Modeling Intimate Partner Violence and Associated Factors in The Gambia: A Bayesian Hierarchical Analysis

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Abstract

Intimate partner violence (IPV) is a major public health problem that disproportionately impacts women, and results in significant social, economic, and health costs for women, their families, and broader society. Increases in the incidence of physical IPV and broad social acceptance of domestic violence (DV) in The Gambia highlight a need for targeted, culturally specific interventions. This study aimed to investigate regional level variation in physical IPV prevalence across The Gambia, and identify regional-level predictors of physical IPV risk. Using 2019 Demographic and Health Surveys data on women aged 15-49 in The Gambia and Senegal, this study fitted a spatial Bayesian hierarchical Poisson model. Senegal was included to improve estimation of spatial effects and reduce variance in border regions of The Gambia. Physical IPV incidence ranged from 15.38% to 36.96% across regions. Women's approval of IPV within a region was significantly positively associated with increased physical IPV incidence. Other model covariates, including women's decision-making autonomy, women's education level, and age gap between partners were not significant predictors of physical IPV incidence. Spatial effects accounted for a substantial proportion of variation in physical IPV incidence. These findings emphasize the importance of considering social and cultural context in IPV prevention and intervention. Interventions specifically targeting societal acceptance of IPV may be an important factor for reducing the rate of physical IPV incidence.

Background/Objectives

Intimate partner violence (IPV) is "behavior within an intimate relationship that causes physical, sexual, or psychological harm, including acts of physical aggression, sexual coercion, psychological abuse, and controlling behaviors” [6]. While IPV can impact both men and women, IPV rates are “gender asymmetric”, with women experiencing both greater overall prevalence and greater frequency and severity at the population level [16]. This violence has significant social, economic, and health costs for women, their families, and broader society [12], and “is a major public health problem and a violation of human rights” [6]. IPV can result in both short-term and long-term health problems, and is a significant contributor to mortality [12, 14].

Globally, 30% of women are estimated to have experienced IPV at some point in their lives [12] , while Africa as a whole is estimated to have a slightly higher rate of 33% [13]. In The Gambia, the percentage of married women who have ever experienced IPV increased from 26% in 2013 to 39% in 2019, with those who experienced IPV in the past year increasing from 12% to 17% over the same time period [15]. Rates of IPV vary geographically across The Gambia, ranging from a low of 32% to a high 56% between different local government areas. [15]

While men are the main perpetrators of IPV in The Gambia, more than 80% of women believe it is justified for a man to beat his wife (Jatta, et al, 2022). This increase in IPV and overall approval of domestic violence (DV) indicate a need for the development of targeted interventions. Identifying significant factors associated with IPV against women and how these patterns vary geographically is crucial for developing targeted interventions and prevention strategies. Community-level prevention strategies have been shown to be effective in improving women’s access to social support, improving health outcomes, and reducing violence [17, 18]. Understanding spatial patterns in IPV rates informs allocation of resources and community-level interventions tailored to the specific social contexts of the woman and the broader community.

Methods

The analysis used data from the 2019 Gambian Demographic and Health Survey (DHS) and the 2019 Senegal DHS. As The Gambia is a long, narrow strip of land surrounded by the country of Senegal [1], in order to reduce variance and improve estimation of spatial effect, the model included both the Gambia and Senegal.

DHS surveys are nationally representative and collect health and population indicators [cite DHS program booklet]. For the 2019 Gambian DHS, the survey sample is representative at the national level and for the eight local government areas [15]. Access to and permission to use the datasets were granted by the DHS Program. The 2019 Gambia dataset was accessed through IPUMS-DHS. The 2019 Senegal data were obtained directly from the DHS Program website, due to unavailability through IPUMS-DHS.

Results are nationally representative of ever-partnered women, between the ages of 15-49. For the Domestic Violence module used in this analysis, the DHS Program collected IPV data on ever-partnered women, ages 15-49. Therefore, although the survey includes demographic data on a wider range of women between the ages of 15 and 49, the analysis was restricted to women who were included in the Domestic Violence module. Individual level survey data were weighted using the DHS sampling weights for the Domestic Violence module, in order to produce nationally and regionally representative results, then aggregated to region level to match the administrative regions available.

The DHS samples are constructed using a two-stage stratified cluster sampling design. The first stage selects from 281 census enumeration areas, while the second stage uses household as the sampling unit. A total of 7,025 households were selected, 25 from each enumeration area. All women between the ages of 15 and 49 who live in the household or spent the previous night in the household were eligible for inclusion. Due to WHO guidelines on the ethical research of domestic violence, a maximum of one woman per household was asked questions from the domestic violence module.[15]

The Gambia and Senegal shapefiles were downloaded from the DHS Spatial Data Repository, which provides administrative boundaries for countries and years included in the DHS Program. The analyses included 8 and 14 regions for The Gambia and Senegal, respectively. Individual level survey data were weighted using the DHS sampling weights for the Domestic Violence module, then aggregated to region level to match the administrative regions available.

The outcome variable is the observed weighted count of women who reported *physical* IPV within each administrative region. This was constructed by combining two standard DHS Program variables, one indicating whether the woman reported ever experiencing any form of less severe IPV (i.e., pushed, shaken, had something thrown at her, slapped, punched, or had her arm twisted), and the other indicating whether the woman reported ever experiencing any form of severe IPV (i.e., choked, kicked, or threatened or attacked with a knife, gun, or other weapon). Women with yes responses to either variable were considered to have experienced physical IPV.

A range of socioeconomic and demographic covariates and interaction terms were considered as potential predictors in the model, based on prior literature and data availability. The WHO identifies a range of key risk factors for IPV including lower levels of education for both the perpetrator and the victim, witnessing family violence as a child, community norms, low levels of gender equality, low levels of access to employment for women. In addition to the summary covariates described below, see Table 1 for a description of all covariates considered.

Three summary covariates were created as potential predictors in the model, including the mean women's autonomy score, mean IPV approval score, and proportion of domestic violence interviews interrupted. Mean autonomy score was calculated as the proportion of domains in which the woman has decision-making power, either alone or jointly with a partner/others, and ranges from 0 (no domains) to 1 (all domains). Domains include visits to family, large household purchases, the woman's own earnings, her husband's earnings, and decisions about her own healthcare. Mean IPV approval score was calculated as the mean number of situations in which a woman agrees a husband is justified in hitting or beating his wife and ranges from 0 (no situations) to 1 (all situations). Situations included differ between The

Gambia and Senegal, with The Gambia analysis including if a woman uses contraception without her husband's consent, if she disrespects her in-laws, if she neglects the children, if she refuses to have sex, if she goes out without permission, if she burns food, and if she argues with her husband. The Senegal analysis includes all aforementioned situations except using contraception without consent and disrespecting her in-laws. Proportion of domestic violence interviews interrupted is a summary variable of three separate variables indicating interruption by children, men, or other women.

The observed and posterior standardized morbidity ratio (SMR) for physical IPV for each region was calculated separately for each country using each country's national IPV rate. The SMR is the observed count of women who ever experienced physical IPV in each region divided by the expected count based on the national rate and the region's population.

Bayesian statistical modeling was conducted using the NIMBLE package in R. We fit a spatial Bayesian hierarchical Poisson model to assess regional variation in risk of physical IPV and associations with regional covariates in The Gambia. Senegal was included in the model to reduce variance and improve estimation of spatial effects.

For region i (n = 22), the observed count of women reporting any physical IPV (Y_i), is assumed to follow a Poisson distribution with rate parameter μ_i, which is modeled as:

$$Y_i \sim \text{Poisson}(\mu_i),\ \mu_i = E_i * \eta_i$$

$$\log(\eta_i) = \beta_0 + \sum_{j=1 \text{ to } p} \boldsymbol{\beta}_j \mathbf{X}_{ij} + \phi_i + \Theta_i$$

Where:

- E_i is the expected count of IPV in region *i*, based on each country's national rate and weighted regional population
- η_i is the relative risk of IPV in region *i*
- X_{ij} are regional covariates
- $\boldsymbol{\beta}_0$ is the intercept

- $\boldsymbol{\beta}_j$ are covariate coefficients
- ϕ_i is the region-level spatial random effect, and follows an ICAR prior $\phi_i \sim CAR(\boldsymbol{\tau}_c)$ where $\boldsymbol{\tau}_c$ is the precision
- Θ_i is an unstructured heterogeneity term, with prior $\Theta_i \sim N(0, 1/\boldsymbol{\tau}_h)$, where $\boldsymbol{\tau}_h$ controls the magnitude of Θ_i

The proportion of variability in random effects due to region-level spatial random effects was modeled as:

$$\alpha = \sigma_c / (\sigma_c + \sigma_H)$$

Where:

- σ_c is the standard deviation of the spatial effects
- σ_H is the standard deviation of the unstructured effects
- and higher α indicates a greater degree of variability due to spatial effects.

Vague priors were set for the intercept ($\beta_0 \sim N(0, 10)$) and covariate coefficients ($\boldsymbol{\beta}_j \sim N(0, 10)$ for $j = 1,...,p$) and Gelman-style priors (Gelman, 2006) for variance, where $\sigma_c \sim Unif(0, 100)$, $\sigma_H \sim Unif(0, 100)$, the $\boldsymbol{\tau}_h$ prior is $1/\sigma_H^2$, and the $\boldsymbol{\tau}_c$ prior is $1/\sigma_c^2$.

Covariates were selected using forward selection based on WAIC values and effective number of parameters (pWAIC). At each step, a single covariate was added that most improved WAIC and effective number of parameters compared to the previous model. The initial starting model began with only the intercept, the spatial random effect ϕ_i, and the unstructured heterogeneity effect Θ_i. Model selection continued until additional covariates no longer improved WAIC. Model selection was performed using three MCMC chains, discarding the first 5,000 and retaining the remaining 5,000. Convergence was assessed using the Gelman-Rubin diagnostic ($\hat{R}$) and trace-plots for the initial intercept-only model.

The final model included covariates for mean women's IPV approval score, mean woman's autonomy score, mean age gap between women and their husbands, and mean woman's education level. The final model was fitted using three MCMC chains, discarding the first 100,000 and retaining the remaining 400,000. Convergence was assessed using the Gelman-Rubin diagnostic ($\hat{R}$) and trace plots.

Results

The final analysis included 22 regions from the Gambia and Senegal, with 8 regions from The Gambia and 14 from Senegal. Senegal was included to improve estimates and reduce variance and edge effects within results for The Gambia. After subsetting the sample to include ever-partnered women ages 15-49 included in the DHS Program Domestic Violence Model, domestic violence weights were applied to reflect a nationally and regionally representative sample. In The Gambia, the weighted percentage of women reporting any physical IPV ranged from 15.38% in Kanifing to 36.96% in Janjanbureh, largely consistent with previous research. Means of covariates included in the model varied across regions in The Gambia, as well. Mean DV approval ranged from 12.24% in Kanifing to 52% in Basse. Mean autonomy score ranged from 29.61% in Kuntaur to 58.25% in Kanifing. Women's mean education level ranged from 0.56 (indicating a mean education level less than primary school) in Kuntaur to 1.56 in Kanifing. (indicating a mean education level between primary school and secondary school). Mean age gap ranged from husbands being on average 9.97 years older than women in Banjul to 13.17 years older on average in Basse. See Table 2 for full descriptive statistics by region.

The observed standardized morbidity ratio (SMR) for any physical IPV was calculated using the region's weighted IPV count divided by the expected count based on the national IPV rate. Observed SMRs ranged from 0.74 in Kanifing to 1.78 in Janjanbureh. The posterior mean SMRs produced by the spatial Bayesian hierarchical model ranged from 0.74 in Kanifing to 1.63 in Janjanbureh. See Figure 1 comparing the observed and posterior SMRs across regions in

The Gambia and see Figure 2 for overall observed and posterior SMRs for The Gambia and Senegal.

For the final model, covariates were selected using forward selection based on WAIC values and fit a spatial Bayesian hierarchical Poisson model to assess regional variation in physical IPV rates across The Gambia.

The initial intercept-only model, fit before any covariates were added to the model to determine a baseline level WAIC model for comparison, shows significant spatially structured effects that account for a substantial portion of the residual variation in regional IPV rates. The posterior mean rate of 0.67 with 95% Credible Interval [0.13- 96.54], while significant, indicates uncertainty in the magnitude of the proportion due to spatially structured effects. These results provide justification for including spatially structured random effects in our model.

The final model consisted of mean woman's IPV approval score, mean woman's autonomy score, mean age gap between woman and her husband, and mean woman's education level, along with spatially structured and unstructured random effects.

Results included in Table 3 display the posterior mean and 95% Credible Interval for each parameter included in the final model. Results indicate a strong positive association between women's approval of IPV and IPV incidence (mean: 2.775; 95% CI: [1.188.4.538]). This may indicate that societal approval of domestic violence contributes to higher regional rates of IPV. Alternatively, women who experience domestic violence at higher rates may be more likely to approve of subsequent domestic violence as a means to justify staying in a relationship when divorce may not be possible due to stigma or a lack of family and community support [8].

Women's autonomy in decision-making exhibited a small positive but non-significant association with regional IPV rates (mean: 1.512; 95% CI: [-0.801, 3.966]). The age gap between a woman's age and her husband's age did not show a significant association with regional IPV rates (mean: 0.002; 95% CI: [-0.181, 0.207]).

Results indicate an uncertain and insignificant association between regional IPV incidence and women's education level (mean: -0.135 ; 95% CI: [-1.3117, 1.064]). The uncertain relationship may be due to regional variations in education and attitudes towards domestic violence. Studies generally show higher educational attainment to be a protective factor for IPV [6, 9], however, community-level acceptance of abuse can suppress the protective influence of higher educational attainment [10] [11].

Spatial effects remain important in the model of physical IPV rates in The Gambia even after accounting for model covariates. Spatial effects account for a substantial variation in regional IPV rates, but there is considerable uncertainty in the magnitude of the proportion. (mean: 0.566; 95% CI: [0.07, 0.951]).

Discussion

This study examined regional variation in physical IPV rates among women in The Gambia and identified regional level predictors of physical IPV risk. Significant spatial effects indicate the presence of regional-level factors not included in the model influencing physical IPV risk. Results further demonstrate higher mean approval of domestic violence among women as a significant predictor of higher physical IPV rates. This highlights the importance of community level acceptance and norms as a predictor of physical IPV. This analysis adds to the research demonstrating the necessity of interventions developed with consideration of the local social and cultural contexts. Interventions focused on combating norms supporting domestic violence are a viable avenue for reducing the overall incidence of physical IPV.

Although this study provides further insight into region-level variation of physical IPV rates and its predictors, there are several limitations worth nothing. The analysis focused mainly on characteristics of the women, and only included men's age and education level. Future studies investigating characteristics of men may give additional insight into relationships at risk of physical IPV. Additional variables assessing men's approval of domestic violence, employment, exposure to violence in childhood, substance use, and other social factors may provide further insight into spatial patterns of physical IPV.

Additionally, this study was limited to physical IPV, and did not include measures of emotional, financial, or sexual IPV. Expanding the analysis to include broader forms of IPV may provide a clearer picture of associated risk factors and regional variations in IPV.

This analysis was limited to The Gambia using 2019 DHS data, limiting generalizability to other countries, years, and social contexts. Including additional years may elucidate the role of factors influencing changes in IPV rates over time and the impacts of interventions and laws related to IPV. Including additional countries would allow for greater insight into the role of spatial, social, and cultural influences on IPV rates, as differences may be greater between than within countries.

Finally, the DHS includes self-reported data which is limited by a woman's willingness to disclose IPV to interviewers, socially desirable reporting, a woman's lack of awareness of IPV, and broader social stigma and fear of social and relational consequences of IPV disclosure.

Table 1. Region-Level Covariates

Variable Name	**Description**
working_percent	Proportion of women currently working
mean_wealth _quantile	Average household wealth quintile
mean_educlvl	Mean women's education level
mean_hused	Mean husband's education level
news_percent	Proportion of women who read newspaper at least once a week
tv_percent	Proportion of women who watch TV at least once a week
radio_percent	Proportion of women who listen to radio at least once a week
internet_percent	Proportion of women who used internet in last year
urban_percent	Proportion of women in urban areas
mean_agefrstmar	Mean age at first marriage
mean_autonomy	Mean autonomy score

mean_age	Mean age of women
mean_husage	Mean age of husbands
mean_age_gap	Mean age gap between woman and her husband
pct_pahitma	Proportion of DV interviews interrupted
mean_dv_approve	Mean IPV approval score
mean_wealth_work_int	Interaction between wealth and working status
dv_inter_percent	Proportion of women ever experiencing physical IPV

Table 2. Descriptive Statistics

Region	Any Physical IPV %	Mean Autonomy Score	Mean Women's Education Level	Mean DV Approval Score	Mean Age Gap (>0 means husband older)
Banjul	17.65	0.56	1.44	0.19	9.97
Kanifing	15.44	0.58	1.56	0.12	11.12
Brikama	19.41	0.42	1.35	0.28	11.19
Mansakonko	22.06	0.34	1.04	0.47	12.74
Kerewan	16.4	0.54	0.94	0.3	11.89
Kuntaur	29.76	0.3	0.56	0.48	13.11
Janjanbureh	36.95	0.49	0.64	0.35	12.39
Basse	31.19	0.44	0.72	0.52	13.18

Table 3. Bayesian Spatial Poisson Model Results - Exponentiated			
Parameter	Mean	Std. Dev	95% CI
Intercept	-1.375	1.375	[-4.376, 1.215]
Mean Women's DV Approval Score	2.775	0.836	[1.188, 4.538]
Mean Women's Autonomy Score	1.512	1.190	[-0.801, 3.966]
Mean Age Gap Between Woman and Husband	0.002	0.097	[-0.181, 0.207]
Mean Women's Education Level	-0.135	0.581	[-1.317, 1.064]
Spatial Variance Proportion	0.566	0.241	[0.07, 0.951]
Spatial SD	0.353	0.222	[0.022, 0.846]
Non-spatial SD	0.232	0.124	[0.026, 0.502]

Figure 1. Observed and Posterior Mean Standardized Morbidity Rates in The Gambia

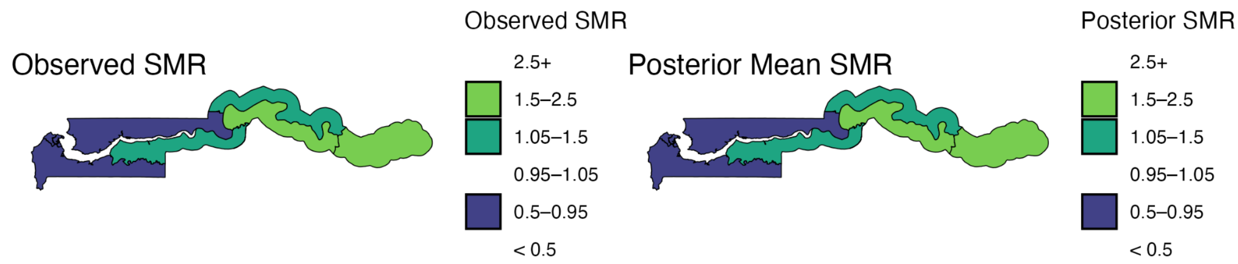
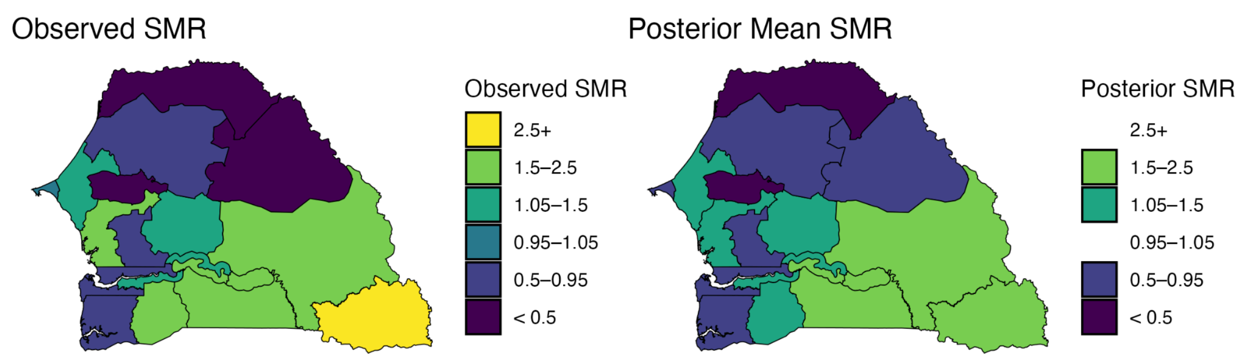


Figure 2.

Observed and Posterior Mean Standardized Morbidity Rates in The Gambia and Senegal



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