Geographical hotspots and correlates of early sexual debut among women in Ghana

Fiifi Amoako Johnson*

Abstract

Objectives: Generalisation of sexual behaviour, including early sexual initiation, does not provide comprehensive knowledge of young people’s sexual attitudes, behaviours and challenges, given the high sociocultural diversity and economic inequalities within countries. This study examines geographical hotspots of early sexual initiation, at the district level in Ghana and the factors associated with the observed spatial patterns.

Methods: Data was derived from the 2017 Ghana Maternal Health Survey, covering 21,392 women aged 15–49 years. Early sexual debut denotes first sexual intercourse before attaining the legal age of sexual consent, which in Ghana, is 16 years. The Bayesian geoadditive semiparametric regression technique was used to examine geographical hotspots and correlates of the observed spatial patterns, classified into demographic, socioeconomic and pregnancy outcome factors.

Results: The results show that 26.7% (95% CI = 26.1–27.3) of women had their first sexual intercourse before attaining the age of 16 years. Hotspots of early sexual debut was observed predominantly among districts along the mainstream of the Volta Lake, which are also reported hotspots of child trafficking, labour and slavery. Demographic, socioeconomic and pregnancy related factors were identified to be correlated with the observed spatial clustering.

Conclusion: Policies and interventions such as sexual and reproductive health education should target at-risk population, simultaneously addressing other child abuses perpetuating the practice.

Keywords: Early sexual debut, Early sexual initiation, Geographical hotspots, Maternal Health Survey, Ghana, Bayesian geoadditive semiparametric regression

Plain language summary

Ghana operates a decentralised health system, where health policies and interventions, including those for sexual and reproductive health are implemented at the district level. Yet, there are no studies that systematically identify districts where sexual behaviours, such as early sexual debut, require attention. This study uses spatial models and data from the 2017 Ghana Maternal Health Survey to identify areas (districts) with high concentration of women who initiated sex before the legal age of consent. Early sexual debut refers to first sexual intercourse before attainment of the legal age (16 years) of sexual consent. Early sexual initiation has been associated with adverse sexual and reproductive health outcomes such as unwanted pregnancies and STIs. The results show that about one in four women reported having early sexual intercourse. High early sexual intercourse was observed to be particularly concentrated among districts along the mainstream of the Volta Lake. With regards to the spatial correlates, for the districts in the Oti

*Correspondence: famoakojohnson@ucc.edu.gh

Department of Population and Health, Faculty of Social Sciences, College of Humanities and Legal Studies, University of Cape Coast, Cape Coast, Ghana

© The Author(s) 2022. Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/. The Creative Commons Public Domain Dedication waiver (http://creativecommons.org/publicdomain/zero/1.0/) applies to the data made available in this article, unless otherwise stated in a credit line to the data.
Introduction

Almost one-third of Ghana’s population are aged between 10 and 24 years, many of whom are at risk or have experienced or are experiencing the negative impacts of unwanted pregnancies and Sexually Transmitted Infections (STI), including HIV/AIDS [1, 2]. Research evidence show that early sexual debut is one of the major predisposing factors to elevated risk of STIs [2, 3]. Although there are studies that have examined the correlates of early sexual debut in sub-Saharan Africa, there are no systematic studies that identify hotspots of these practices and their spatial correlates, which are important for target interventions. Given the high sociocultural diversity and economic inequalities within countries of sub-Saharan Africa, generalisation of adolescent sexual behaviour even at the country level does not provide comprehensive knowledge of attitudes and behaviours of young people. In this regard, this study using data from the 2017 Ghana Maternal Health Survey (GMHS) examines geographic hotspots of early sexual debut (sex before the legal age of consent) among women of reproductive age in Ghana and their spatial correlates. Identifying geographical hotspots of early sexual debut and their correlates at the district level where health interventions are planned, implemented and monitored are essential for promoting targeted interventions.

The Ghana Criminal Code (amendment) Act, 2003 (Act 646) states the legal age of sexual consent as 16 years and prohibit sexual intercourse before the attainment of this age, be it consensual or not [4]. Further, the children’s Act of 1998 state the legal age of marriage as 18 years and prohibit marriage or union formation before the attainment of this age [5]. Although the laws of Ghana allow freedom of worship and customary practices, the legal age of sexual consent and marriage are the same for all. It is also worth noting that, the laws of the country are superior to any religious doctrine or cultural practices. In this regard, chapter 1(2) of the 1992 Constitution of the Republic of Ghana, states: “The Constitution shall be the supreme law of Ghana and any other law found to be inconsistent with any provision of this Constitution should, to the extent of this inconsistency, be void” [6]. It is therefore illegal in Ghana and against the sexual rights of young people to engage in sexual intercourse before attaining the legal age of 16 years.

Studies have shown that early sexual debutants are more likely to have multiple, concurrent sexual partners, transactional and unprotected sex, exposing them to acquiring STIs [7, 8]. Early sexual intercourse increases risk of unwanted pregnancy, predisposing young girls to maternal mortality and morbidity including higher risks of eclampsia, puerperal endometritis, systemic infections, low birthweight, preterm delivery and severe neonatal outcomes [9, 10]. Further, they face social challenges including limited opportunities for education and economic prospects [11]. Young people who initiate sex early are more likely to be exposed to sexual coercion, systemic physical and psychological violence [12, 13]. The effects are not only limited to the formative years of young people but also in their adult lives. It is reported that early sexual debut leads to poor psychosocial health and risky behaviours in later life, including alcoholism, drug use, antisocial and violent behaviours, low self-esteem and poor mental health, among others [14].

Early sexual initiation varies by sex and across the countries of sub-Saharan Africa. A study in five sub-Saharan African countries covering adolescents aged between 18 and 24 years revealed that in Kenya (boys = 16.3%, girls = 6.7%), Malawi (boys = 22.0%, girls = 14.1%) and Uganda (boys = 15.0%, girls = 10.4%) more boys initiate early sex compared to girls, whilst in Tanzania (boys = 6.8%, girls = 10.1%) and Nigeria (boys = 5.4%, girls = 14.5%) more girls than boys initiate sex early [15]. A multicounty study of 24 sub-Saharan African countries using nationally representative datasets, found large variations in the proportion of men and women aged 15–19 years who initiated sex before the age of 15 years, ranging from 2.0% to 27.0% for men and 5.0% to 26.0% for women [16]. The study further reported that, in Western African countries, females were more likely than men to initiate sex before age 15 years, whilst in Central, Eastern and Southern Africa a mixed pattern was observed, with early sexual initiation being more common in rural than urban areas in most countries [16]. In addition, a declining median age at first sex among young people has also been reported across many sub-Saharan African countries [2].

In Ghana, a recent study reported that 10.8% of women and 6.8% of men aged 15–24 years, reported having sex before age 15 years [17]. The 2014 Ghana Demographic
and Health Survey, reported that among women age 25–49 years, 11% had their first sex by age 15 years, with a median age at first sex of 18.4 years, more than two years lower than the median age (20.7 years) at first marriage [18]. Substantial variations in median age at first sexual intercourse was also reported by region (ranging from 17.6 years in the Northern region to 19.0 years in the Greater Accra region), place of residence (urban = 18.8 years, rural = 17.8 years) and wealth status (poorest = 17.6 years, richest = 19.8 years) [18]. Ethnic variations in early sexual intercourse have also been reported in Ghana, with ethnic groups (Mande, Grusi and Mole-Dagbani) in the northern part of the country initiating sex at a later age than other groups [19].

Studies have identified multifaceted factors at the individual, family and community levels that predict early sexual debut. Observed individual level predictors include low aspiration and self-esteem, lack of knowledge on sexual and reproductive health including STIs and attitudes to premarital sex [20]. At the family level, family structures and parental participation in adolescent sexual activities including supervision, sexual education, family dysfunction and socioeconomic situation are observed predictors of early sexual debut [7, 21]. In a study in Burkina Faso, Ghana, Malawi and Uganda, it was revealed that community factors such as adolescent marriage, wealth, religious affiliation, membership in adolescent social groups and use of alcohol were potential risks factors for early sexual initiation [22].

The Government of Ghana over the years has enacted a number of policies to address the sexual and reproductive health needs and challenges of young people. These include the 1999 National Youth Policy, the 2000 Adolescent Reproductive Health Policy, and the 2010 National Youth Policy of Ghana [23–25]. These policies provide comprehensive strategies for addressing the health challenges of young people, including their sexual and reproductive health needs and issue of STIs including HIV/AIDS. In 2016, the Government of Ghana enacted the 2016–2020 Adolescent Health Service Policy and Strategy to address the multiple challenges faced by young people, including their sexual and reproductive health needs and other factors that expose them to negative health and social outcomes [26]. This policy was to provide a framework for the efficient use of resources for providing health and other related services towards achieving wide-ranging health sector goals for adolescents and young people in Ghana. Despite all these policy efforts, Ghana is one of the countries in sub-Saharan Africa where young people continually face sexual, reproductive health and rights challenges [27]. Key limitations to all these policies initiatives are that they fail to identify at risk groups and geographic areas where targeted interventions are needed. Thus, identifying hotspots of early sexual debut and their spatial correlates are essential for designing and implementing target interventions to reduce its consequential negatives effects including unwanted pregnancies, maternal mortality and morbidity and STIs among adolescents and young people in Ghana.

**Methods**

**Data**

The data for the analysis was secondary data derived from the 2017 Ghana Maternal Health Survey (GMHS) [28]. The GMHS adopted a two-stage stratified cluster (Census enumeration areas) sampling design. A total of 900 (466 urban and 434 rural) clusters (census enumeration areas) were selected, with 30 households selected from each cluster, resulting in a total sample of 27,000 households. Within the selected households, 25,062 women aged 15–49 years were interviewed. This study covered 21,392 women for whom complete data was available. The study considered all women aged 15–49 years to examine generational changes in early sexual debut among women in Ghana. The 2017 GMHS collected detailed demographic and health information from respondents including marriage and sexual activity. The survey also collected information on the deaths of women aged 12–49 years, who died on or after 1 January 2012. The GMHS reported a median age at first sexual intercourse of 18.1 years for women aged 20–49 years, with 12.0% of these women having their first sexual intercourse by age 15 years.

Following Ghana’s Criminal Code (amendment) Act, 2003 (Act 646) [4], the outcome variable for the analysis was binary coded 1 if a woman aged between 15 and 49 years had her first sexual intercourse before attaining 16 years of age and 0 otherwise. The covariates for the analysis were selected based on evidence from the literature [2, 7, 12, 29, 30] and their availability in the GMHS data. The covariates were grouped into three categories: demographic, socioeconomic and pregnancy outcome factors to examine their associations with the spatial patterns of early sexual debut at the district level. The selected covariates, their classification and coding are shown in Table 1.

**Statistical analysis**

The Analysis of Variance (ANOVA) technique was used to examine the mean distribution of the continuous covariates (current age of respondent and parity) aggregated by respondents who had early sexual debut and those who did not have early sexual debut. The percentage distribution of respondents who had early sexual intercourse by the categorical covariates was examined, using the Chi-squared test to assess statistically significant differences. The Bayesian Geadditive
Semiparametric (BGS) regression technique was used to examine geospatial clustering of early sexual debut at the district level and the covariates associated with the observed clustering [31]. The BGS approach allows for simultaneous estimation of non-linear effects of the continuous covariates and the fixed effects of the categorical covariates in addition to the unobserved spatial effects, both spatially structured and unstructured [31]. The analysis covered the 216 districts created in 2012 and adopted for the 2017 GMHS.

The dependent variable $y_{ij}$ was coded 1 if woman $i$ in district $j$ reported having early sexual intercourse and 0 otherwise. Thus, the dependent variable follows a binomial distribution with the expected probability $\pi_{ij}$ of a woman having early sexual intercourse. Thus, the logistic model linking the probability $\pi_{ij}$ of having early sexual intercourse is of the form

$$y_{ij}|\pi_{ij} \sim B(\pi_{ij})$$

$$\pi_{ij} = P(y_{ij} = 1|\pi_{ij}) = \frac{\exp(\eta_{ij})}{1 + \exp(\eta_{ij})}$$

where $\eta_{ij}$ are the covariates of interest. If we have a vector $x_{ij} = (x_{ij1}, \ldots, x_{ijk})$ of $k$ continuous covariates and $\lambda_{ij} = (\lambda_{ij1}, \ldots, \lambda_{ijd})$ a vector of $d$ categorical covariates, then the predictor $\eta_{ij}$ can be specified as

$$\eta_{ij} = \alpha \lambda_{ij} + \beta x_{ij}$$

where $\alpha$ is a vector of unknown regression coefficients for the categorical covariates, $\lambda_{ij} \beta$ is a vector of unknown regression coefficients for the continuous covariates $x_{ij}$.

The BGS framework, which replaces the strictly linear predictors with flexible semiparametric predictors was adopted to account for the non-linear effects of the continuous covariates and their spatial correlation with the outcome variable. The model is thus specified as

$$\eta_{ij} = \alpha \lambda_{ij} + f_k x_{ijk} + f^{\text{spat}(S_j)}$$

where $f_k(x)$ are the non-linear smoothing function of the continuous variables $x_{ijk}$, and $f^{\text{spat}(S_j)}$ accounts for unobserved spatial heterogeneity at district $j$ ($j = 1, \ldots, S$), of which some may be spatially structured (correlated) and others unstructured (uncorrelated). The spatially structured effects show the effect of location by assuming that geographically close areas are more similar than distant areas, whilst the unstructured spatial effects account for spatial randomness in the model [32]. Equation 5, in this regard, is specified as

$$\eta_{ij} = \alpha \lambda_{ij} + f_k x_{ijk} + f^{\text{str}(S_j)} + f^{\text{unstr}(S_j)}$$

where $f^{\text{str}}$ is the structured spatial effects, and $f^{\text{unstr}}$ is the unstructured spatial effects and $f^{\text{spat}(S_j)} = f^{\text{str}} + f^{\text{unstr}}$. The spatially structured effects

| Variables and their classification | Coding | Type |
|----------------------------------|--------|------|
| Demographic covariates          |        |      |
| Current age of respondent       |        |      |
| Marital status                  |        |      |
| Parity                          |        |      |
| Socioeconomic covariates        |        |      |
| Educational attainment          |        |      |
| Religious affiliation           |        |      |
| Household wealth status         |        |      |
| Relation to household head      |        |      |
| Type of place of residence      |        |      |
| Reads newspaper                 |        |      |
| Listens to radio                |        |      |
| Watches television              |        |      |
| Pregnancy outcome covariates    |        |      |
| Ever had miscarriage            |        |      |
| Ever had abortion               |        |      |
| Ever had a stillbirth           |        |      |
depict the extent of clustering of early sexual intercourse at the district level and the associative effects of unaccounted covariates, which may be spatially clustered or random [32]. The smooth effects of continuous factors are modelled with P-spline priors, whilst the spatial effects are modelled using Markov random field priors.

The posterior modes of the structured spatial effects and their corresponding probabilities at 95% nominal level were used to examine spatial correlates of the outcome variable at the district level. The posterior probabilities at the 95% nominal level show districts where early sexual debut was statistically significantly high. That is, high positive and statistically significant estimates of the posterior mode show clustering of districts with high early sexual debut.

The estimated posterior mode of the spatial effects characterises unexplained spatially correlated covariate information. Thus, a sequential modelling approach was used to identify districts where the demographic, socioeconomic and pregnancy outcome covariates were spatially associated with the observed clustering of high early sexual debut. Model 0 was a null (constant) model. Model 1 accounted for only the spatial effects. Model 2 included the demographic covariates; Model 3 added the socioeconomic factors and Model 4 further added the pregnancy outcome predictors. Only covariates significant at $p < 0.05$ were retained in the model. The statistical software R was used for the analysis [33].

Results
Bivariate analysis
Table 2 shows the weighted percentage distribution of respondents who had first sexual intercourse before the legal age of 16 years by the demographic, socioeconomic and pregnancy outcomes covariates. Overall, 26.7% of women reported having their first sexual intercourse before attaining the age of 16 years. With regards to the demographic covariates, a significantly ($p = 0.000$) higher percentage of co-habiting women (32.5%, 95% CI = 31.0–33.9) and women not in union (27.6%, 95% CI = 26.5–28.7) reported having early sexual debut when compared to those currently married (24.0%, 95% CI = 23.2–24.8). The mean current age for women who had their first sexual intercourse before attaining age 16 years is 30.5 years (95% CI = 30.3–30.8), whilst that for those who did not have early sexual debut is 31.8 years (95% CI = 31.7–32.0). This suggests that early sexual initiation is more common among younger women compared to their older counterparts. On parity, the estimates show that women who initiate sex early are more likely to have had a higher number of children (mean = 3.2, 95% CI = 3.1–3.3) when compared to those who initiate sex after attaining the legal age (mean = 2.4, 95% CI = 2.4–2.4).

| Background characteristics | % [95% CI] | n       | p-value |
|----------------------------|-----------|---------|---------|
| Overall                    | 26.7 [26.1–27.3] | 21,392 |         |
| Categorical covariates     |           |         |         |
| Demographic factors        |           |         |         |
| Marital status             |           |         |         |
| Married                    | 24.0 [23.2–24.8] | 10,864 | 0.000   |
| Co-habiting                | 32.5 [31.0–33.9] | 4180   |         |
| Not in union               | 27.6 [26.5–28.7] | 6348   |         |
| Socioeconomic factors      |           |         |         |
| Educational attainment     |           |         |         |
| No formal education        | 32.8 [31.7–34.0] | 6375   | 0.000   |
| Middle                     | 38.4 [36.7–40.1] | 3269   |         |
| Primary                    | 23.1 [20.3–26.0] | 847    |         |
| Junior High School         | 27.1 [26.0–28.2] | 6070   |         |
| Senior High School         | 13.7 [12.5–14.9] | 3242   |         |
| Higher                     | 5.2 [4.1–6.3]    | 1589   |         |
| Religious affiliation      |           |         |         |
| Catholic                   | 26.6 [25.0–28.3] | 2802   | 0.000   |
| Protestant                 | 23.5 [21.7–25.3] | 2077   |         |
| Pentecostal/Charismatic    | 27.4 [26.4–28.4] | 7667   |         |
| Other Christians           | 29.0 [27.2–30.8] | 2533   |         |
| Islam                      | 23.7 [22.5–24.9] | 5156   |         |
| Traditionalist             | 37.5 [33.6–41.5] | 570    |         |
| Other                      | 35.9 [32.1–39.8] | 587    |         |
| Household wealth status    |           |         |         |
| Lowest                     | 34.6 [33.4–35.8] | 5800   | 0.000   |
| Second                     | 31.2 [29.9–32.5] | 4657   |         |
| Middle                     | 28.7 [27.3–30.1] | 4035   |         |
| Fourth                     | 22.7 [21.4–24.0] | 3702   |         |
| Highest                    | 17.8 [16.5–19.1] | 3198   |         |
| Relation to household head |           |         |         |
| Head                       | 26.0 [24.7–27.3] | 4204   | 0.000   |
| Spouse                     | 26.4 [25.6–27.2] | 10,699 |         |
| Son/daughter               | 26.3 [24.8–27.8] | 3515   |         |
| Son/daughter-in-law        | 27.8 [24.4–31.2] | 669    |         |
| Grand child                | 37.5 [32.8–42.2] | 416    |         |
| Brother/sister             | 26.9 [23.1–30.7] | 528    |         |
| Other relative             | 27.8 [25.2–30.4] | 1105   |         |
| Not related                | 27.6 [22.4–32.8] | 286    |         |
| Type of place of residence |           |         |         |
| Urban                      | 21.5 [20.7–22.3] | 10,600 | 0.000   |
| Rural                      | 31.9 [31.0–32.7] | 10,792 |         |
| Categorical covariates     |           |         |         |
| Reads newspaper            |           |         |         |
| At least once a week       | 12.4 [10.3–14.4] | 1019   | 0.000   |
| Less than once a week      | 14.7 [13.1–16.4] | 1744   |         |
| Not at all                 | 20.8 [19.8–21.8] | 6498   |         |
| Cannot read                | 32.8 [32.0–33.7] | 12,131 |         |
Considering the socioeconomic covariates, generally, the proportion who had early sexual debut decreases with increasing levels of educational attainment (Table 2). The estimates also shows that a significantly (p = 0.000) higher proportion of women of traditional believe initiated sex before age 16 years when compared to women of other beliefs. Further, women from poorer households were significantly (p = 0.000) more likely to have initiated sex early compared to those from richer households. Table 2 shows that women who are grandchildren to the head of the household were more likely to have initiated sex early compared to those from richer households. With respect to pregnancy outcomes, the results show that women who initiated sex early were more likely to have had a miscarriage, abortion or stillbirth (Table 2).

### Geographical hotspots of early sexual debut

The estimated posterior variance of the continuous covariates and the posterior odds ratios of the categorical covariates for a woman having early sexual intercourse and their corresponding 95% credible intervals are shown in Table 3, along with their model summary statistics. Interpretation of the model coefficients is based on the final model (Table 3, Model 4). The estimated deviance and AIC for Model 0 (null model) were 24,838.3 and 24,840, respectively (Table 3). When the spatial effects were included in the model (Model 1), the deviance and AIC reduced by 1039.9 and 755.0, respectively. The high reduction in the deviance and AIC after the spatial effects were included in the model indicates spatial clustering of early sexual intercourse at the district level. Figure 1a show districts where the posterior mode of the structured spatial effects was high, positive and statistically significant (clusters of high early sexual debut), at the 95% nominal level. The figure shows clustering of high early sexual debut in 19 districts. The observed hotspot districts are predominantly in the Oti region (Biakoye, Jasikan, Krachi East, Krachi West, Nkwanta South, Nkwanta North and Kadjebi districts) and Volta region (Kpando and Hohoe Municipals, Afadzato South and Krachi Nchumuru districts). Also, districts in the Bono East region (Sene West and Sene East), the Ashanti region (Amansie Central and Sekyere Afram Plains North districts), Eastern (Kwahu Afram Plains North and Kwahu Afram Plains South), Northern region (Kpandai district) and Central region (Upper Denkyira West district). An interesting spatial pattern observed was that, apart from the Upper Denkya West district in the Central region and the Amansie Central district in the Ashanti region, all other districts with high early sexual debut were clustered along the mainstream of the Volta Lake (Fig. 1a).

### Geospatial correlates of early sexual debut

The demographic covariates were included in Model 2 (Table 3), leading to a reduction of 2363.9 and 2311.0 in the AIC and BIC, respectively. The considerable decline in the AIC and BIC suggest that the demographic factors are spatially associated with the odds of a woman having an early sexual debut. The current age of the respondent and parity were observed to have a non-linear association with the observed spatial clustering of early sexual debut (Fig. 2a and b). Figure 2a shows higher odds of

#### Table 2 (continued)

| Category                        | % [95% CI]   | n    | p-value |
|---------------------------------|--------------|------|---------|
| **Listens to radio**            |              |      |         |
| At least once a week             | 24.0 [23.2–24.8] | 10,145 | 0.000   |
| Less than once a week            | 27.1 [25.9–28.3] | 5328  |         |
| Not at all                       | 31.1 [29.9–32.2] | 5919  |         |
| **Watches television**          |              |      |         |
| At least once a week             | 23.2 [22.4–24.0] | 11,093 | 0.000   |
| Less than once a week            | 26.8 [25.4–28.2] | 3949  |         |
| Not at all                       | 32.9 [31.7–34.0] | 6350  |         |
| **Pregnancy outcome factors**   |              |      |         |
| Ever had miscarriage            |              |      |         |
| Yes                             | 28.0 [26.6–29.5] | 3908  | 0.041   |
| No                              | 26.4 [25.8–27.1] | 17,484|         |
| Ever had abortion               |              |      |         |
| Yes                             | 32.5 [31.0–34.0] | 3700  | 0.000   |
| No                              | 25.5 [24.9–26.2] | 17,692|         |
| Ever had a stillbirth           |              |      |         |
| Yes                             | 29.6 [26.9–32.2] | 1126  | 0.029   |
| No                              | 26.6 [26.0–27.2] | 20,266|         |
| **Continuous covariates**       |              |      |         |
| Current age of respondent       |              |      |         |
| Had early sexual debut          | 30.5 [30.3–30.8] | 5718  | 0.000   |
| No early sexual debut           | 31.8 [31.7–32.0] | 15,674|         |
| All                             | 31.5 [31.4–31.6] | 21,392|         |
| Total number of births          |              |      |         |
| Had early sexual debut          | 3.2 [3.1–3.3] | 5718  | 0.000   |
| No early sexual debut           | 2.4 [2.4–2.4] | 15,674|         |
| All                             | 2.6 [2.6–2.6] | 21,392|         |

n sample size
Table 3 Posterior odds ratios of the categorical covariates and their 95% credible intervals, variance of the non-linear covariates and the spatial effects at the district-level and model summary statistics

| Background characteristics | Model 1 POR [95% CI] | Model 2 POR [95% CI] | Model 3 POR [95% CI] | Model 4 POR [95% CI] |
|----------------------------|----------------------|----------------------|----------------------|----------------------|
| Demographic factors        |                      |                      |                      |                      |
| Marital status             |                      |                      |                      |                      |
| Married                    | 1.00                 | 1.00                 | 1.00                 | 1.00                 |
| Co-habiting                | 1.55 [1.41–1.70]**   | 1.49 [1.35–1.63]**   | 1.43 [1.30–1.57]**   | 1.69 [1.54–1.87]**   |
| Not in union               | 1.68 [1.53–1.85]**   | 1.69 [1.53–1.86]**   | 1.69 [1.54–1.87]**   |                      |
| Socioeconomic factors      |                      |                      |                      |                      |
| Educational attainment     |                      |                      |                      |                      |
| No formal education        | 1.00                 | 1.00                 |                      |                      |
| Middle                     | 1.03 [0.93–1.14]     | 0.97 [0.88–1.08]     |                      |                      |
| Primary                    | 0.88 [0.72–1.08]     | 0.83 [0.67–1.01]     |                      |                      |
| Junior High School         | 0.66 [0.59–0.74]**   | 0.61 [0.54–0.68]**   |                      |                      |
| Senior High School         | 0.46 [0.39–0.55]**   | 0.44 [0.37–0.52]**   |                      |                      |
| Higher                     | 0.30 [0.23–0.39]**   | 0.30 [0.23–0.39]**   |                      |                      |
| Reads newspaper            |                      |                      |                      |                      |
| At least once a week       | 1.00                 | 1.00                 |                      |                      |
| Less than once a week      | 0.87 [0.67–1.13]     | 0.86 [0.66–1.12]     |                      |                      |
| Not at all                 | 1.01 [0.81–1.28]     | 1.00 [0.80–1.27]     |                      |                      |
| Cannot read                | 1.26 [1.01–1.61]*    | 1.27 [1.01–1.63]*    |                      |                      |
| Pregnancy outcome factors  |                      |                      |                      |                      |
| Ever had miscarriage       | 1.36 [1.25–1.49]**   | 1.36 [1.25–1.49]**   |                      |                      |
| No                        | 1.00                 | 1.00                 |                      |                      |
| Ever had abortion          |                      |                      |                      |                      |
| Yes                       | 2.10 [1.91–2.30]**   | 2.10 [1.91–2.30]**   |                      |                      |
| No                        | 1.00                 | 1.00                 |                      |                      |
| Ever had a stillbirth      | 1.18 [1.03–1.37]**   | 1.18 [1.03–1.37]**   |                      |                      |
| Yes                       | 1.18 [1.03–1.37]**   | 1.18 [1.03–1.37]**   |                      |                      |
| No                        | 1.00                 | 1.00                 |                      |                      |
| Variance of non-linear effects |                  |                      |                      |                      |
| Demographic factors        |                      |                      |                      |                      |
| Current age of respondent  | 1.0224               | 0.9513               | 0.9736               |                      |
| Total number of births     | 0.2220               | 0.1479               | 0.1560               |                      |
| District level variance    |                      |                      |                      |                      |
| Structured spatial effects (SSE) | 0.1039               | 0.0908               | 0.1228               | 0.1114               |
| Unstructured spatial effects (USE) | 0.1305               | 0.085                | 0.082                | 0.0863               |
| % Change in SSE            |                      |                      |                      |                      |
| Summary statistics         |                      |                      |                      |                      |
| Deviance                   | 23,798.4             | 21,420.1             | 21,025.4             | 20,727.2             |
| AIC                        | 24,085               | 21,721.1             | 21,339.6             | 21,048.9             |
| BIC                        | 25,231.6             | 22,920.6             | 22,592.0             | 22,331.2             |
| GVC                        | 1.1276               | 1.0156               | 0.9975               | 0.9837               |
| Change in deviance         | 1039.9               | 2378.3               | 394.7                | 298.2                |
| Change in AIC              | 755.0                | 2363.9               | 381.5                | 290.7                |
| Change in BIC              | –                    | 2311.0               | 328.6                | 260.8                |

Model 0 Deviance = 24,838.3, AIC = 24,840; **p < 0.01, *p < 0.05
having early sexual intercourse for younger women which decreases exponentially with increasing age. This indicates that the younger generation have higher odds of engaging in early sexual intercourse when compared with the older generation. With regards to parity, Fig. 2b shows that women who had early sexual debut have
higher odds of being of higher parities. The figure shows an increasing exponential relationship between the odds of having early sexual debut and women's parity, indicating that women who had early sexual debut are more likely to have higher number of children. Further, marital status was observed to be statistically significantly associated with the probability of a woman having an early sexual intercourse. The estimates show that women who had early sexual intercourse have increased posterior odds ratio of 1.43 of being in co-habiting relationships and 1.69 of not being in union compared to those who were married. This suggest that women who had their first sexual intercourse after attaining the legal age are more likely to be married (Table 3), whilst those who had early sexual intercourse are likely to be co-habiting or not in union. The demographic factors were observed to be associated with the spatial clustering of early sexual debut in the Upper Denkyira West district in the Central region, the Amanse Central and Sekyere Afram Plains North in the Ashanti region, Nkwanta North in the Oti region, Sene West in the Bono East region and the Kpandai district in the Northern region (Fig. 1b).

The socioeconomic factors were added in in Model 3 (Table 3), leading to a decline of 381.5 and 328.6 in the AIC and BIC, respectively. The socioeconomic characteristics identified to be statistically significantly (p < 0.05) associated with the observed spatial clustering of early sexual debut were educational attainment and reading of newspapers/literacy (Table 3, Model 3). The estimates show that the higher the level of educational attainment, the lower the odds of having early sexual debut. The estimated posterior odds ratios show that women with middle and primary education are not statistically significantly different from women with no formal education, however, women with junior high school (POR = 0.66, 95% CI = 0.59–0.74), senior high school (POR = 0.46, 95% CI = 0.39–0.55) and higher-level (POR = 0.30, 95% CI = 0.23–0.39) education have significantly lower odds of having early sexual debut when compared with those with no formal education. Considering frequency of reading newspapers/literacy, the results show that women who cannot read have increased odds of 27.0% of having early sexual debut compared to those who read newspapers at least once a week. This indicates that women who are illiterate were more likely to engage in early sexual intercourse. The socioeconomic factors were observed to be associated with the spatial clustering of early sexual debut in the Biakoye, Krachi East, Krachi West, Nkwanta South and Kadjebi districts in the Oti region and the Krachi Nchumuru district in the Volta region (Fig. 1b).

With regards to the pregnancy outcome covariates, the results show that women who engaged in early sexual intercourse have higher odds of having miscarriage, abortion and stillbirth. The estimated posterior odds ratios show that women who had early sexual debut are 1.36, 2.10 and 1.18 times more likely to have miscarriage, abortion and stillbirth, respectively, when compared to their counterpart who did not engage in early sexual intercourse. The pregnancy outcome covariates were associated with the observed spatial clustering of early sexual debut in the Kwahu Afram Plains North and Kwahu Afram Plains South districts in the Eastern region and Sene East in the Bono East region (Fig. 1b).

Although the Kpando and Hohoe Municipalities and the Afadzato South districts in the Volta region and the Jasikan district in the Oti region were observed among the spatial clusters of high early sexual debut, neither the demographic, socioeconomic nor pregnancy outcome covariates were significantly associated with the observed spatial clustering. Thus, the observed spatial clustering of high early sexual debut in these districts were unexplained by the selected covariates (Fig. 1b).

**Discussions**

This study examined whether early sexual debut in Ghana were spatially clustered or randomly distributed at the district level and the factors that were associated with the observed spatial patterns. The findings of the study revealed that high rates of early sexual debut in Ghana was statistically significantly clustered in districts along the shores of the mainstream of the Volta Lake and its neighboring districts, predominantly in the Oti region (Biakoye, Jasikan, Krachi East, Krachi West, Nkwanta South, Nkwanta North and Kadjebi districts) and the Volta region (Kpando and Hohoe Municipalities, Afadzato South and Krachi Nchumuru districts). Also, neighboring districts in Bono East (Sene West and Sene East districts), Ashanti (Sekyere Afram Plains North districts), Eastern (Kwahu Afram Plains North and Kwahu Afram Plains South) and Northern (Kpandai district) regions. The bordering districts of Amanse Central in the Ashanti region and Upper Denkyira West districts in the Central region were also found to form a cluster of high early sexual debut.

Insightfully, districts along the Volta Lake, where the study identified clustering of high early sexual debut, have also been reported as hotspots of child trafficking with several consequential effects for both male and female children [34]. The International Labour Organisation (ILO) estimates that more than 21,000 trafficked children engaged in hazardous activities on the Volta Lake in Ghana, which is the largest man-made lake in the world [34, 35]. Research evidence show that these areas are sated with child sexual exploitation, hazardous and abusive labour engagements, denial of medical care, education and other social opportunities [35]. Narratives
from children suggest that they are not abused sexually at a young age only by their masters but also pimps who solicit their services for pay to their masters [35]. For example, it has been reported that there are hard-to-access secret island communities on the Volta Lake where trafficked girls are kept in “sexual slavery camps” to have sex with patrons whiles their masters take the money for the children's services [36]. The observed spatial pattern of early sexual initiation conforms to stories of children trafficked and enslaved in districts along the Volta Lake, depicting that child trafficking and early sexual initiation coexist.

The socioeconomic and pregnancy outcome factors were identified to be associated with the observed spatial clustering of high early sexual debut in districts at the immediate shores of the larger stream of the Volta Lake in the Oti region (socioeconomic factors) and Eastern and Bono East regions (pregnancy outcome factors). The demographic factors on the other hand were associated with the observed pattern for districts to the further extent of the Volta Lake in the Bono East, Ashanti, Central and Northern regions. For the Upper Denkira West district (Central region), Nkwanta North district (Oti region), Amansie Central and Sekyere Afram Plains North districts (Ashanti region), Sene West district (Bono East region) and Kpandai district (Norther region) where the demographic factors were observed to be associated with the observed spatial clustering of high early sexual debut, the results shows that younger women in these districts are more likely to have early sexual intercourse compared to their older counterparts, indicating a generation change in age of sexual initiation in these districts. Asante et al. (2018) [2] although focused on adolescents aged 15–24 years, also found that younger women have a higher odds of having early sexual debut when compared to their older counterparts. Also, women in these districts who had early sexual intercourse were more likely to be of higher parity and not be in union or in cohabiting union.

In the districts (Biakoye, Krachi East, Krachi West, Nkwanta South, Krachi Nchumuru, and Kadjebi) of the Oti region where clustering of high early sexual debut was observed, the effects were associated with the socioeconomic (education and access to information/literacy) factors. The findings show that in these districts’ women with no education or lower educational levels (primary school and below) and those who cannot read have increased odds of having early sexual debut. The literature shows that the Oti region is one of the poorest regions in Ghana, with poor infrastructure and weak institutions to promote rural development [37]. In addition, it is noted for high rates of child abuse, child labour, child abduction, teenage pregnancy and STIs including HIV/AIDS [37, 38], apprehensions concurrent with early sexual intercourse.

The study also investigated associated reproductive health problems with the observed spatial patterns of early sexual debut. The findings revealed that the clustering of high early sexual debut in the Kwahu Afram Plains North and Kwahu Afram Plains South districts in the Eastern region and the Sene East districts in the Bono East region were statistically significantly associated with the pregnancy outcome factors. In these districts, it was observed that women who engage in early sexual debut were more likely to have miscarriage, abortion and stillbirth. Studies across Ghana and sub-Saharan African have highlighted the association between early sexual debut and risk of unwanted pregnancies [2, 39, 40]. Poverty and socioeconomic deprivation have been identified to perpetuate young girls to early sexual initiation and intergeneration sex, leading to unwanted pregnancies and inevitably abortions and other unfavourable pregnancy outcomes such as miscarriages and stillbirths [40–43], as identified in the Kwahu Afram Plains North and Kwahu Afram Plains South districts in the Eastern region and the Sene East district in the Bono East region.

The findings of this study show that early sexual debut in Ghana is geographical clustered with clustering of high rates in areas where child trafficking, child labour and other related child abuses are also high. In this regard, policies and interventions such as sexual and reproductive health education should target at-risk populations, simultaneously addressing other child abuses which perpetuate the act.

Conclusions

The study examined geographical hotspots of early sexual initiation among women in Ghana, and their spatial correlates at the district level where health policies are implemented and monitored, using the BGS regression technique. The findings of the study show that there are geographical hotspots of early sexual initiation among women in Ghana. The hotspots were found predominantly among districts along the mainstream of the Volta Lake, the biggest man-made lake in the world. These observed hotspots of early sexual debut have also been reported as hotspots of child trafficking, slavery, sexual exploitation and engagement in hazardous and abusive labour activities. The observed spatial patterns of this study reveals that child trafficking and early sexual initiation coexist along the Volta Lake of Ghana. Given the observed spatial patterns, sexual and reproductive health interventions should target at-risk populations, addressing other abuses such as child trafficking which perpetuate the act as outlined in the 2016–2020 Adolescent Health Service Policy and Strategy.
Abbreviations
GMHS: Ghana Maternal Health Survey; BGS: Bayesian geo-additive semiparametric.

Acknowledgements
The author is grateful to The DHS Program for providing the data for the study.

Author contributions
FAU—Conception, literature review, extracted data and conducted the statisti-
cal analysis, drafting/review, and approval of final manuscript. The author read
and approved the final manuscript.

Funding
No funding was received for this research.

Availability of data and materials
The data that support the findings of this study are available from The DHS
Program (https://dhsprogram.com/) but restrictions apply to the availability
of these data, which were used under permission for the current study, and so
are not publicly available. Data are however available upon request from The
DHS Program or the author and with permission of The DHS Program.

Declarations

Ethics approval and consent to participate
Not applicable.

Consent for publication
Not applicable.

Competing interests
The author declares no competing interests.

Received: 11 November 2021    Accepted: 1 May 2022
Published online: 12 May 2022

References
1. Ghana Statistical Service, 2010 Population & Housing Census Report. 
Children, adolescents & young people in Ghana. 2013, Ghana Statistical
Service: Accra.
2. Asante KO, et al. Correlates of early sexual debut among sexually active
youth in Ghana. Int Q Community Health Educ. 2018;39(1):9–17.
3. Stöckl H, et al. Is early sexual debut a risk factor for HIV infection among
women in sub-Saharan Africa? A systematic review. Am J Reprod Immunol.
2013;69:27–40.
4. Government of Ghana, Acts of Ghana: Criminal Code, 1960 (Act 29). 1960:
Accra.
5. Government of Ghana, Act No. 560 of 1998, Children’s Act [Ghana], 
N.L.B.N. Authorities, Editor. 1998, Government of Ghana: Ghana.
6. Republic of Ghana, Constitution of the Republic of Ghana, 1992. 1992.
7. Marston M, et al. Predictors of sexual debut among young adolescents in
Nairobi’s informal settlements. Int Perspect Sex Reprod Health. 2013;39(1):22.
8. Onsomu EO, et al. Delaying sexual debut as a strategy for reducing HIV
epidemic in Kenya. Afr J Reprod Health. 2013;17(2):46–57.
9. UNFPA, Marrying too young: end child marriage. 2012, United Nations
Population Fund: New York.
10. Ganchimeg T, et al. Pregnancy and childbirth outcomes among adoles-
cent mothers: a World Health Organization multicountry study. BJOG.
2014;121(Suppl 1):40–8.
11. Bengesai AV, Khan HTA, Dube R. Effect of early sexual debut on high
school completion in South Africa. J Biosoc Sci. 2018;50(1):124–43.
12. Pelzer K. Early sexual debut and associated factors among in-school
adolescents in eight African countries. Acta Paediatr. 2010;99(8):1242–7.
13. Richter L, et al. Early sexual debut: voluntary or coerced? Evidence from
longitudinal data in South Africa—the Birth to Twenty Plus study. S Afr
Med J. 2015;105(4):304–7.
14. Kastbom AA, et al. Sexual debut before the age of 14 leads to poorer
psychosocial health and risky behaviour in later life. Acta Paediatr.
2015;104(1):91–100.
15. Seff I, Steiner JJ, Stark L. Early sexual debut: a multi-country, sex-stratified
analysis in sub-Saharan Africa. Glob Public Health. 2021;16(7):1046–56.
16. Doyle AM, et al. The sexual behaviour of adolescents in sub-Saharan
Africa: patterns and trends from national surveys. Trop Med Int Health.
2012;17(7):796–807.
17. Ghana Statistical Service, Ghana Multiple Indicator Cluster Survey (MICS
2017/18), survey findings report. 2018, GSS, Accra, Ghana.
18. Ghana Statistical Service, Ghana Health Service and ICF International,
Ghana Demographic and Health Survey 2014. 2015, GSS, GHS, and ICF
International: Rockville, Maryland, USA.
19. Teye-Kau M, Godley J. Ethnicity and age at first sexual intercourse in
Ghana. Can Stud Popul. 2020;47(4):229–44.
20. Boafo IM, Dagbanu EA, Asante KO. Dating violence and self-efficacy for
delayed sex among adolescents in Cape Town, South Africa. Afr J Reprod
Health. 2014;18(2):46–57.
21. Biddlecom A, Avusabo-Asare K, Bankole A. Role of parents in adoles-
cent sexual activity and contraceptive use in four African countries. Int
Perspect Sex Reprod Health. 2009;35(2):72–81.
22. Stephenson R, Simon C, Finneran C. Community factors shaping early
age at first sex among adolescents in Burkina Faso, Ghana, Malawi, and
Uganda. J Health Popul Nutr. 2014;32(2):161–75.
23. Ministry of Youth and Sports, National Youth Policy of Ghana. Towards an
emowered youth, impacting positively on national development. 2010,
Ministry of Youth and Sports: Accra.
24. National Population Council, Adolescent Reproductive Health Policy.
2000, National Population Council: Accra.
25. Tagoe MA, Chenebe-Sakyi Y. Harnessing the power of the youth through
national youth policies in Ghana: challenges to notions of empower-
ment. Contemp J Afr Stud. 2013;15(1):69–91.
26. UNICEF and Ghana Health Service, Adolescent Health Service Policy and
Strategy. 2016, Ghana Health Service: Accra.
27. Akazili J, et al. Challenges and facilitators to the provision of sexual, repro-
ductive health and rights services in Ghana. Sex Reprod Health Matters.
2020;28(2):1846247.
28. Ghana Statistical Service, Ghana Health Service and ICF, Ghana Maternal
Health Survey. 2018: Accra, Ghana.
29. Muhammad T, et al. What predicts the early sexual debut among unmar-
hied adolescents (10–19 years)? Evidence from UDAYA survey, 2015–16.
PLOS ONE. 2021;16(6): e0252940.
30. Ningpanuyeh WC, Susuman S. Correlates of early sexual debut and its
associated STI/HIV risk factors among sexually active youths in Malawi. J
Asian Afr Stud. 2017;52(8):1213–24.
31. Kneib T, Tutz G. Statistical modelling and regression structures. Heidel-
burg: Springer; 2010.
32. Amoako Johnson F, Abu M, Utazi CE. Geospatial correlates of early mar-
rriage and union formation in Ghana. PLoS ONE. 2019;14(10):e0223296.
33. Umlauf N, et al. Structured additive regression models: an R interface to
BayesX. J Stat Softw. 2015;63(21):1–46.
34. Annan JK. Ending child trafficking and slavery in Ghana. Nat Hum Behav.
2017;1(5):1–1.
35. Hamenoo ES, Sottie CA. Stories from Lake Volta: the lived experiences of
trafficked children in Ghana. Child abuse neglect. 2015;40:103–12.
36. Adeborna D, Johnson K. Child labour literature review and scoping study
report. The USAID/Ghana Sustainable Fisheries Management Project. Nar-
grangansett, RI: Coastal Resources Center, Graduate School of Oceanogra-
phy, University of Rhode Island, Netherlands Development Organization
Friends of the Nation. GH_POL025_SNV. 2015.
37. Agyabeng AN. Does regional reorganization have implications on socio-
economic development? Understanding Ghana’s experience. Interna-
tional Journal of Public Leadership. 2021.
38. Ghana Statistical Service, 2010 Population and Housing Census Report:
Urbanisation in Ghana. 2014, Ghana Statistical Service Accra: Accra.
39. Grindlay K, et al. Contraceptive use and unintended pregnancy among
young women and men in Accra, Ghana. PLoS ONE. 2018;13(8):
e0201663.
40. Wado YD, Sully EA, Mumah JN. Pregnancy and early motherhood among adolescents in five East African countries: a multi-level analysis of risk and protective factors. BMC Pregnancy Childbirth. 2019;19(1):59.

41. Yakubu I, Salisu WJ. Determinants of adolescent pregnancy in sub-Saharan Africa: a systematic review. Reprod Health. 2018;15(1):15.

42. Mumah JN, et al. Adolescents’ narratives of coping with unintended pregnancy in Nairobi’s informal settlements. PLoS ONE. 2020;15(10): e0240797.

43. Magadi M. Poor pregnancy outcomes among adolescents in South Nyanza region of Kenya. Afr J Reprod Health. 2006;10(1):26–38.

Publisher’s Note
Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.