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Using Spatial Analysis to Increase Understanding of Population-based Survey Indicators

Ghana's 2008 DHS Survey: Unmet Need for Contraception and Contraceptive Prevalence Rate

Introduction

You can improve targeting for programs if you know how indicators are distributed within an area; for example, indicators for family planning needs such as, unmet need and contraceptive prevalence rate. The USAID | DELIVER PROJECT uses the rate of unmet need and contraceptive prevalence from the Demographic and Health Surveys (DHS) to help inform family planning programming at the regional level. However, because of sampling limitations, we could not analyze the data below this level.

In Volta, the south-east region of Ghana, 1.82 million people, half of them women, live in a 20,570 km2 area. The 2008 Ghana DHS shows that 34% of the women of reproductive age (WRA), in union, living in this region, have an unmet need for contraception (see figure 1): 29% are using a contraceptive method (see figure 2). Therefore, when planning inventions within the country and the region, it is useful to know if these rates are equally distributed throughout Volta, or only concentrated in one area.

To help us understand the characteristics within Ghana, we proposed an innovative technique that combined spatial analysis with traditional data analysis.

Figure 1: Unmet Need in Ghana
Source: (GDHS 2008)

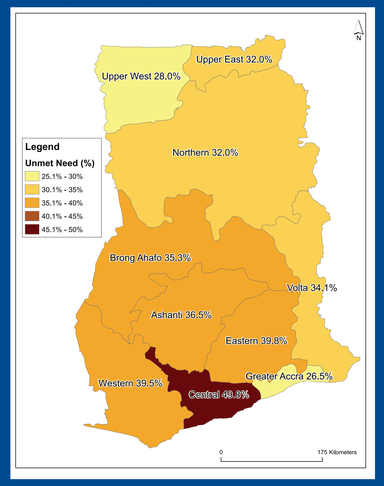
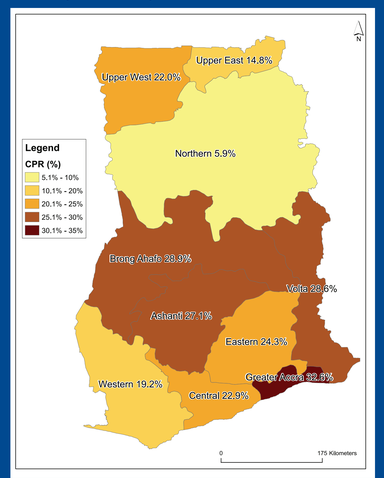


Figure 2: Contraceptive Prevalence Rate (CPR) in Ghana
Source: (GDHS 2008)



Methodology

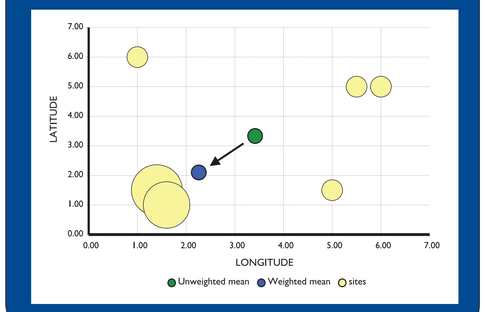
We linked the DHS data with its geographical positioning system (GPS) cluster location, then calculated the weighted geographic mean center (WGMC) within the region. We used an independent t-test of the longitude and latitude axes to determine the statistical significance between the difference in the mean distance of the cluster locations and the two weighted mean points.

What is the WGMC?

The geographic mean center (GMC) is the spatial equivalent of an average. The geographic center is the middle point for the clusters (see figure 3).

The WGMC is similar to the geographic mean center, except that the longitude (x) and latitude (y) values are weighted by an attribute value at each location. Therefore, the mean center influences the weighting of the attribute.

Figure 3: Creating a Geographic Mean Center
Note: The green dot is the GMC of all the yellow points; the blue dot is the WGMC. Notice that the blue dot is at the bottom left corner because of the influence of the two larger yellow points.



The equation we used to calculate the WGMC is—

$$\bar{X}_w = \frac{\sum_{i=1}^{n} w_i x_i}{\sum_{i=1}^{n} w_i} \quad , \quad \bar{Y}_w = \frac{\sum_{i=1}^{n} w_i y_i}{\sum_{i=1}^{n} w_i}$$

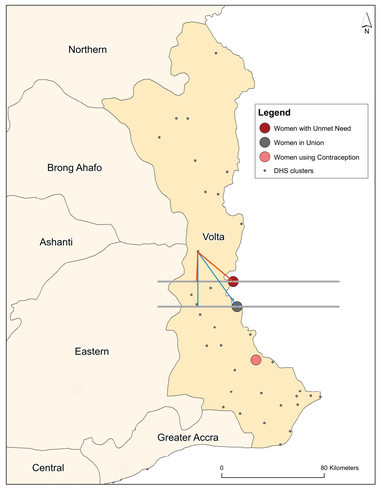
Where x = longitude, y = latitude, and w = weight value

For this analysis, the WGMC is the—

- mean center of sample population WRA, in union, weighted by the number of WRA in union at each cluster
- mean center of sample population of WRA, in union, with unmet need weighted by the number WRA in union at each cluster
- sample population of WRA, in union, using contraceptive method weighted by the number of WRA in union at each cluster.

Figure 4: Weighted Geographic Mean Centres (WGMC) for Women Reproductive Age (WRA) in Union and DHS clusters within Volta in 2008.

Note: This figure shows how the latitude distance is determined for one cluster; the distances are used to determine if the WGMCs are different. An independent t-test is then used to compare the mean distance between the DHS clusters and the WGMCs.



Is the difference in means significant?

We used an independent t-test of the mean differences in longitude (x) and latitude (y) from the clusters to the WGMCs to determine if there they were statistically different (p ≥0.05). To conduct this analysis, we grouped the distance to WGMC, based on their relationship to the mean centers, i.e., clusters located to the south of the mean centers are grouped together and those to the north are grouped together. We analyzed the groups separately. Because the numbers of clusters on either side of the WGMCs are not equal when grouped, we used the side with the larger number of clusters to determine if the difference was significant. It should be noted that we excluded the clusters where the relationship to the mean centers were different from the analysis (i.e., clusters north of the mean center of total population and south of the mean center for unmet need).

Results

For Volta (see figure 4), the WGMC for unmet need is north of the WGMC for WRA in union, which indicates unmet need is concentrated more in the north than in the south (p ≥0.05). Similarly, the WGMC for CPR (any method) is in the south and east—most of the contraceptive method use among women in union is in the south-east (p ≥0.01, p≥0.001). In addition, the CPR is focused in the east of Northern region (p ≥0.05). The results for the other regions were not significant, indicating that neither unmet need nor CPR are concentrated in any particular area (see table 1).

Figure 5: Weighted Geographic Mean Centers for Women of Reproductive Age, in Union, within Ghana (2008)

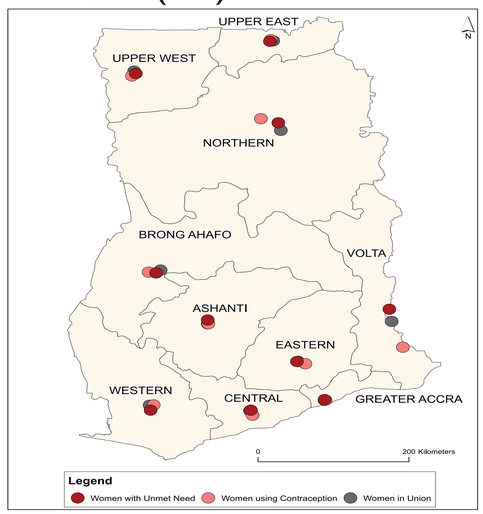


Table 1: Independent T-Test Results for Contraceptive Prevalence Rate and Unmet Need

CPR	LONGITUDE (X)		LATITUDE (Y)	
	p-value	n	p-value	n
Western	0.392	19	0.951	22
Central	0.723	16	0.275	18
Greater Accra	0.273	35	0.901	36
Volta	0.004 *	19	0.000 *	15
Eastern	0.075	25	0.319	23
Ashanti	0.885	43	0.998	38
Brong Ahafo	0.071	17	0.674	19
Northern	0.016 *	17	0.158	21
Upper East	0.631	14	0.315	17
Upper West	0.583	19	0.123	15

UNMET NEED	LONGITUDE (X)		LATITUDE (Y)	
	p-value	n	p-value	n
Western	0.858	20	0.233	21
Central	0.853	18	0.884	17
Greater Accra	0.965	35	0.132	36
Volta	0.540	18	0.033 *	20
Eastern	0.786	23	0.957	24
Ashanti	0.974	42	0.266	38
Brong Ahafo	0.482	20	0.568	19
Northern	0.861	19	0.358	21
Upper East	0.506	13	0.697	18
Upper West	0.620	20	0.458	16

Conclusion and Study Implications

By incorporating spatial analysis into traditional data analysis, you can improve your understanding of regional characteristics. You can use this method for different DHS indicators, or other survey-based results, to show where the attribute is focused within a region: whether it is uniform throughout the area; or in the northern, southern, eastern, or western areas. For Volta, the results indicate that family planning programs should focus on improving contraceptive use in the north because this is where WRA in union have a greater unmet need.

Limitations

- The small sample size (GDHS n=399, Volta, n=33) decreased the sensitivity of the analysis.
- The location of the WGMC does not provide the actual physical location for the unmet need.

Note: For this analysis, we used the MeasureDHS "need of family planning" definition 2 (V626).
Source: Ghana Statistical Service (GSS), Ghana Health Service (GHS), and ICF Macro. 2009. *Ghana Demographic and Health Survey 2008*. Accra: GSS, GHS, and ICF Macro.

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