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Trends in female genital mutilation/cutting in Senegal: What can we learn from successive household surveys in sub-Saharan African countries?

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Abstract

Background

Over the last several decades, global efforts to end female genital cutting/mutilation (FGM/C) have intensified through combined efforts of international and non-governmental organizations, governments, and religious and civil society groups. One question asked by donors, program implementers and observers alike is whether there is any evidence that FGM/C is declining. For many years this question was not easily answerable due to the lack of nationally representative data. In the last two decades, however, reliable data have been generated in numerous countries through major household surveys, including repeat cross-sectional surveys. What can we learn from these data? We explore this question by analyzing data on FGM/C obtained from women aged 15-49 in two successive household surveys in Senegal (2005 and 2010-11). The aggregate national-level statistics suggest that there has been no significant change in the prevalence of FGM/C among adult women. These figures are, however, unadjusted for potentially confounding factors, and potentially mask important variation in the practice. More refined statistical analyses are, therefore, needed to examine factors influencing FGM/C at the individual- and community-level. This information can provide a deeper understanding of trends in FGM/C across regions, and possibly across generations, providing evidence as to when and where the practice of FGM/C is changing.

Methods

Participants were 14,602 and 14,228 respondents from two consecutive Senegal Demographic and Health Surveys from 2005 to 2010 (FGM/C prevalence 30.1% in 2005 and 28.1% in 2010). A Bayesian geo-additive mixed model based on Markov Chain Monte Carlo techniques was used to map the change in the spatial distribution of FGM/C risk at the regional level during the five-year period, while simultaneously examining the effect of individual-level risk factors.

Findings

Overall, the prevalence of FGM/C at that national level changed little over the 5-year period, but the fully-adjusted model and map of trend in residual spatial effects at the regional level reveal important spatial patterns. Across both survey periods, several high prevalence regions remained "hot spots," bearing a consistently high FGM/C risk. These include Kolda (along with the newly subdivided region of

Sédhiou in 2010), Tambacounda (along with the newly subdivided region of Kédougou in 2010), and Matam. At the same time, risk remained non-significant in the high prevalence regions of Saint Louis and Zinguinchor, and was attenuated between 2005 and 2010-11 in Kaolack (including the newly subdivided region of Kaffrine in 2010), shifting from non-significant risk in 2005 to a very low FGM/C risk in 2010-11. In both surveys, unadjusted estimates of the effect of age show no significant difference in risk of FGM across age cohorts. However, non-parametric covariate-adjusted estimates show that in both surveys age is a significant risk factor for FGM/C, although not in the anticipated direction. The effect of age on risk of FGM/C is highest in women aged 15-20, and declines with increasing age. Other significant factors include socio-demographic variables, particularly ethnicity.

Interpretation

Findings from two consecutive surveys reveal that while no significant changes in FGM/C prevalence are found at the national level, mixed changes are visible at the regional level, as well as at the individual level. Adjusted non-parametric estimates reveal that the risk of FGM/C decreases with increasing age, a finding that is at first surprising given the strong local and national efforts aimed at reducing FGM/C in Senegal. When interpreting these findings, however, it is important to note that most women were cut before the age at five, at a time that precedes some of the most intensive FGM-prevention activities. Spatial analysis reveals that geographic location is an important correlate of changes in likelihood of FGM/C, suggesting that community factors, above and beyond individual factors, play a crucial role in the perpetuation, spread, or decline in the practice of FGM/C. These novel findings fit with predictions of theory on social norms and conventions which suggest that the practice is upheld by interdependent expectations regarding the practice, and when such expectations are challenged within a community, the possibility for abandonment is opened.

INTRODUCTION

Over the last four decades, global efforts to end female genital cutting/mutilation (FGM/C) have intensified through combined efforts of international and non-governmental organizations, governments, and religious and civil society groups. One question asked by donors, program implementers and observers alike is whether there is any evidence that FGM/C is declining (Toubia and Sharief, 2003; UNICEF, 2013; Yoder and Wang, 2013). For many years this question was not easily answerable due to the lack of nationally representative data. In the last two decades, however, reliable data have been generated in numerous countries through major household surveys, and in some countries repeat surveys have been implemented (UNICEF, 2013; Yoder and Wang, 2013). What can we learn from these data? We explore this question by analyzing data from two successive household surveys in Senegal (2005 and 2010-11 Demographic and Health Surveys), adopting a novel Bayesian geo-additive model and mapping changes in FGM/C at the regional level. We explore the effects of geographic location, as well as individual factors, in an effort to gain a deeper understanding of trends in female genital mutilation/cutting (FGM/C) across the generations in Senegal.

FGM/C refers to a set of practices for altering the female genitalia for non-medical reasons. The practice is known by a variety of names. In addition to those found in languages of those who uphold the practice, there is an exhaustive terminology in English, including female circumcision, female genital operations or surgeries, female genital cutting, and female genital mutilation, each of which carries political connotations and arouses sensitivities of various stakeholders (Shell-Duncan and Hernlund, 2000). UNICEF and UNFPA currently promote the use of the hybrid female genital mutilation/cutting to reflect the significance of using "mutilation" at the policy level and employing non-judgemental terminology when working with practicing communities (UNICEF, 2013). Collectively, these terms refer to a range of practices that span from nicking the tissue surrounding the clitoris to the complete removal of the external genitalia. WHO (2008) has classified different types of FGM/C as follows: Type I (clitoridectomy) involved removal of all or part of the clitoris and/or the prepuce; Type II (excision) involves removal of the clitoris and the labia minora; Type III (infibulation) involves removal of all of the external genitalia, and appositioning the labia to form a seal, leaving a pinhole opening for the passage of urine and blood; and Type IV, all unclassified forms, including nicking or symbolic circumcision. Just as the forms of these practices are not monolithic, neither are the people who uphold the custom nor geographic regions in which it takes place. FGM/C is carried out in a wide variety locations from Indonesia and the Middle East, to Europe and North America; however, the vast majority of FGM/C occurs on the African continent in countries spanning North Africa and the Horn to West Africa. Practitioners include Muslims, Christians, Falasha Jews, and followers of indigenous African religions. UNICEF (2014) estimates that worldwide 133 million women have undergone some form of FGM/C, and approximately 3.3 million girls are cut each year.

While opposition to FGM/C can be traced back more than a century, the most current wave of activism was launched through a series of conferences held during the U.N. Decade for Women (1975-85). Since that time a wide range of intervention strategies have been implemented with the goal of accelerating abandonment of FGM/C. Initially, the most common approach used was information and education campaigns that sought to educate people about the adverse health outcomes associated with FGM/C. This approach rested on the assumption that as people became increasingly aware of negative health risks, they would weigh this against the perceived positive aspects, and become motivated to abandon the practice (Muteshi and Sass, 2005). Increasingly health education campaigns were complemented by other strategies, such as retraining traditional circumcisers and compensating them for "handing over the knife" (Gosselin, 2000; WHO, 1999). Additionally, education became incorporated as one element in more complex strategies, such as intergenerational dialogue programs that facilitate conversation and critical assessment of FGM/C among elder and younger members of practicing communities (UNICEF, 2010), and alternative rites of passage programs which encouraged upholding, and in some cases reviving, traditional ceremonial aspects of girls' initiation, but eliminating the cutting aspect of the ritual (Chege et al., 2001, Hernlund, 2000; for a fuller discussion of key intervention approaches for preventing FGM/C, see Feldman-Jacobs and Ryniak, 2006; Denison et al., 2009; Johansen et al., 2013). The most well-known and systematically implemented approach has been the holistic community education program developed by the Senegal-based nongovernmental organization Tostan. This program aims to empower communities to participate in their own social, economic, political and cultural development (Tostan, 1999). Their two-year education program focuses on hygiene, problem solving, women's health and human rights, and culminates in a public declaration to abandon FGM/C (Diop et al., 2003). By 2010, more than 4000 communities in Senegal had participated in public declarations (www.tostan.org, accessed July 2012). Media coverage of these declarations have generated triumphalist stories featuring headlines such as "Victory in sight for revolution over female genital mutilation" (Lakhani, 2012), leading to speculation about the imminent end of FGM/C.

The Tostan program has also garnered recognition owing to its alignment with a prominent theory of change with respect to FGM/C. Tostan's focus on coordinating change within communities by organizing public declarations to abandon FGM/C corresponds closely to social convention theory, which has now become the dominant theoretical framework for programs focusing on FGM/C prevention. Social convention theory uses a game-theoretic approach to explain how certain social practices, such as FGM/C, can become locked in place, and most effectively changed through a process of collective action (Mackie, 1996, 2000). It highlights that independent behavior change among individuals is difficult, even if they have become opposed to the practice, because reciprocal expectations and sanctions from violating social norms make it costly for an individual or family to opt out (Mackie and LeJeune, 2009). Communicating changed social norms and expectations, and coordinating behavior change among interconnected social actors allows a critical mass of individuals to move to a new equilibrium, and alter behavior without experiencing negative repercussions. For years, the social norms approach and its emphasis on coordinating incentives has come to form the cornerstone of a number of development programs focused on prevention of FGM/C in Senegal, as well as elsewhere in Africa (UNCIEF, 2007; UNICEF, 2010; UNICEF, 2013). This has led many observers to wonder whether in Senegal, as well as other countries with active intervention programs, there has been progress leading to change in the prevalence of FGM/C detectable in national survey data. This has motivated UNICEF (2013) and Yoder and Wang (2013) to complete statistical overviews of nationally-representative data on FGM/C. For Senegal, consecutive survey data are available from 2005 and 2010-11, and aggregate statistics on prevalence of FGM/C among women aged 15-49 reveals no significant decline (30.1% in 2005 and 28.1% in 2010-11). More refined statistical analyses are, therefore, required to control for potentially confounding factors.

There are two important considerations that guide the development of an appropriate analytical approach for analysing factors associated with FGM/C in currently available nationally-representative data sets. First, the DHS employs a multistage sampling strategy that involves cluster sampling to draw upon women responders; this creates an analytical challenge because observational units are not independent. Hence, statistical analyses that rely on the assumption of independence, such as standard probit and logistic models, are no longer valid. Second, knowledge of nonlinear effects for some covariates means that it is not possible to assume strictly linear predictors. Analytical approaches have been developed to handle each of these issues. Hayford's (2005) analysis of the 1998 Kenya DHS employed hierarchical models, also known as multilevel models, to separately estimate the effect of community-level and individual-level effects on risk of FGM/C. While this approach provides unbiased estimates when individual-level observations are not independent, it does not address the structured spatial effects that arise from cluster sampling. The DHS clusters often include more than one village that are close to each other and share common risk factors, and consequently, the assumption of independence at the geographical level, such as state, province or region, is not correct. The independence assumption has an inherent problem of consistency: if the location of the event matters, it makes sense to assume that areas close to each other are more similar than those far apart. Therefore, in this study we adopt methods that account for spatial effects on risk of FGM/C that were applied by Kandala and colleagues (2009) in their analysis of the 2003 Nigeria DHS. This novel approach involves using geo-additive, semi-parametric models that control for spatial dependence and possible nonlinear and time-varying covariates. Specifically, we investigate the following questions:

1. What are the trends in FGM/C among women across Senegal and within regions?
2. Are individual characteristics, such as education, wealth and ethnicity, associated with likelihood FGM/C?
3. Are community-level factors, captured by covariate-adjusted geographic estimates, important predictors likelihood of FGM/C, as predicted by social convention theory?
4. After adjusting for individual- and community-level factors, do we see a decrease in the prevalence of FGM/C across generations of women in Senegal?

FEMALE GENITAL MUTILATION/CUTTING IN SENEGAL

The Republic of Senegal, with a 2010 population of more than 12.5 million, is home to more than 20 ethnic groups, each with their own language, culture and history. The country is divided into 14 administrative regions **(Figure 1)**. Three of these regions were newly created in 2008, when Kaffrine Region was split from Kaolack, Kédougou was split from Tambacounda, and Sédhiou Region was split from Kolda. A minority of the Senegalese population practices FGM/C, predominantly non-infibulating forms. FGM/C is called excision in French, and by a wide variety of terms in local languages. FGM/C in Senegal is generally understood to be tied to ethnicity, with some exceptions, due in part to increasingly common inter-ethnic marriages that are FGM/C-incongruent, where one partner comes from a family that practices FGM/C, while the other does not. FGM/C is said to be "not practiced" by the Wolof and Sereer (Sylla, 1990), who make up 58% of the total population. FGM/C is thought to be near universal among the Tukulor and Mandinka ethnic groups, and among the Jola and Fula, the prevalence is understood to run along lines of lineages. Generally, the practice is passed down from elders to the younger generations by serving as an obligation for acceptance and social integration (Shell-Duncan et al., 2011).

Beyond demarking group membership, ethnographic studies reveal a multitude of reasons for the practice related to constructs related to gender ideology and proper childrearing. In some groups, the practice serves as an important rite of passage that marks the transition from childhood to adulthood. In recent decades, however, there is a trend in practicing communities to uncouple FGC from initiation, and perform the procedure at younger and younger ages (Shell-Duncan et al., 2010). Nonetheless, in many groups FGM/C is still widely held to be essential for the moral upbringing of girls, teaching them, among other things, sexual restraint and how to display respect to elders. Additionally, in certain groups FGC is associated with Islam, providing the ritual purity and cleanliness believed to be required for prayer (Dellenborg, 2007; Shell-Duncan et al., 2010).

Across different communities, the cultural meanings of FGM/C are multiple, fluid, and increasingly contested and negotiated by diverse groups of people who draw on local social and political movements, as well as national and international campaigns aimed at ending FGM/C. Senegal has been the site of a number of media campaigns and NGO-sponsored initiatives aimed at ending the practice of FGM/C, including, but not limited to, Tostan[1]. At the same time, the Senegalese Government has taken a strong stance in opposition to the practice of FGM/C. In 1999 Senegal adopted a criminal law that prohibits the violation of "the integrity of the genital organs of a female person,"[2] carrying a penalty includes prison for 6 months to 5 years, or where cutting results in death, hard labor for life. Additionally the Government adopted a National Action Plan for 2001-2005 that articulated a clear goal of working toward the total abandonment of FGM/C by 2015 (Diop-Diagne, 2008), and reiterated this goal in a second National Action Plan for 2010-2015, adopted in February 2010 (UNICEF, 2010).

With a strong local and national commitment to ending FGM/C in Senegal, backed by the international community, international organizations organization, as well as private donors, there is tremendous interest in assessing whether progress has been made toward abandonment of FGM/C. Hence, results of nationally-representative statistical surveys on FGM/C have been awaited with great anticipation. Summary statistics from these surveys have been released (UNICEF, 2013; Yoder and Wang, 2013; Creel, 2001). The data summarized in **Table 1** describe the circumstances surrounding the

[1] Among these are L'Association Sénégalaise pour le Bien Etre Familial (ASBE – Senegalese Association for Family Well-Being), Comité Sénégalais sur les Pratiques Traditionnelles Ayant Effet sur la Santé de la Mère at de l'Enfant (COFESEPRAT – National Committee for the Abandonment of Harmful Practices Affecting Women and Children, Senegal); ENDA – ACAS (Environment and Development Action – Action in Casamance); the Siggel Jigeen network (Network for the Empowerment of Women); Femmes et Société (Women and Society); le Collectif des Femmes Parlementaires (Women Parliamentarians Collective); Réseau des Parlementaires en Population et Développment (Nework of Parliamentarians on Population and Development); Réseau des Journalistes en Population et Déveleppment (Network of Journalists on Population and Development); Réseau des Communicateurs Traditionnels (Network of Traditional Communicators); Développement Holistiques des Filles Project (Girls' Holistic Development Project); and Tostan.

[2] Article 299A of Senegal's penal code.

practice of FGM/C in Senegal. FGM/C typically occurs at very young ages, with the majority of girls cut by age 1, and over 70% cut by age 4. The most common form of cutting is "cut/flesh removed," which may correspond to FGM Type I (clitoridectomy) or Type II (excision)[3]. In contrast to other parts of Africa such as Egypt, Kenya and Sudan, FGM/C in Senegal has not become medicalized (performed by health professionals). Support for the continuation of FGM/C (18% in 2005 and 17% in 2010-11) is lower than the estimated national prevalence of FGM/C (weighted estimates are 28% in 2005 and 26% in 2010) (UNICEF, 2013). Overall, aggregate statistics on prevalence, unadjusted for potentially confounding factors, provide the impression that there is very little change in FGM/C among women in Senegal. In this paper we present results from multivariate analyses that highlight patterns in the data after adjusting for the effect of proximate variables. Specifically, using data from successive household surveys, we examine the spatial distribution of FGM/C, and estimate the effects of a number of sociodemographic factors that could mediate the observed prevalence of FGM/C in Senegal.

[INSERT TABLE 1 ABOUT HERE]

METHODS

Data source

The data analyzed in this study are from two nationally-representative household surveys: the 2005 Senegal Demographic and Health Survey (SDHS 2005), and the 2010-11 DHS survey with questions from the Multiple Indicator Survey (SDHS-MICS 2010-11). The Demographic Health Surveys (DHS) are periodic cross sectional health surveys funded by USAID (the U.S. Agency for International Development's) Bureau for Global Health. The DHS includes a number of modules on demographics and household affluence; fertility, reproductive health, maternal and child health, nutrition, and knowledge and practice related to HIV/AIDS (DHS, 1990-2004). The core questionnaire for households collects data from adult women (age 15-49) and men from a nationally representative probability samples of households. Surveys allow for an optional additional series of questions about FGM/C to be added to the women's questionnaire (Yoder et al., 2004; Creel, 2001). The module on FGC includes 3 sections: 1) questions on whether the woman was circumcised or not, and details about that event, 2) whether one daughter was circumcised or not, and details about that event, and 3) a woman's opinion about the continuation of the practice. Since 2000, UNICEF's Multiple Indicator Cluster Surveys (MICS) have used a similar module to collect information on FGM in selected countries (Yoder et al., 2004; Creel, 2001). We draw on data from the core questionnaire for households, as well as the module on FGM/C, administered to women age 15-49 years. For the 2010-11 survey, the FGM/C module was modified to ask questions about the FGC status of each daughter under the age of 10, rather than about only one daughter, thus providing more detailed information about recent changes in the practice. We present finding of analyses of daughter data elsewhere (Kandala and Shell-Duncan, forthcoming). Further details on the methods, objectives, organization, sample design, and questionnaires used in the 2005 SDHS and 2010-11 SDHS-MICS are described elsewhere (Yoder et al., 2004; Creel, 2001). The study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki as reflected in a *priori* approval by the institution's human research committee. Ethical approval was granted by the Ethics Committee of the National Statistical Office of Senegal.

The sampling strategy for each survey was designed to be nationally representative, and provide information for each region. A two stage sampling process was employed. In the first stage clusters (377 in 2005, and 391 in 2010-11) were selected from a list of enumeration areas with probability

[3] Yoder and Wang (2013) describe the evolution of DHS questions designed to determine type of cutting.

proportional to size. In the second stage, a complete household listing was completed in each selected cluster, followed by the random selection of 21 households per cluster. In each household, all women age 15-49 were interviewed. In 2005 survey data were collected from a total of 7,412 household and 14,602 women age 15-49, with a response rate of 93.7%. The 2010-11 survey selected 8,212 households, and collected data from 15,688 women age 15-49, with a response rate of 92.7%. Further details on sampling can be found elsewhere (Ndiaye and Ayad. 2006). For both surveys, there were few participants with missing data for FGM/C and other covariates; thus, data analysis on FGM/C was based on 14602 women in 2005 and 14,228 women in 2010-11 sample with a complete set of data.

Outcome variable

We studied FGM as the main outcome in terms of "whether a participant had had FGM performed on her". This question was converted into a binary variable, with two categories defined as 1 if the participant was cut and 0 if the participant had no FGM performed on her.

Exposure variables

The main exposure variable in the analysis was the "region of residence" (of which there are 11 in 2005 as shown in **Figure 1** 2010-11, and 14 in 2010-11), in addition to various control variables on socio-demographic factors potentially associated with FGM: sex, age, education level, wealth index, marital status, family size, place of residence (urban vs. rural). Age was recorded as a continuous variable, and was re-coded into a categorical variable of 5-year age cohorts in the preliminary analysis. For the modelling of the prevalence of FGM, we examine the cohort's effect of age of the respondent as a continuous variable using a flexible nonlinear function to estimate the age-related trend of FGM risk among women in the two surveys. Education level was categorized as "None", "Primary", "Secondary" and "Higher", and wealth index was categorized as "Poorest", "Poorer", "Middle", "Richer" and "Richest". The variable for family size was re-coded into three categories of small size "1-4 children", middle size "5-7 children" and large size "8+ children", the ethnicity was recorded as "Wolof", "Poular", "Serer", "Mandingu", "Diola", "Sononke", "Not Senegalese" and "Other".

STATISTICAL ANALYSIS

The 2005 to 2010-11 of the Senegalese DHS include geographical information that allow us to examine spatial effects along with individual sociodemographic factors that may influence the risk of FGM/C. These factors are explored within a simultaneous, coherent regression framework, using a geo-additive, semi-parametric mixed model that simultaneously controls spatial dependence and possibly nonlinear or time effects of covariates and the complex sampling design (Kandala et al., 2009). The Bayesian model used here is a special class of generalized linear mixed model. They extend classical geo-statistical methods such as kriging to allow, amongst other features, formal incorporation of: (i) sampling error in the observed data; (ii) relationships with covariates (and the uncertainty in the form of these relationships); (iii) uncertainty in the spatial autocorrelation structure of the outcome variable.

In brief, the strictly linear predictor:

$$\eta_i = x^{'}\beta + w_i{}'\gamma + \varepsilon_i \qquad (1)$$

is replaced with a logit link function with dynamic and spatial effects,

$\Pr(y_i=1 / \eta_\iota) = e^{\eta\iota}/(1+ e^{\eta\iota})$, and a geo-additive semi-parametric predictor $\mu_i = h(\eta_i)$:

$$\eta_\iota = f_1(x_{i1}) + \ldots + f_p(x_{ip}) + f_{spat}(s_i) + w'_i\,\gamma + \varepsilon_i \qquad (2)$$

where *h* is a known response function with a logit link function, $f_1, \ldots, f_p$ are non-linear smoothed effects of the metrical covariates (respondent's age), and $f_{spat}(s_i)$ is the effect of the spatial covariate $s_i \in \{1,\ldots,S\}$ labelling the region in Senegal. Covariates in w'_i are categorical variables such as education and urban–rural residence. Regression models with predictors such as those in Equation 2 are sometimes referred to as geo-additive models. In a further step we may split up the spatial effect f_{spat} into a spatially correlated (structured) and an uncorrelated (unstructured) effect: $f_{spat}(s_i) = f_{str}(s_i) + f_{unstr}(s_i)$. The rationale is that a spatial effect is usually a surrogate of many unobserved influences, some of them may obey a strong spatial structure and others may be present only locally.

To estimate smooth effect functions and model parameters, we use a fully Bayesian approach, as developed in Fahrmeir and Lang (2001). For all parameters and functions we have to assign appropriate priors. The non-linear effects in (2) of $f_1, \ldots, f_p$ are modelled by cubic penalized splines (P-splines) with second order random walk penalty. For the structured spatial effect $f_{spat}(s_i)$, we experimented with different prior assumptions (two-dimensional P-splines or Gaussian random field (GRF) priors based on radial basis functions or Markov random field priors (MRF)) common in spatial statistics. In the final model, P-spline priors were assigned to the functions $f_1,\ldots,f_p$, while a Markov random field prior was used for $f_{spat}(s_i)$ since they outperformed the other priors (Fahrmeir and Lang, 2001). The standard measure of effect was the posterior odds ratios (POR) and 95% credible region (CR). Although the estimation process with this model is complex, the estimated POR that were produced could be interpreted as similar to those of ordinary logistic models. The analysis was carried out using version 2.0.1 of the BayesX software package (Belitz et al. 2012), which permits Bayesian inference based on Markov chain Monte Carlo (MCMC) simulation techniques. The statistical significance of associations between potential risk factors and pro-FGM attitude were explored in chi-square and Mann–Whitney *U*-tests, as appropriate.

Multivariate Bayesian geo-additive regression models were used to evaluate the significance of the POR determined for the fixed effects and spatial effects between prevalence of FGM in Senegal. Each factor was looked at separately in unadjusted models using conventional logistic regression model. Next, fully adjusted multivariate Bayesian geo-additive regressions analyses were performed to look again for a statistically significant correlation between these variables, but this time further controlling for any influence from individual (age), ethnicity, education and religious factors. A *P*-value of <0.05 was considered indicative of a statistically significant difference.

RESULTS

Descriptive results

Unweighted baseline socio-demographic characteristics are shown in **Table 2,** and by FGM/C status (whether circumcised or not) in **Table 3**. The overall prevalence of FGM/C differs slightly between the two surveys (30.1% in 2005 and 28.1% in 2010-11). Before investigating factors associated with FGM/C and trends across the two surveys, we examined comparability of women sampled in each survey. The two survey populations are similar in terms of the mean ages of women (for 2005 the mean age was 27.8 years, with a standard deviation of ±9.9 years and in 2010-11 the mean age of the sample was 27.9 years, with a standard deviation of ±9.5 years). Most of the population sampled lived in rural settings (51.3% in 2005 and 50.7% in 2010-11) and 73.0% were married in 2005 with slightly less at 66.5% in 2010-11. The mean age for women's partner was higher than that for women in both the 2005 (42.6 vs. 27.8 years) and the 2010-11 survey (43.5 vs. 27.9 years). A total of 14.2% of women in the 2005 population had a secondary education while 59.6% had no education compared to 18.3% (secondary education) and 57.9% no education in 2010-11. Women with FGM/C were mostly married (34.0% vs 30.6%), with no education for themselves (34.4% vs 31.4%) or their partners (36.7% vs 32.2%), were "poorest" (43.8% vs 48.7%), had a large family size (41.0% vs 35.5%), lived in rural areas (37.7% vs

35.6%), were Soninke (78.7% vs 66.3%), were Muslim (31.0% vs 29.0%) and were living in Matam and Kédougou (94.9% vs 87.7%) and Kolda and Matam (94.3% vs 89.6%) in 2005 and 2010-11 respectively. Notably, in both surveys, women's age group is not significantly associated with FGM/C. Thus, there is no evidence of change in rates of FGM/C across age cohorts.

[INSERT TABLE 2 AND 3 ABOUT HERE]

Regression analysis results

Unadjusted and fully adjusted marginal odds ratios are presented in **Table 4**. In 2005 factors associated with FGM/C in the unadjusted analysis were: rural place of residence (OR=2.09, 95%CI=1.94-2.25), being married (OR=2.22, 95%CI=1.99-2.47), with "no education" (OR=2.05, 95%CI=1.13-3.70), wealth index with poorer quintile in the lead (OR=5.37, 95%CI=4.59-6.29), being Soninke (OR=3.70, 95%CI=2.62-5.21) or Mandingu (OR=2.96, 95%CI=2.36-3.72), being Muslim (OR=3.54, 95%CI=2.70-4.64) and living in Matam (OR=18.2, 95%CI=14.0-23.7) or Kolda (OR=16.5, 95%CI=13.2-20.6). After adjusting for all other factors (fully adjusted model), the likelihood of FGM/C in women with only primary or secondary education became statistically insignificant. The effect disappeared also for small and middle family size; the statistically significant effect remains only for women living rural areas, with no education, partners with primary education, in all wealth quintiles, all ethnicities, and the region of residence. Women with no education were 3.26 times more likely to be circumcised than all higher educated persons (95%CI=1.04–10.1); women of the poorest wealth quintile were 4.60 times more likely to be cut than those from the richest; women living rural communities were 1.47 times more likely to have undergone FGM/C (95%CI=1.31–1.65) than women living urban areas, and 3.02 times more likely to be Muslim than another religion; Soninke women were 75.4 times more likely to be circumcised than Wolof women. Women with FGM/C were least likely to live in Louga and Fatick and most likely in Matam and Kolda.

In the following survey year of 2010-11**,** factors associated with FGM/C in the unadjusted analysis were: rural place of residence (OR=1.42, 95%CI=1.32-1.53); being married (OR=1.47, 95%CI=1.33-1.63); education, with the category "no education" highest (OR=4.10, 95%CI=2.57–6.53), followed by primary education (OR=3.55, 95%CI=2.21–5.68) and secondary (OR=2.87, 95%CI=1.79–4.61) vs people with higher education; wealth index for women in the poorest quintile(OR=5.21, 95%CI=4.42–6.14), poorer women (OR=3.05, 95%CI=2.58-3.60), middle income (OR=2.22, 95%CI=1.87-2.64), and richer women (OR=1.51, 95%CI=1.25-1.83), as compared to richest women; family size for middle size family of 5-7 children (OR=1.22, 95%CI=1.08–1.37), and for large family size of 8+ children (OR=1.46, 95%CI=1.19–1.80) vs people with a small size family (1-4 children); ethnicity; religion and region of residence. After adjusting for all other factors, the likelihood of FGM/C in women living rural with any education became statistically insignificant. The effect disappeared also for middle and large family size and partner's education. A statistically significant effect remained only for the wealth index, ethnicity and religion. Women from the poorest quintile were 5.77 times more likely to be circumcised than the richest (95%CI=4.55-7.33), participants from the Mandingu tribe were 89.4 times more likely to be cut than people from the Wolof (95%CI=55.5–144); women who were Muslim were 2.52 times more likely to have FGM/C than women who were not (95%CI=1.61–3.96). Women with FGM/C were least likely to be in Thiès and Louga and most likely in Matam and Sédhiou.

[INSERT TABLE 4 ABOUT HERE]

The shift in the prevalence of FGM at the region level and across age cohorts during the 5 years period

Looking the overall national prevalence of FGM/C between the 5 years period, there was only a slight decrease of 2 percentage point from 30.1% in 2005 to 28.1% in 2010-11 (unweighted average).

Aggregate national figures on FGM/C prevalence, however, conceals important spatial variation at the region level within the survey periods. By the time of the 2010-11 survey, 3 regions has been subdivided; to appropriately compare trends in prevalence, we reported the weighted average of subdivided regions in 2010-11. The observed FGM/C prevalence at the region level shown in **Table 3** indicates that the regions in which FGM/C prevalence is lowest and below the national average in both surveys are Dakar, Diourbel, Fatick, Kaolack (along with Kaffine in 2010-11), Louga and Thiès. The prevalence of FGM/C was consistently higher than the national average in both surveys in Kolda (combined with Sédhiou in 2010-11), Matam, Saint Louis, Tambacounda (combined with Kédougou in 2010-11). Between 2005 and 2010-11 the prevalence of FGM/C increased slightly in the low prevalence regions of Dakar (18.0 to 20.9%) and Fatick (6.2 to 9.6%). It reduced slightly in the low prevalence regions of Diourbel (2.0 to 0.5%) and Thiès (7.3 to 3.8%). The high prevalence region of Tambacunda saw no substantial change in the prevalence of FGM/C between the 2005 and 2010-11 surveys (87.5 to 88.7), while decreases were seen in Kolda (94.3 to 88.3), Matam (94.8 to 89.6), Saint Louis (46.9 to 44.0), and especially Ziguinchor (69.8 to 61.3). Unadjusted marginal odds ratios shown in **Table 4** indicate that in 2005 the highest risk of FGM/C was in Matam (OR=18.2, 95%CI=14.0-23.7) and Kolda (OR16.5, 95%CI=13.2-20.6), and the lowest risk in Louga (OR=0.05, 95%CI=0.04-0.07). In 2010-11, the highest risk was in Kédougou, and the lowest was in Thiès and again in Louga. Regarding the effect of age, the unadjusted marginal odds ratio show no significant differences in FGM/C risk across age cohorts of women, suggesting that there is no secular decline in FGM/C risk.

Bayesian Spatial analysis results

In multivariable Bayesian geo-additive regression analyses, we introduced and controlled for spatial and nonlinear factors associated with higher FGM/C risk in both years. Region of residence was modelled as a spatial variable in **Figure 2 and 3**, and age of the respondent at the time of interview was modelled as a continuous variable using a flexible nonlinear curve in **Figure 4 and 5**. The modelled covariates results confirmed what was observed in the logistic regression analysis but the patterns differ markedly with region of residence and age remaining significant risk factors in both surveys. Overall, results of 2005 (**Figure 2**) show that after accounting for (i) sampling error in the observed data; (ii) relationships with covariates and the uncertainty in the form of these relationships); (iii) uncertainty in the spatial autocorrelation structure of the outcome variable, the regions with the highest FGM/C risk included Tambacounda, Kolda, Matam and Ziguinchor, but not Saint Louis. In 2010 (**Figure 3**), the highest risk regions included Matam, Tambacounda, Kolda, and the newly formed regions of Sédhiou and Kédougou, but again, not the high prevalence region of Saint Louis.

[INSERT FIGURE 2 & 3 ABOUT HERE]

With regard to the shift of FGM/C by regions, in both samples, the spatial analysis has captured the substantial variation in FGM/C risk across regions observed in the marginal regression analyses. The results shown in **Figure 2 and 3** are in other words covariate-adjusted region FGM/C spatial variation captured by **the global total residual region effects (i.e. the sum of the unstructured and structured spatial effect)**. There is a clear pattern of regions with higher risk of FGM/C, mostly the south-eastern states of Tambacounda, Kolda and Matam in 2005, including the eastern state of Kédougou and the southern one of Sédhiou in 2010 (Figure 4 & 5), which were associated with a higher risk of FGM/C, while states such as Louga, Thiès, Diourbel, Kaolack and Fatick in 2005 and Louga, Thiès, Diourbel, Fatick, Kaolack and Kaffrine in 2010 were associated with a lower risk of FGM/C. These spatial patterns confirm the observed marginal model findings shown in Table 3 with a shift observed for Kaolack region, which moved from a non-significant FGM/C risk in 2005 to a very low significant FGM/C risk in 2010 (Kaffrine and Kaolack combined).

Specifically, the left-hand map in Figure 3 shows estimated posterior total residual region odds of FGM/C for each region in 2005, ranging from a lower POR of 0.04 (0.01, 0.18) in Diourbel to a higher POR of 27.83 (7.36, 132.76) in Kolda and in 2010 the POR ranges as low as 0.02(0.00, 0.07) in Diourbel to a higher POR of 17.57(3.96, 67.30) in Matam, with red color indicating the higher risk recorded and green color denoting lower risk. The right-hand map shows the 95% posterior probability map of FGM/C, which indicates the statistical significance associated with the total excess risk. White indicates a negative spatial effect (associated with reduced risk of FGM/C prevalence), black a positive effect (an increased risk) and grey a non-significant effect. However, the total spatial residuals in **Figure 2 and 3** in both surveys show that much of the variation in FGM/C likelihood remains to be explained. The spatial effects of the Kaolack region in 2005 was greatly attenuated after multiple adjustments of other risk factors indicating that perhaps the higher number of FGM/C affected women living in the state was inflated by other factors such as ethnicity, socio-economic status and education. Overall, the results indicate that across surveys, certain high prevalence regions remain "hot spots" regarding FGM/C risk. These include Kolda (along with the newly subdivided region of Sédhiou in 2010), Tambacounda (along with the newly subdivided region of Kédougou in 2010), and Matam. Risk remained non-significant in the high prevalence regions of Saint Louis and Zinguinchor, and was attenuated between 2005 and 2010-11 in Kaolack (including the newly subdivided region of Kaffrine in 2010-11).

[INSERT FIGURES 4 &5 ABOUT HERE]

Figure 4 and **5** show the estimated nonparametric trend of women's FGM/C risk by respondent's age cohort (left) and respondent partner's age cohort in 2005 and 2010 (right). Shown is the posterior mean within 80% credible regions. Surprisingly, the figures show an inverse U-shape non-linear relationship between the likelihood of FGM/C and women's age, with a higher risk of FGM for younger cohorts (under 20 years of age) for both samples. The nonlinear association between age and the likelihood of FGM/C before age 20 do not differ in the two samples starting very high, with a gradual decrease thereafter in both surveys. At all other ages, the two surveys also show agreement in the pattern of decreasing probability of FGM until age 49. At age 40, this probability decreases quickly as age increases, although the variation in probability increases rapidly at the same time. For women over age 45, there are wide confidence intervals suggesting few observations in both samples that make it difficult to discern a consistent downward decrease in the FGM/C risk for this cohort (instability of the estimates) in both surveys. It is worth mentioning that at first glance, the figures seem to be different. However, a careful examination of the two figures reveals that in both figures the age's effects start at an estimate of 1, with a gradual decrease thereafter. Thus, contrary to expectations, the adjusted non-parametric estimates reveal that the risk of FGM/C goes up with decreasing age.

DISCUSSION

When tracking changes in the prevalence of FGM/C using nationally-representative survey data, it is important to bear in mind that aggregate figures at the national level may mask important variation along the lines such as ethnicity or region. Consequently, it is useful to disaggregate the data, and control for potentially confounding factors. This study has used advanced the statistical methodology to analyze survey data collected with complex sampling strategies, and including possible non-linear covariates. Importantly, this novel approach, developed by Kandala and colleagues (2009), makes it possible to simultaneously examine individual-level and spatial variability. Overall, among women aged 15-49 in Senegal, the prevalence of FGM/C has changed little over the 5 year period between successive surveys carried out in 2005 and 2010-11 (FGM/C prevalence of 30.1% in 2005 and 28.1% in 2010-11).

We find that these unadjusted figures do indeed mask important variation at both the regional and individual levels. In the multivariate Bayesian geo-additive regression analysis, we controlled for individual-level factors while simultaneously modelling the region of residence as a spatial variable.

The spatial analysis performed in this study reveals that the risk of FGM/C varies across regions, with the highest risk across both survey periods found in the high-prevalence south-eastern regions including include Kolda (along with the newly subdivided region of Sédhiou in 2010), Tambacounda (along with the newly subdivided region of Kédougou in 2010), and Matam. In two other high prevalence regions- Saint Louis and Zinguinchor- risk of FGM/C remained non-significant across both surveys. Additionally, the likelihood of FGM/C was attenuated between 2005 and 2010-11 in Kaolack (including the newly subdivided region of Kaffrine in 2010-11), shifting from being non-significant in 2005 to very low risk of FGM/C in 2010-11.

How can we interpret these spatial findings given that that certain high prevalence regions remained "hot spots" regarding FGM/C risk and others did not? Importantly, these results show that community-level effects, above and beyond individual-level effects, play a crucial role in determining the likelihood of FGM/C. In other words, the context in which an individual woman lives bears an important influence on whether FGM/C is practiced. This finding is consistent with social convention theory, which predicts that interdependent expectations and social norms shared by community members serve to uphold the practice, making it difficult for individuals to abandon FGM/C without experiencing adverse social sanctions (Mackie and Lejeune, 2009). The theory predicts that change is most likely to come about when members of social groups have simultaneously shifted social norms pertaining to FGM/C (Mackie, 2000). It may be the case that regional differences in FGM/C risk capture this shift in social norms. At the same time, theory on social norms and conventions does not rule out the possibility of individual-level factors influence of decision-making regarding FGM/C, although the social environment can constrain these choices. Indeed, in our study we find evidence for the simultaneous influence of community- and individual-level factors influencing the risk of FGM/C.

In the fully adjusted model, a number of individual-level factors were found to be associated with the likelihood of FGM/C. In the 2005 survey data these include rural residence, no education, wealth, religion, and especially ethnicity (Soninike women were 75.4 times more likely to be cut than Wolof women) and age. In 2010-11, significant individual-level variables in the fully adjusted model included wealth, religion, and especially ethnicity (Mankingu women were 89.4 times more likely to be cut than Wolof women) and age. The consistent and robust effect of ethnicity is unsurprising given that in Senegal, like many other setting settings, FGM/C derives much of its meaning and tenacity from its intimate association with ethnic identity (Gruenbaum, 2001). There are, however, a number of challenges in tracing ethnicity from survey data. Ethnic classifications are not static, and ongoing processes of migration, mixing, and socioeconomic and political change can contribute to ethnic definitions that change over time. The categorization of ethnic identity is further complicated by the fact that inter-ethnic marriage has recently become increasingly common in certain regions of Senegal, and elsewhere (Shell-Duncan at el., 2010; 2011). The convention in many societies is to trace ethnicity along paternal lines, although this is not the case in every instance, and contributes to further fluidity in ethnic identification (Yoder et al., 2004). Despite these challenges, measures of ethnicity is often found in survey research to explain more variation and change in FGM/C prevalence than any other sociodemographic variable (UNICEF, 2013). Where there exists a strong link between FGM/C and ethnicity, as is the case in Senegal, ethnicity may serve to signal shared expectations that hold the practice in place. In other words, ethnicity may be a proxy for shared norms concerning personhood, religion, sexual restraint, or other cultural values. Hence, it is increasingly understood that programming efforts should be uniquely tailored to address these issues (UNICEF, 2013).

Our most surprising finding with respect to individual-level predictors of risk of FGM/C among women in Senegal is with respect to age. Unadjusted estimates of risk of FGM/C showed no significant variation across age cohorts. However, fully adjusted nonparametric estimates show that in both surveys, age is a significant risk factor for FGM/C, but not in the anticipated direction. The effect of age on the likelihood of FGM/C is highest in women aged 15-20, and declines with increasing age. How can we understand this unexpected finding? The anticipation of reductions in FGM/C detectable in survey data have been driven by several factors. These include combined efforts at the local level, most notably the holistic development program of Tostan that by 2010 culminated in more than 4000 communities participating in public declarations to abandon FGM/C (www.tostan.org, accessed July 2012). Moreover, community-based programs have supported by a strong national framework to create an "enabling environment" for the abandonment of FGM/C, including developing a detailed national plan of action and implementing legislative reform strategies (UNICEF, 2013; Diop-Diagne, 2008; Shell-Duncan et al., 2013). Thus, a recent evaluation of the UNFPA-UNICEF Joint Programme on Female Genital Mutilation/Cutting concluded that "Senegal has made concrete progress toward abandonment of FGM/C," and further speculated that "Senegal could be free from the practice in the near future" (UNPFA-UNICEF, 2013: 4).

With clear reasons for anticipating of reductions in FGM/C in Senegal, there has been great interest in documenting potential changes on the ground (UNPFA-UNICEF, 2013). Yoder and Wang (2013) comment on the possibility of using DHS data to assess the magnitude of reductions in FGM/C, but join several commentators in urging caution about the limitations of self-reported survey data on FGM/C status. Because of the sensitivity of the topic or illegal status, women may be unwilling to disclose having undergone FGM/C (Askew, 2005; Shell-Duncan et al., 2013). Additionally, particularly when FGM/C is performed at an early age, women may be unaware of whether they have been cut or the extent of the cutting (Yoder et al., 2004; UNICEF, 2013). A number of studies have attempted to determine the reliability of self-reports of FGC status by verifying them through clinical examinations, and have reported variable rates of concordance. While one study in Sudan reported complete agreement between clinical examination and women's reports of having undergone some form of FGM/C or not (Elmusharaf et al., 2006), others report variable degrees of discrepancy. Morison and colleagues found 3% disagreement in The Gambia, whereas studies in Tanzania and Nigeria reported disagreements in more than 20% of women (Adinma, 1997; Msuya et al., 2002; Klouman et al., 2005; Snow et al., 2002). A longitudinal study in Ghana afforded a unique opportunity to assess the consistency of women's self-reports of FGM/C status over repeat surveys (Jackson et al., 2003). The data showed that a substantial number of adolescent girls who initially reported having undergone FGM/C later denied being cut. The authors concluded that denials of having undergone FGM/C were influenced by exposure to anti-FGM/C interventions, and by passage of a law banning FGM/C. In a detailed overview of methodological considerations for measuring change in FGM/C, Askew (2005: 472-73) emphasized the need to consider the context in which questions of FGM/C status are being asked: "If FGC is widespread, socially acceptable and there is no well-publicized interventions causing people to question its acceptability and legality…, then self-reporting is likely to be valid. If there are reasons why it would not be attractive for respondents to declare that they are cut…, then self-reported measures should be questioned and ways sought to validate the results." With this warning in mind, we concur with Yoder and colleagues (2004: 10), who conclude that "there is sufficiently strong confirmation of FGC status from women's reports to warrant the use of survey data to calculate the prevalence of FGC" (Yoder et al., 2004: 10).

Yoder and Wang (2013) discuss the possibility of using DHS data to assess the impact of interventions that promote the abandonment of FGM/C. It is important to note, however, that these data do not provide information needed to complete a rigorous evaluation of any single intervention program. Askew (2005) emphasizes that such evaluations require a quasi-experimental design, with "case" and "control" communities, as well as pre- and post-intervention measures to differentiate ongoing or "natural" change from those that may arise from intervention efforts[4]. DHS and MICS data do not provide baseline and post-intervention measures, nor are they accompanied by information on the types of intervention activities that have taken place in any region, cluster, or village selected for inclusion in the survey. Since communities may participate in numerous intervention programs, in addition to being targeted by media messages such as those on health risks or legislation banning FGM/C, it is not possible to isolate the effect of any one intervention program. It is, however, possible to examine change in attitudes or FGM/C behavior that may arise from combined "natural" social change processes and a some potential mixture of directed interventions.

When examining trends in FGM/C using nationally-representative survey data, it is important to specify what one should expect to see. Several considerations are salient. First, since data on national prevalence provides information on the proportion of women aged 15-49 who have undergone FGM/C, this aggregate number is unlikely to change dramatically in consecutive surveys implemented 5 years apart; women who are cut will remain cut, and the national prevalence estimate changes only as an increasing proportion of uncut women age into the 15-49 group, and cut women age out. A more sensitive indicator of change is to look at the prevalence along age cohorts, as we have done in this study. Second, in doing so, we need to take into account age at cutting, as women's FGM/C status reflects an event that took place some years in the past (Yoder and Wang, 2013; UNICEF, 2013). In Senegal, over 60% of girls are cut by age 1, and nearly three quarters of girls are cut before the age of 5 (UNICEF, 2013). Thus, when looking at rates of FGM/C in women aged 15-19, we are examining the results of an event that likely took place between 11 and 19 years prior to collection of the survey data. Notably, the youngest cohort of women in the 2010-11 survey were born prior to passage of the law banning FGM/C, and at a time where the Tostan program's work on FGM/C was just beginning to scale up in Senegal (Tostan, 1999). To detect more recent changes, it is possible to examine trends in FGM/C among daughters of the survey respondents. The results of our analysis of daughter data from Senegal DHS is forthcoming (Kandala and Shell-Duncan, in preparation). Given the timing of scaled-up local intervention activities and implementation of legal reform efforts, it may not be reasonable to expect to see a dramatic decline in FGM/C risk in the youngest cohort of women in the 2010-11 survey. However, the finding of increased risk of FGM/C in the youngest women in the 2005 and 2010-11 samples is a puzzling finding that we cannot easily explain. Further research will be required to understand this observation, as well as to assess whether FGM/C risk has begun to decline in girls under the age of 15.

[4] A well-designed evaluation of the Tostan progam in Kolda, Thiès, and Fatick regions used such a quasi-experimental design (UNICEF, 2008). Comparisons of the reported prevalence of FGM/C were made across three types of communities: 1) those who received the Tostan education program and participated before 2000 in a public declaration to abandon FGM/C; 2) those who did not receive the Tostan education program but did participate before 2000 in a public declaration; and 3) those that neither received the education program nor participated in a public declaration, thus serving as "control villages." The frequency of FGM/C among girls 0-9 years of age was found to have strongly decreased in both Tostan program communities, as well as those that participated in the declaration, and did not receive training, as compared to control villages.

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Table 1. Circumstances Surrounding FGM/C in Senegal

	SDHS 20005	SDHS 2010-11
Age at cutting (%, cumulative %)		
0-1	63.3	61.7
2-4	9.5 (72.8)	9.5 (71.2)
5-9	14.9 (87.7)	13.8 (85.0)
10-14	5.1 (92.8)	6.0 (91.0)
15+	0.9 (93.7)	0.7 (91.7)
Type of FGM/C (%)		
Cut, no flesh removed	0	10
Cut, flesh removed	83	53
Sewn closed	12	14
Not sure/don't know	5	24
Practitioner of FGM/C (%)		
Traditional practitioner	93	100
Medical practitioner	1	0
Don't know	7	0
Support continuation (all women, both cut and uncut) (%)	53	52
Prevalence (weighted %)	28	26

Source: UNICEF, 2013; Yoder and Wang, 2013; Creel, 2001

Table 2. Baseline characteristics of the study population of women ages 15-49 (Senegal DHS, 2005 & 2010)*

Variable	**Women 2005** (N=14602)	**Women 2010** (N=15688)
Mean age† (SD) respondent	27.8 (9.9)	27.9 (9.5)
Mean age† (SD) partner	42.6 (9.9)	43.5 (17.5)
Circumcised (%)		
Yes	30.1	28.1
No	69.9	71.9
Place of residence (%)		
Urban	48.7	49.3
Rural	51.3	50.7
Married (%)		
Yes	73.0	66.5
No	27.0	33.5
Education (%)		
No education	59.6	57.9
Primary education	25.2	21.8
Secondary education	14.2	18.3
Higher education	1.0	2.1
Partner's education (%)		
No education	70.3	75.4
Primary education	12.6	11.9
Secondary education	12.9	9.2
Higher education	4.3	3.5
Wealth Index (%)		
Poorest	16.7	16.5
Poorer	17.6	17.9

Middle	19.4	19.8
Richer	21.6	22.3
Richest	24.7	23.5
Family size (%)		
Small (1-4 children)	84.6	82.1
Middle (5-7 children)	13.0	15.4
Large (8+ children)	2.5	2.6
Ethnicity (%)		
Wolof	39.7	38.7
Poular	25.2	26.5
Serer	15.9	15.0
Mandingu	4.6	4.2
Diola	4.9	4.0
Soninke	2.8	2.3
Not Senegalese	1.7	2.0
Other	5.2	7.3
Religion (%)		
Muslim	95.5	95.4
Other	4.5	4.6
Region of residence (%)		
Dakar	26.5	26.0
Diourbel	10.6	11.8
Fatick	4.8	4.6
Kaffrine		3.7
Kaolack	11.3	7.5
Kédougou		0.7
Kolda	7.2	4.1
Louga	6.3	7.2
Matam	3.7	3.8
Saint Louis	6.5	6.6
Sédhiou		2.9
Tambacounda	5.8	4.6
Thiès	13.5	12.9
Ziguinch	3.9	3.7

* Data are expressed as mean (standard deviation) or as percentages.
†Age ranges from 15-49 year for women, and 18 to 97 years for partners.

Table 3. Baseline characteristics of the women study population by circumcision status ¶ (Senegal DHS, 2005 & 2010)*

	Women 2005			**Women 2010**		
Variable	Not circum. (N=8455)	Circumcised (N=5277)	P-value†	Not circum. (N=8539)	Circumcised (N=5689)	P-value†
Age group (%)			p=0.31			p=0.32
15-19 years	71.7	28.3		71.9	28.1	
20-24 years	70.3	29.7		73.3	26.7	
25-29 years	70.3	29.7		71.8	28.2	
30-34 years	68.6	31.4		73.1	26.9	
35-39 years	68.7	31.3		69.5	30.5	
40-44 years	68.6	31.4		71.4	28.6	
45-49 years	68.5	31.5		70.2	29.8	
Partner's age group (%)						P=0.06
15-30 years	62.4	37.6		69.6	30.4	
31-49 years	67.4	32.6		69.8	30.2	
50-60 years	67.0	33.0		70.2	29.8	
> 61 years	60.3	39.7		64.4	35.6	
Place of residence (%)			p<0.001			P<0.001
Urban	77.5	22.5		75.4	24.6	
Rural	62.3	37.7		68.2	31.8	
Married (%)			p<0.001			p<0.001
Yes	66.0	34.0		69.4	30.6	
No	81.2	18.8		77.0	23.0	
Education (%)			p<0.001			p<0.001
No education	65.6	34.4		68.6	31.4	
Primary education	73.3	26.7		73.8	26.2	
Secondary educ.	80.7	19.3		78.3	21.7	
Higher education	79.6	20.4		85.4	14.6	
Partner's education (%)			p<0.001			0.017
No education	63.3	36.7		68.0	32.2	
Primary education	68.2	31.8		70.0	30.0	
Secondary educ.	71.8	28.2		70.8	29.2	
Higher education	77.2	22.8		78.2	21.8	
Wealth Index (%)			p<0.001			p<0.001
Poorest	56.2	43.8		51.3	48.7	
Poorer	54.6	45.4		64.3	35.7	
Middle	65.4	34.6		71.2	28.8	
Richer	76.6	23.4		78.4	21.6	
Richest	86.6	13.4		84.6	15.4	
Family size (%)			p<0.001			p<0.001
Small (1-4 children)	70.5	29.5		72.7	27.3	
Middle (5-7children)	68.5	31.5		68.7	31.3	
Large (8+ children)	59.0	41.0		64.5	35.5	
Ethnicity (%)			p<0.001			p<0.001
Wolof	98.3	1.7		98.9	1.1	
Poular	35.8	64.2		42.2	57.8	
Serer	98.0	2.0		97.4	2.6	
Mandingu	25.3	74.7		16.5	83.5	
Diola	39.4	60.6		43.0	57.0	
Soninke	21.3	78.7		33.7	66.3	

Not Senegalese	28.7	71.3		35.9	64.1	
Other	61.1	38.9		65.3	34.7	
Religion (%)			p<0.001			p<0.001
Muslim	69.0	31.0		71.0	29.0	
Other	88.7	11.3		91.0	9.0	
State of residence (%)			p<0.001			p<0.001
Dakar	82.0	18.0		79.1	20.9	
Diourbel	98.0	2.0		99.5	0.5	
Fatick	93.8	6.2		90.4	9.6	
Kaolack/Kaffrine**	87.5	12.5		92.7	8.7	
Kolda/Sédhiou**	5.7	94.3		12.3	88.3	
Louga	94.9	5.1		95.5	4.5	
Matam	5.2	94.8		10.4	89.6	
Saint Louis	53.1	46.9		56.0	44.0	
Sédhiou				10.8	89.2	
Tambacounda/ Kédougou**	12.5	87.5		12.0	87.7	
Thiès	92.7	7.3		96.2	3.8	
Ziguinchor	30.2	69.8		38.7	61.3	

*Data are expressed as mean (standard deviation) or as percentages.
†*P*-values for comparison between women with and without FGM/C.
**Figures for 2010-11 are weighted average of the two subdivided regions to make them geographically comparable to the original region from 2005.

Table 4: Unadjusted and fully adjusted odds ratios of women's circumcision across selected covariates (Senegal, DHS 2005 &2010)

	Women 2005		**Women 2010**	
Variable	Unadjusted OR & 95%CI‡	Fully adjusted OR & 95% CI†	Unadjusted OR & 95%CI‡	Fully adjusted OR & 95% CI†
Age				
15-19 years	0.93(0.81, 1.07)		1.00(0.86,1.15)	
20-24 years	1.00(0.86, 1.15)	See Figure 4 left	0.93(0.80,1.08)	See Figure 5 left
25-29 years	1.00		1.00	
30-34 years	1.08(0.92, 1.27)		0.94(0.80,1.10)	
35-39 years	1.08(0.91, 1.27)		1.12(0.95, 1.33)	
40-44 years	1.08(0.91, 1.29)		1.02(0.85, 1.23)	
45-49 years	1.09(0.90, 1.32)		1.08(0.88, 1.33)	
Age Partner				
15-30 years	1.00	See Figure 4 right	1.01(0.88,1.16)	See Figure 5 right
31-49 years	0.80		1.00	
50-60 years	0.82		0.98(0.86, 1.12)	
> 61 years	1.10		1.28(1.06, 1.54)	
Place of residence				
Urban	1.00	1.00	1.00	1.00
Rural	2.09(1.94, 2.25)	1.47(1.31, 1.65)	1.42(1.32, 1.53)	0.78(0.70, 0.87)
Married				
Yes	2.22(1.99, 2.47)		1.47(1.33, 1.63)	
No	1.00		1.00	
Education				
No education	2.05(1.13, 3.70)	3.26(1.04, 10.1)	4.10(2.57, 6.53)	1.86(0.74, 4.65)
Primary education	1.42(0.78, 2.57)	3.11(0.99, 9.73)	3.55(2.21, 5.68)	1.77(0.71, 4.45)
Secondary educ.	0.93(0.51, 1.71)	2.41(0.76, 7.63)	2.87(1.79, 4.61)	1.62(0.64, 4.13)
Higher education	1.00	1.00	1.00	1.00
Partner's education				
No education	1.96(1.44, 2.68)	1.30(0.87, 1.93)	1.69(1.18, 2.43)	1.21(0.81, 1.80)
Primary education	1.58(1.12, 2.22)	1.58(1.12, 2.22)	1.55(1.04, 2.30)	1.45(0.95, 2.21)
Secondary educ.	1.33(0.94, 1.88)	1.33(0.94, 1.88)	1.48(0.98, 2.23)	1.43(0.92, 2.22)
Higher education	1.00	1.00	1.00	1.00
Wealth Index				
Poorest	5.03(4.30, 5.88)	4.60(3.61, 5.86)	5.21(4.42, 6.14)	5.77(4.55, 7.33)
Poorer	5.37(4.59, 6.29)	4.52(3.57, 5.72)	3.05(2.58, 3.60)	3.35(2.64, 4.27)
Middle	3.42(2.92, 4.02)	2.44(1.94, 3.07)	2.22(1.87, 2.64)	2.16(1.70, 2.73)
Richer	1.97(1.64, 2.37)	1.79(1.37, 2.33)	1.51(1.25, 1.83)	1.37(1.05, 1.79)
Richest	1.00	1.00	1.00	1.00
Family size				
Small (1-4 children)	0.60(0.50, 0.73)	0.98(0.79, 1.23)	1.00	1.00
Middle (5-7children)	0.66(0.53, 0.83)	0.90(0.70, 1.16)	1.22(1.08, 1.37)	1.16(1.00, 1.33)
Large (8+ children)	1.00	1.00	1.46(1.19, 1.80)	1.11(0.88, 1.42)
Ethnicity				
Wolof	1.00	1.00	1.00	1.00
Poular	1.79(1.67, 1.93)	23.9(20.1, 28.5)	129(98.6, 169)	19.9(16.9, 23.5)
Serer	0.02(0.01, 0.03)	0.22(0.14, 0.36)	2.56(1.70, 3.85)	0.39(0.26, 0.60)
Mandingu	2.96(2.36, 3.72)	67.3(45.4, 99.6)	478(326, 702)	89.4(55.5, 144)
Diola	1.53(1.26, 1.87)	20.3(14.3, 28.6)	125(89.6, 174)	29.4(20.0, 43.3)
Soninke	3.70(2.62, 5.21)	75.4(44.1, 129)	185(123, 280)	31.2(17.1, 56.6)
Not Senegalese	2.49(1.69, 3.67)	33.9(20.6, 55.9)	168(107, 264)	24.8(15.4, 39.9)

Other	0.64(0.54, 0.75)	11.2(8.41, 14.9)	50.1(36.8, 68.3)	9.22(6.88, 12.3)
Religion				
Muslim	3.54(2.70, 4.64)	3.02(2.11, 4.34)	4.10(2.92, 5.77)	2.52(1.61, 3.96)
Other	1.00	1.00	1.00	1.00
Region of residence				
Dakar	0.22(0.19, 0.25)		0.26(0.23, 0.31)	
Diourbel	1.00		1.00	
Fatick	0.07(0.05, 0.08)		0.11(0.09, 0.13)	
Kaffrine	New state in 2010		0.12(0.10, 0.15)	
Kaolack	0.14(0.12, 0.16)	See Figure 2	0.08(0.06, 0.10)	See Figure 3
Kédougou	New state in 2010		14.5(10.4, 20.4)	
Kolda	16.5(13.2, 20.6)		7.10(6.02, 8.39)	
Louga	0.05(0.04, 0.07)		0.05(0.04, 0.05)	
Matam	18.2(14.0, 23.7)		8.65(7.12, 10.5)	
Saint Louis	0.88(0.84, 0.93)		0.78(0.72, 0.85)	
Sédhiou	New state in 2010		8.29(6.90, 9.94)	
Tambacounda	6.98(5.95, 8.19)		7.32(6.20, 8.63)	
Thiès	0.08(0.07, 0.10)		0.04(0.03, 0.05)	
Ziguinchor	2.32(2.08, 2.58)		1.59(1.40, 1.80)	

‡Unadjusted marginal odds ratio (OR) from standard logistic regression models. †Adjusted marginal odds ratio (OR) from standard logistic regression models.

*Adjusted for women's age, partner's age, region and rural/urban location.

Figure legends

Figure 1: Political map of Senegal showing 1 administrative regions

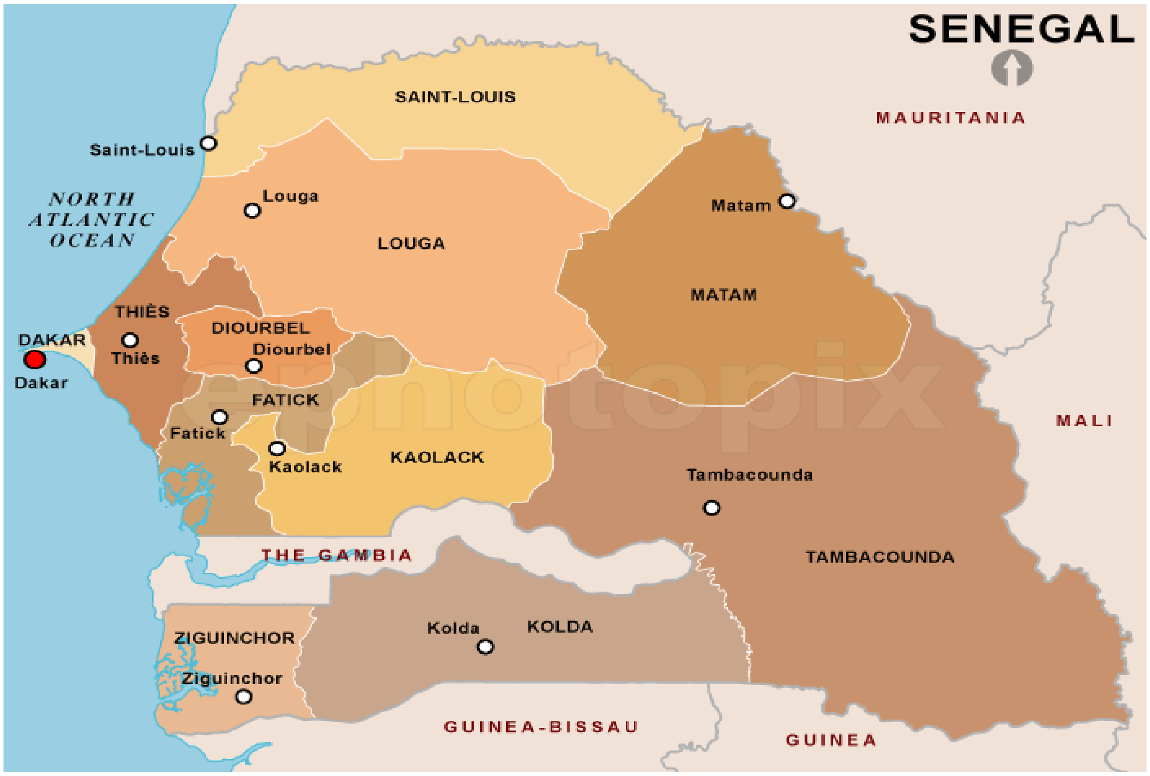
Figure 2: Left: Adjusted total residual spatial effects for women's circumcision, at regions level in Senegal in 2005. Shown are the posterior odds ratios. Right: Corresponding posterior probabilities at 90% nominal level (SDHS, 2005).

Figure 3: Left: Adjusted total residual spatial effects for women circumcision, at regions level in Senegal in 2010. Shown are the posterior odds ratios. Right: Corresponding posterior probabilities at 90% nominal level (SDHS, 2010).

Figure 4: Left: Estimated nonparametric trend of women's FGM by respondent's age cohort (left) and respondent partner's age cohort in 2005 (right). Shown is the posterior mean within 80% credible regions. [SDHS 2005]

Figure 5: Left: Estimated nonparametric trend of women's FGM by respondent's age cohort (left) and respondent partner's age cohort in 2010 (right). Shown is the posterior mean within 80% credible regions.[SDHS 2010]

Figure 1: Map of Senegal showing the 11 administrative regions



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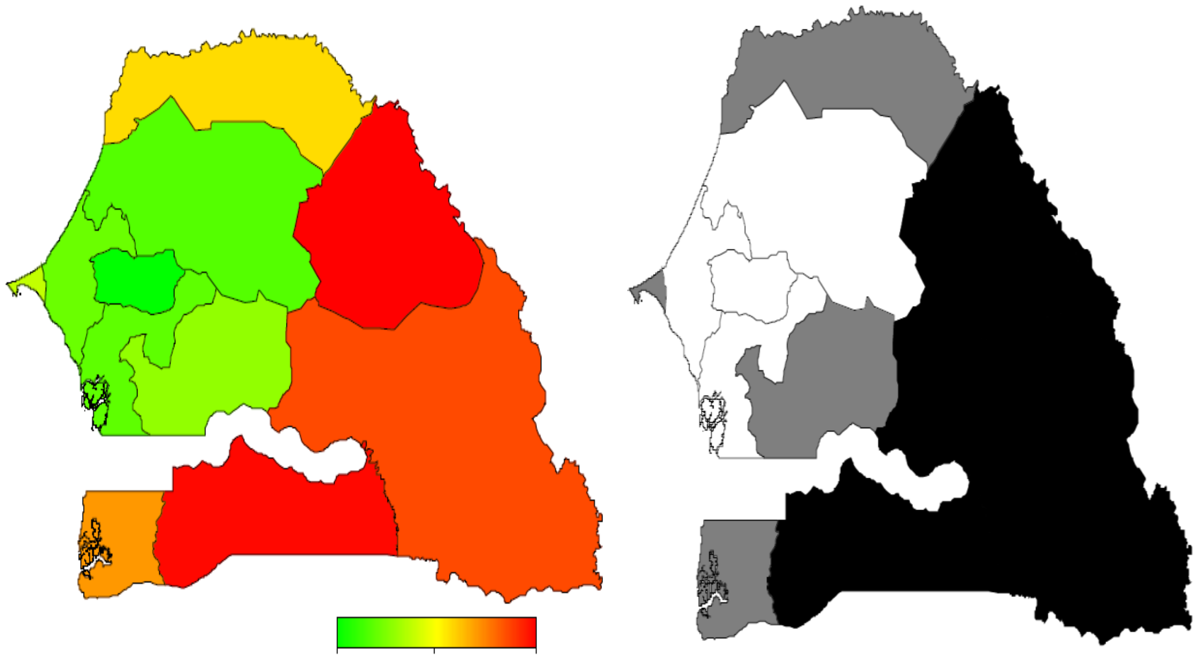

Red coloured – high risk

Green coloured – low risk

Black coloured – significant positive spatial effect

White coloured- significant negative spatial effect

Grey coloured – no significant effect

Figure 3: Left: Adjusted total residual spatial effects for women circumcision, at regions level in Senegal in 2010. Shown are the posterior odds ratios. Right: Corresponding posterior probabilities at 90% nominal level (SDHS, 2010).

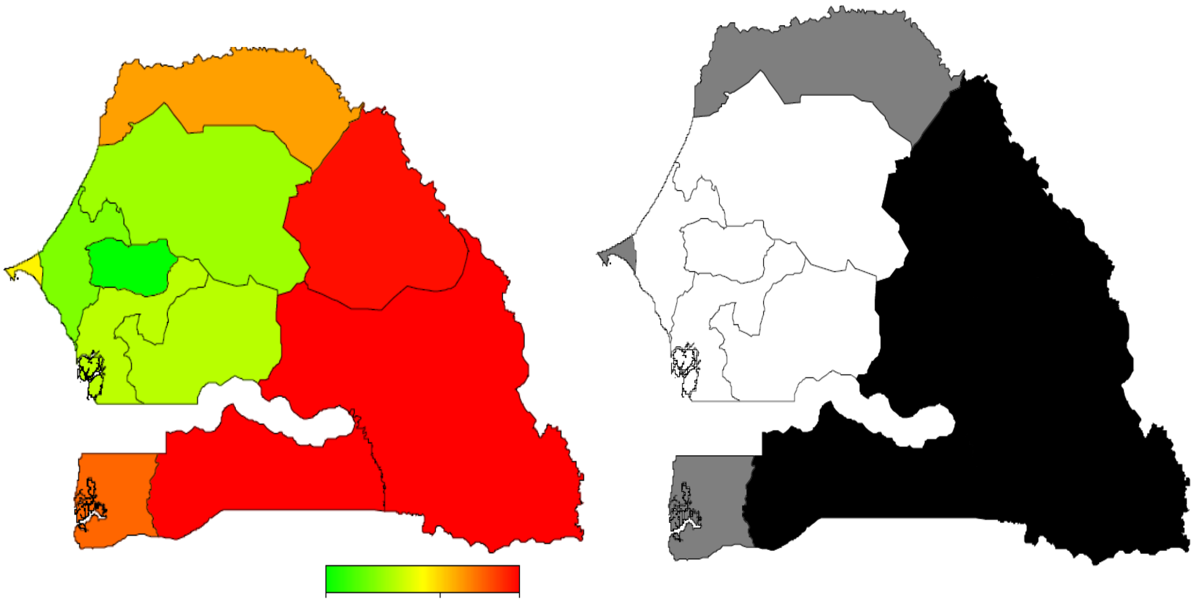

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Figure 4: Left: Estimated nonparametric trend of women's FGM by respondent's age cohort (left) and respondent partner's age cohort in 2005 (right). Shown is the posterior mean within 80% credible regions. [SDHS 2005]

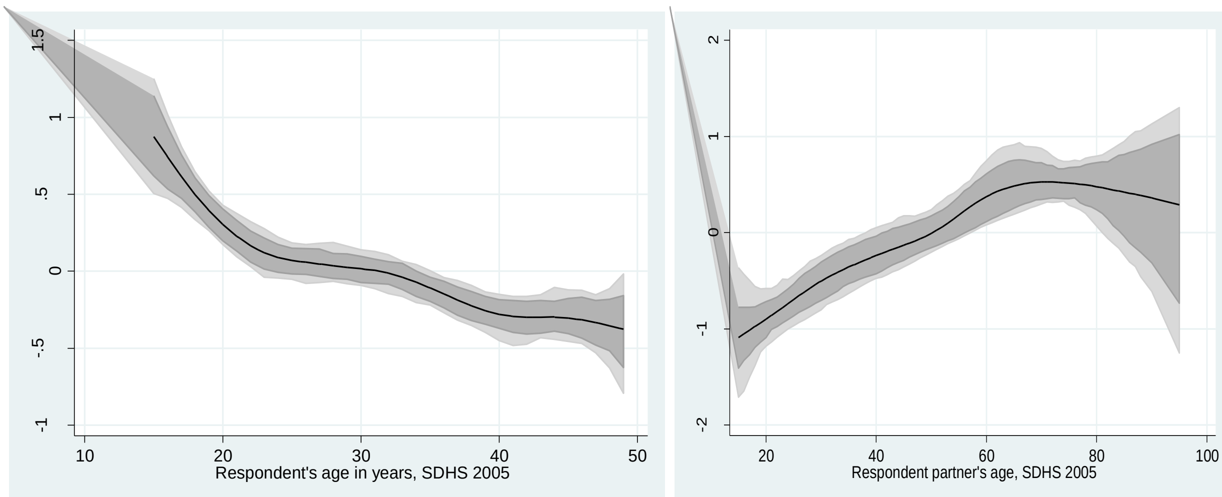

Figure 5: Left: Estimated nonparametric trend of women's FGM by respondent's age cohort (left) and respondent partner's age cohort in 2010 (right). Shown is the posterior mean within 80% credible regions.[SDHS 2010]