Population 40-143$^{\phi}$	0.96	(0.61, 1.52)	0.88	1.53	(1.09, 2.16)	0.01
Husband ever attended school	0.47	(0.34, 0.63)	0.00	1.54	(1.21, 1.96)	0.00
Parity0$^{\delta}$	0.23	(0.10, 0.53)	0.00	0.27	(0.09, 0.80)	0.02
Parity1$^{\delta}$	0.39	(0.22, 0.69)	0.00	0.73	(0.44, 1.22)	0.23
Parity2$^{\delta}$	0.62	(0.37, 1.02)	0.06	0.80	(0.55, 1.16)	0.24
Parity3$^{\delta}$	0.61	(0.38, 0.99)	0.05	1.06	(0.77, 1.46)	0.73
Parity5$^{\delta}$	0.65	(0.36, 1.17)	0.15	1.43	(0.99, 2.07)	0.06
Parity6plus$^{\delta}$	0.83	(0.41, 1.66)	0.59	1.50	(0.99, 2.26)	0.06
Log likelihood		-708.8957			-1065.5858	

Age is also associated with traditional lifestyle and FGC. The prevalence of FGC increases with age because the practice has been declining with time, exposing successive cohorts of young women to lower risks that the practice will be imposed. Thus the estimation of equation 1 controls for the effect of declining FGC over time with the age variable (Reason 2004, Akweongo et al. 200X, Jackson et al. 2003). This represents a potential contaminant in the analysis, as the total fertility rate has also declined over the study period (Debpuur et al. 2002, Phillips et al. 2005). In summary, health-service, compound population, women's educational attainment, religion, ethnicity, ordinal time since 1993, and marriage type represent potential confounders of the relationship between FGC exposure and live birth outcome (parity progression).

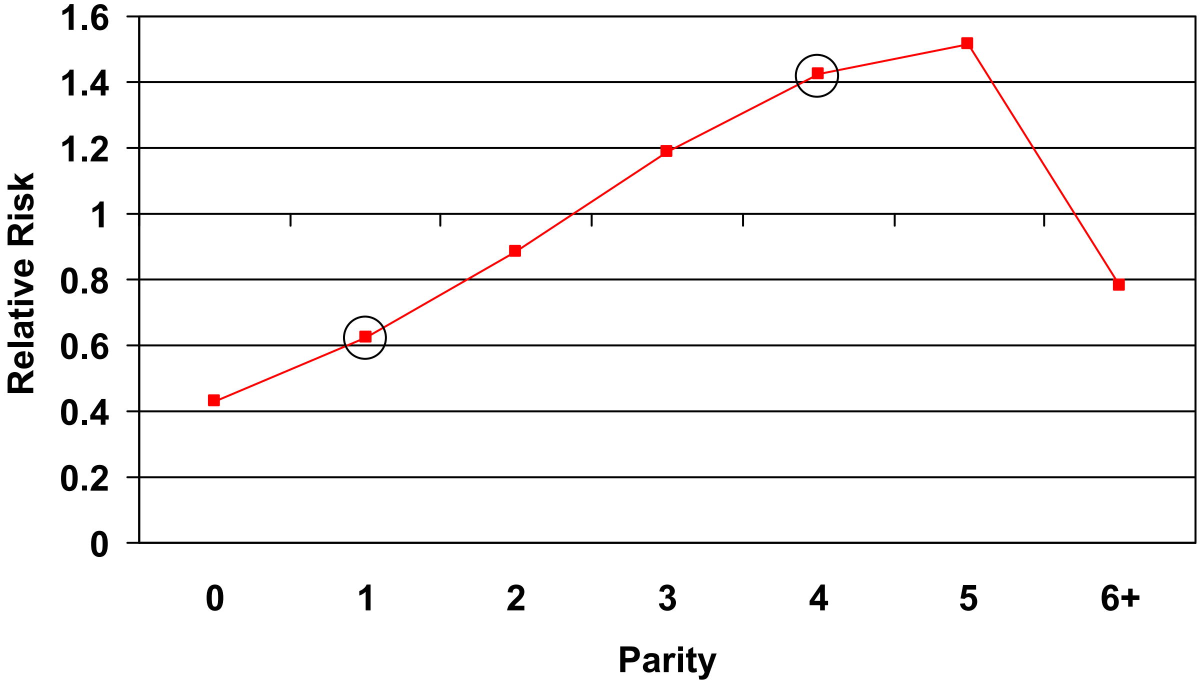
Table 2: Binomial cross-sectional time-series (GEE) regression modeling of the effect of FGC on relative risk of parity progression in a 3 month period for 2,641 individual women observed for a total of 69,274 quarter years

	Risk Ratio	(95% CI)	p-value
N (# obs)		69,274	
Main Exposure: FGC	1.43	(1.05, 1.93)	0.02
Woman attended school	0.95	(0.87, 1.04)	0.29
Woman in polygamous marriage	0.90	(0.84, 0.97)	0.01
Christian	0.87	(0.80, 0.95)	0.00
Muslim	0.79	(0.65, 0.96)	0.02
Other_religion (reference is Traditional)	0.97	(0.59, 1.58)	0.89
Nankam	1.11	(1.01, 1.23)	0.04
Bulsa	0.91	(0.76, 1.08)	0.26
Other_ethnicity (reference is Kassem)	1.20	(0.92, 1.57)	0.18
Age-20	1.10	(1.07, 1.13)	0.00
(Age-20) squared	0.99	(0.99, 1.00)	0.00
Volunteer	1.04	(0.91, 1.19)	0.52
Nurse	1.08	(0.95, 1.23)	0.26
Nurse & Volunteer (reference is MOH)	0.90	(0.82, 1.00)	0.04
Time1997	1.07	(0.94, 1.23)	0.29
Time1998	0.95	(0.83, 1.10)	0.52
Time1999	1.08	(0.93, 1.24)	0.31
Time2000	1.03	(0.89, 1.19)	0.70
Time2001	0.99	(0.85, 1.15)	0.87
Time2002	0.86	(0.73, 1.02)	0.08
Time2003	1.04	(0.88, 1.22)	0.66
Compound Population 1-9	1.06	(0.95, 1.17)	0.30
Compound Population 20-39	1.06	(0.97, 1.15)	0.20
Compound Population 40-143 (ref. 10-19)	1.01	(0.89, 1.15)	0.88
Husband ever attended school	0.92	(0.85, 1.00)	0.05
Parity0	0.88	(0.35, 2.22)	0.79
Parity1	2.88	(1.91, 4.35)	0.00
Parity2	1.96	(1.37, 2.80)	0.00
Parity3	1.41	(0.98, 2.02)	0.06
Parity5	0.87	(0.50, 1.51)	0.63

Parity6plus (reference is Parity 4)	1.58	(0.94, 2.64)	0.08
Parity0*FGC Interaction	0.30	(0.10, 0.95)	0.04
Parity1*FGC Interaction	0.44	(0.28, 0.68)	0.00
Parity2*FGC Interaction	0.62	(0.43, 0.90)	0.01
Parity3*FGC Interaction	0.83	(0.57, 1.21)	0.34
Parity5*FGC Interaction	1.06	(0.60, 1.87)	0.83
Parity6plus*FGC Interaction	0.55	(0.32, 0.93)	0.03

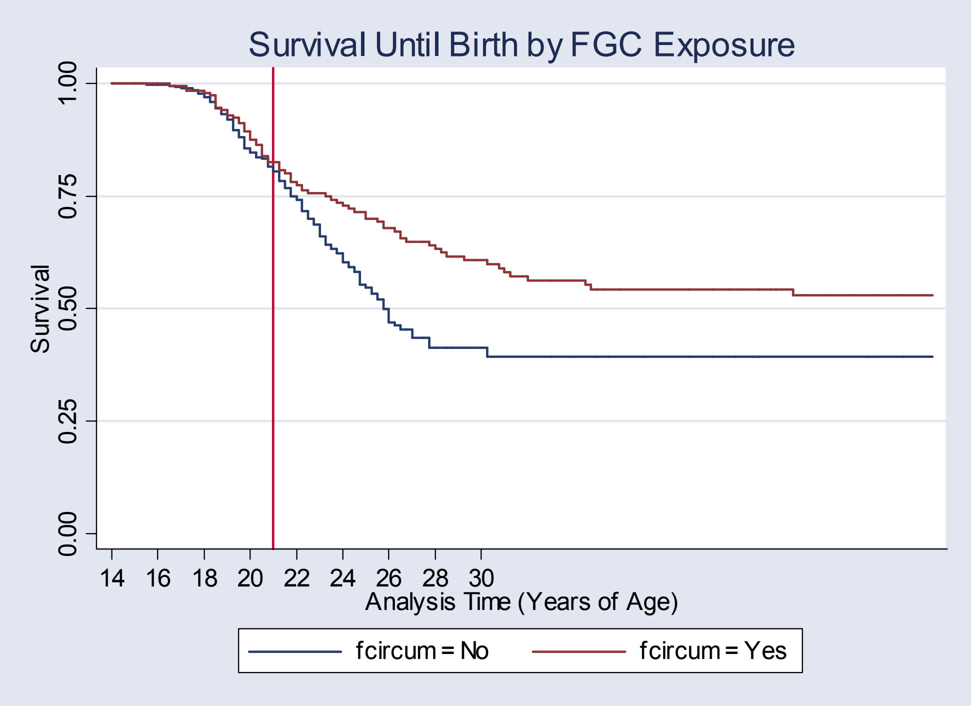
The complete model for the effect of FGC on risk of live birth outcome within a three month period is presented in Table 2. The effect of FGC was found to be heterogeneous by parity, so an interaction term for FGC and parity is included in the model. The risk ratio associated with FGC for each level of parity is presented in Figure 1. The adjusted model found that FGC was associated with increased risk for live birth outcome among women with parity of 3, 4, or 5. Among women who had never given birth or who had a parity of 1, 2, or 6 or more, FGC was associated with a decreased risk of parity progression, or live birth outcome. Low parity women exposed to FGC appear to delay the onset of childbearing and to space births once fertility ensues relative to the pace and level of fertility among uncut women. Similar relative effects associated with FGC are evident at higher parities.

Figure 1: Relative risk of live birth outcome among women exposed to FGC compared to women unexposed to FGC controlling for covariates, by parity. Parity levels for which FGC is associated with a risk ratio significantly different from 1 are circled.



FGC and timing of first live birth. Parity progression among women who have ever given birth before may be understood in terms of birth spacing or cessation. Parity progression among nulliparous women represents the onset of fertility and requires special modeling techniques to account for left-censoring in our dataset. In order to examine the relationship of FGC to the timing of the onset of fertility, we constructed a Cox proportional hazards model of the 622 women aged 15-49 who entered our study with zero parity. Analysis time was assessed as age in quarter years, beginning with age 14 years. As indicated by the cumulative survival plot, below, the hazard of birth associated with FGC was different for women of different ages (Figure 2).

Figure 2: Kaplan-Meier estimate of survival until live birth outcome among nulliparous women, by FGC exposure



A simple Cox proportional hazard model of the relationship between FGC and first live birth showed that for cut women who are over 21 years of age, the hazard ratio for birth, relative to women who are uncircumcised and also over 21, is 0.47 ($p < 0.001$). Cut women who are 21 years of age or younger have a birth hazard that is not significantly different from the null, with a p-value of 0.498. This may reflect selectivity, in that older nulliparous women may have a disproportionately high percent of infecund women relative to younger nulliparous women. From this basic analysis it appears that FGC has no impact on probability of first live birth among younger women, but once a woman is older than 21, if she has yet to give birth, FGC exposure bears some relationship to her hazard of first live birth.

Controlling for current marital status introduces further complexity into observed relationships (Figure 3). A Cox model of the hazard of birth by marital and FGC status illustrates that all cut women and unmarried women who are not cut all have a significantly lower hazard of birth than uncut married women (table 3).

Table 3: Cox proportional hazard of live birth outcome among 622 nulliparous women followed for 6,530 person years since the age of 14, by FGC and marital status

	Hazard Ratio	(95% CI)	p-value
Unmarried, Uncut	0.14	(0.10, 0.19)	0.00
Married, Uncut	0.20	(0.14, 0.29)	0.00
Unmarried, Cut	0.13	(0.08, 0.21)	0.00
(Reference is Married, Uncut)			

Among the Kassena and the Nankana, marriage is often a gradual status reached over time as bride price is paid and wife's residence is negotiated and established once her fertility has been demonstrated. Married women are often abandoned by their husbands if their production of children fails to meet extended family expectations. Women classified as unmarried are therefore a mix of women who are not in union and women who are in sexual unions that are not recognized as marriage by survey respondents. Marriage is thus an ill-defined heterogeneous risk category. Because of this uncertainty, further analysis was restricted to the 180 nulliparous women who were currently married with known status as polygamous or monogamous.

A series of three nested Cox proportional hazard models were estimated to examine the effect of FGC on timing of first live birth among these 180 nulliparous women (Table 4). One limitation of the analysis is that we do not know the timing of marriage for these women; analysis time is still based on time since age 14 years. Although FGC is associated with earlier marriage in this study population (Reason 2004), among nulliparous women, FGC appears to be responsible for increased delays in timing of first live birth even though women exposed to FGC are likely to have been in marital union for longer duration.

Table 4 models demonstrate that the effect of FGC exposure among nulliparous women on hazard of live birth outcome is modified by a woman's age and marital status as monogamous or polygamous. In Model 1, the overall effect of FGC on live birth outcome is negative but the 95% confidence interval includes zero. According to the risk ratios estimated for Model 2, FGC has a progressively stronger negative effect on birth hazard with age. A 21 year old who has been cut has 0.32 times the hazard of birth than a 21 year old who has not been cut ($p < 0.001$), while FGC makes no difference for a 14 year old's parity progression hazard. However, adding polygamy and a polygamy and FGC interaction term produces significant new and complex conditional hazards. (Table 4, model 2). The effect of FGC and marriage type on live birth hazard is robust to the addition of possible confounding factors in Model 3[3].

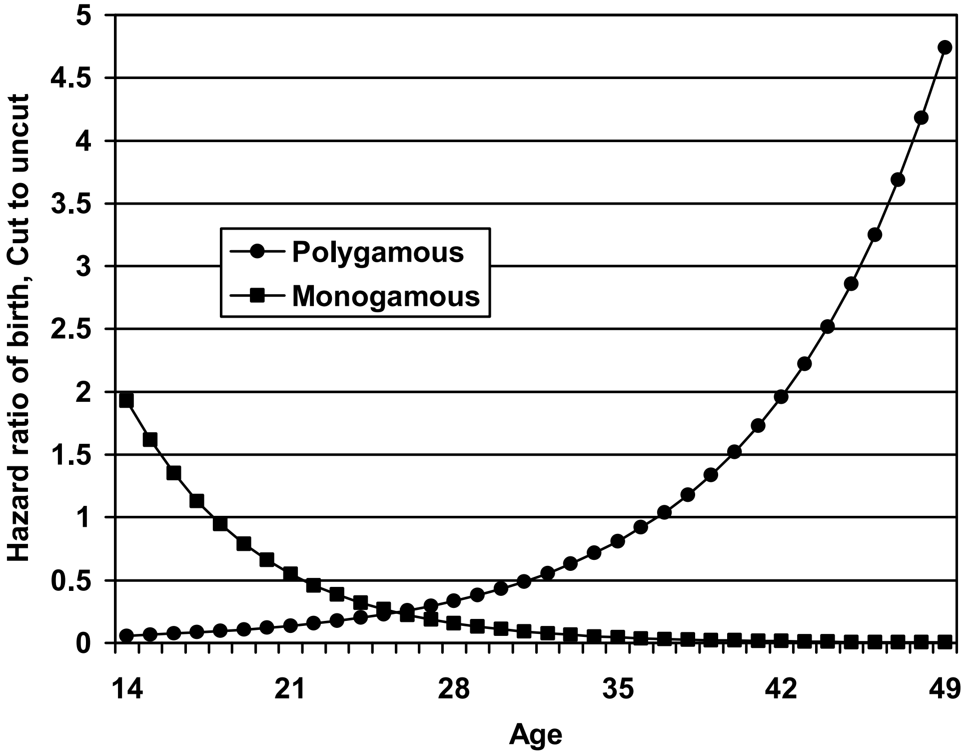
Table 4: Cox proportional hazard ratios comparing live birth outcome of cut and uncut women among 180 currently married nulliparous women followed for 2,454 person years since age 14

	Model 3		Model 2		Model 1	
	HR (95% CI)	P	HR (95% CI)	p	HR (95% CI)	p
Main exposure: FGC	1.93 (0.54, 6.88)	0.31	1.47 (0.43, 5.00)	0.53	0.61 (0.21, 1.74)	0.35
Polygamous	3.00 (0.40, 22.21)	0.28	1.76 (0.24, 12.75)	0.58		
FGC*Polygamy interaction	0.03 (0.00, 0.55)	0.02	0.04 (0.00, 0.76)	0.03		
Woman attended school	0.95 (0.59, 1.54)	0.85				
Christian$^{\pm}$	0.78 (0.49, 1.23)	0.28				
Muslim$^{\pm}$	0.70 (0.23, 2.11)	0.53				
Nankam$^{\nabla}$	1.34 (0.83, 2.15)	0.23				
Bulsa$^{\nabla}$	0.38 (0.05, 2.98)	0.36				
Other_ethnicity$^{\nabla}$	0.28 (0.04, 2.13)	0.22				
Calendar time (quarters)	1.03 (1.00, 1.05)	0.03				
Volunteer$^{\Diamond}$	1.25 (0.60, 2.60)	0.56				
Nurse$^{\Diamond}$	1.07 (0.50, 2.27)	0.87				
Nurse & Volunteer$^{\Diamond}$	1.48 (0.80, 2.72)	0.21				
Compound Population 1-9$^{\phi}$	1.12 (0.70, 1.79)	0.64				
Compound Population 20-39$^{\phi}$	0.56 (0.33, 0.95)	0.03				
Compound Population 40-143$^{\phi}$	0.38 (0.17, 0.86)	0.02				
Interactions with age (analysis time):						
FGC * age	0.96 (0.92, 0.99)	0.02	0.96 (0.92, 0.99)	0.02	0.98 (0.95, 1.01)	0.12
Polygamy * age	0.98 (0.91, 1.04)	0.45	0.99 (0.93, 1.05)	0.69		
Polygamy * FGC * age	1.08 (0.99, 1.17)	0.07	1.07 (0.99, 1.16)	0.11		
Log likelihood	-473.74		-489.86		-494.36	
Number of observations			1,872			
Number of subjects			180			
Number of failures			110			

$^{\pm}$Reference is traditional religion; $^{\nabla}$Reference is Kassem ethnicity; $^{\Diamond}$Reference is Ministry of Health services; $^{\phi}$Reference is Compound Population of 10-19 people

Model 3 hazard ratios for birth event comparing cut and uncut women, controlling for all covariates, are graphically presented in Figure 3. Among polygamous women less than 27 years of age, FGC is associated with a significant reduction in birth hazard. FGC has no effect on the birth hazard of married polygamous women who are 27 years or older. Among monogamous women, there is no effect of FGC on birth hazard if women are under 21 years of age, but for monogamous women who are 21 years or age or older, FGC is associated with a significant decrease in birth hazard.

Figure 3: Hazard ratios associated with FGC among 108 nulliparous currently married women, by polygamy and age



Discussion

This analysis has found that fertility regimes of cut and uncut women differ. Being cut lowered the risk of birth for women of parity below three and for women with parity of above 5. Cut women of parity 3, 4, and 5 had elevated birth risk relative to uncut women. Among nulliparous women, the effect of FGC on risk of live birth differed by age and marital status as monogamous or polygamous. The onset of first birth was delayed for polygamous women who were cut, but not for monogamous women, in spite of the association of FGC with earlier age at marriage that has been documented in the study area (Reason 2004). Among women who remained nulliparous into their thirties, the effect of FGC on fertility was also modified by type of marriage, but in the opposite direction. Cutting made no difference on the live birth risk of polygamous women but was associated with decreased risk of live birth outcome among monogamous women.

The underlying cause of these relationships remains unknown. However, relationships which are age and parity conditional and are robust to the introduction of social characteristics may be predominantly physiological. Relationships that change with the introduction of social background characteristics must be related to social behavior rather than physiology. The precise weight of physiological and behavioral factors cannot be disentangled; the relative importance of these effects can be inferred through investigation of conditionalities. That nulliparous cut women are less likely to give birth than nulliparous uncut women, overall, indicates that FGC may be associated with fertility decreases for some women, given that married cut women are likely to have been married for a longer time than married uncut women of the same age. The finding that, among nulliparous women, the effect of FGC is conditional on marital status as monogamous or polygamous at different ages supports the presence of important behavioral mechanisms for the effect of FGC on risk of birth.

These findings contrast somewhat with other studies. A previous study found no difference in first delivery obstetric morbidity between cut and uncut women once a woman's delivery situation had been taken into account (Slanger et al. 2002). Our study consists of women whose deliveries take place almost entirely at a home rather than a hospital setting. It is possible that if good medical care is available, women exposed to FGC have no greater risk of first-delivery morbidity. However, in resource-poor settings such as Kassena-Nankana district that do not have access to the benefits of modern medical care, it may well be that first deliveries are more complicated for women exposed to FGC.

Our study included important limitations that should be noted. Firstly, we only know the estimated prevalence of the different types of FGC in the study area overall; we do not have information specific to individuals on the type of FGC. Our study classifies simply whether or not a woman has been cut, not to what degree. For this reason, we are not able to differentiate between the effects of different types of cutting which would presumably differ. Secondly, we have no data on coital frequency or physiological outcomes in individual women in the study area. However, we do have information indicating poor reproductive outcomes in a nearby and culturally similar area: Jones et al. conducted a study in a southern Burkina Faso province that is contiguous to the Ghana border showing poor reproductive outcomes among cut women. These women showed a similar distribution of cutting types, although cuttings tended to be slightly milder with fewer excisions (type II) and more clitoridectomies (type I) (Jones et al. 1999)[4]. Thus, the fertility effect that we found can only be attributed to the net effects of behavioral and physiological mechanisms.

Lastly, important covariates such as contraception were only measurable at baseline from the 1995 panel survey. Gauging the interaction of fertility regulation with fertility FGC effects requires a continuous longitudinal register of contraceptive use dynamics among cut and uncut women.

Conclusion

Cultural norms of the Kassena-Nankana place a high value on first and second births early in marriage. Traditional values tend to elevate fertility relative to the behavioral effects of Western education, family building customs, and fertility regulation customs. Elevated fertility associated with mid-parities may reflect unmeasured fertility elevating effects of traditional family building norms. Depressed fertility at low parities is less convincingly attributable to traditionalism and behavior, and may indicate that FGC has permanent fertility effects that sustain the nulliparous state among some cut women and delays the pace of child bearing in subsequent birth intervals among others. This conclusion cannot be definitive, and merits further investigation with data that permit appraisal of the interaction of proximate fertility determinants with FGC. Moreover, significant interactions with indicators of traditionalism suggest that behavioral determinants are more important than physiological explanations. For this reason, the effects observed in this study may not recur in other cultural settings.

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NOTES

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[1] Empirical research on the effects of FGC on sexuality is lacking. A study conducted with 1994-1995 data from the Central African Republic DHS found no association between FGC and coital frequency, although the authors noted that women's fertility desires and their control over coital frequency were not known (Stewart et al. 2002).

[2] Large compound size, thought to be associated with traditionalism, was found to be ssociated with modern contraceptive use, perhaps due to increased social network access.

[3] Husband's education is not added due to the sample size loss it would cause with missing values. This analysis contains women who were unmarried in the 1995 panel and were subsequently married. This may lead to misclassification of FGC exposure if women who were unmarried and uncut in 1995 were cut before marriage. Some women identified as unexposed to FGC in our sample may actually have been cut since 1995. Misclassification of exposure in a cohort study such as this would cause no bias as long as misclassification of exposure occurs equally for women who do and do not experience the outcome.

[4] The majority of women in the Burkina Faso study had undergone clitoridectomy-type FGC procedures; 39 percent had excisions, and five percent were infibulated. (Jones et al. 1999)..