Measuring Geographic Access to Primary Care Physicians

The New Mexico Health Policy Commission and the University of New Mexico's Division of Government Research have been working cooperatively to collect data and develop methods for the analysis of geographic access to health care facilities and providers in New Mexico. This is a brief description of a methodology that was recently used for measuring geographic access to primary care physicians. This methodology, along with the data used, are currently being refined and improved.

The Problem of Measuring Geographic Access

In order to measure geographic access, a specially designed gravity model was applied that compares the distributions of population and primary care physicians. Gravity models (a class of spatial interaction models) and other spatial analysis methods have a history of successful application for retail and marketing studies, and more recently health care studies (Cromley and McLafferty, 2002).

This gravity model based measurement technique considered the following:

- Provided compatibility with traditional ratio-based measures (e.g., federal and state service capacity standards expressed as persons per physician).
- The arbitrary boundary problem imposed by data collection units such as ZIP Codes (people cross ZIP Code boundaries to obtain health care).
- Spatial interaction: the closer medical services, the easier it is to access them.
- Distance decay: the decline of spatial interaction over distance, termed the friction of distance.
- A common scale that allows for the relative comparison of values by ZIP Code.

Population Estimation

This gravity model uses estimated number of people per ZIP Code derived from year 2002 counts of licensed drivers and year 2001 population by county. This estimation process allocates a portion of a county's population to each ZIP Code. Estimated population per ZIP Code is equal to the ratio of licensed drivers per ZIP Code divided by the total number of licensed drivers per county multiplied by the total population of a county. The population estimation is expressed by the following formula:

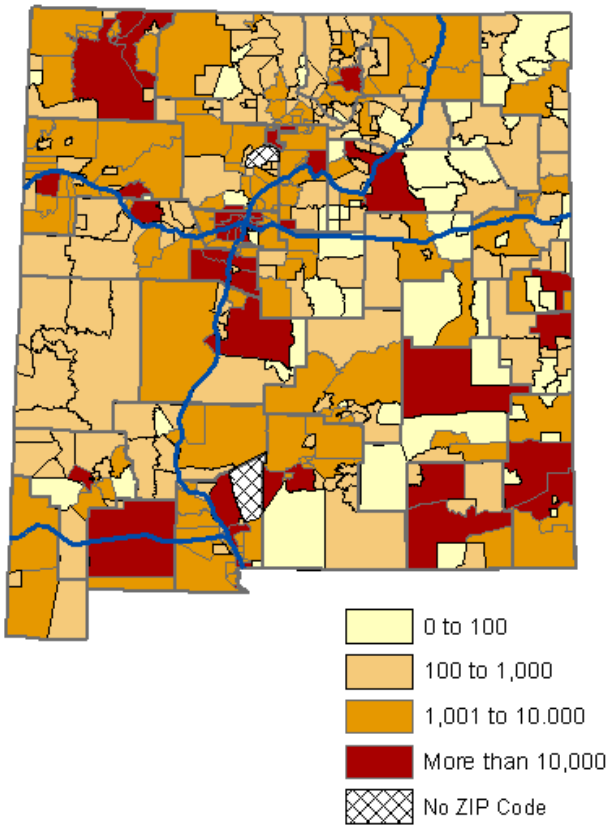
$$P_z = \frac{D_z}{D_c} \text{ x } P_c$$

P_z = Estimated ZIP Code Population
D_z = Number of licensed drivers in a ZIP Code
D_c = Number of licensed drivers in a county
P_c = County Population

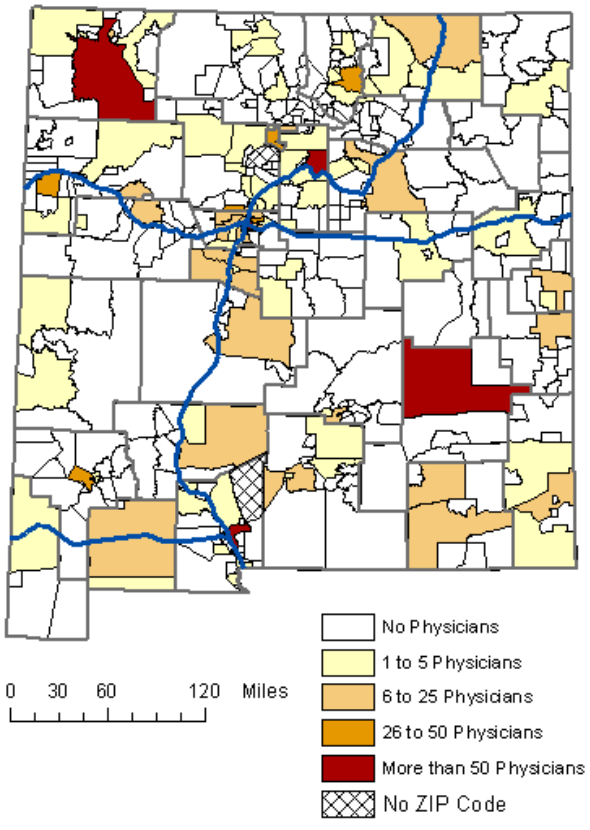
Population and Physician Data

The following maps illustrate the distribution of population and primary care physicians. These physicians are those in family practice, general practice, pediatrics, obstetrics and gynecology, and internal medicine with active licenses and a primary licensing address in New Mexico. The map on the left shows the estimated number of people per ZIP code in New Mexico based on 2002 counts of licensed drivers and 2001 population by county. The map on the right shows the number of primary care physicians by ZIP code in New Mexico as of March 2002 based on data obtained by the New Mexico licensing authorities. It difficult to visually compare these two maps and effectively measure geographic access to primary care physicians.

Estimated Population by ZIP Code



Primary Care Physicians by ZIP Code



Potential Accessibility Gravity Model

This potential accessibility gravity model was used to compare the distributions of population and primary care physicians as depicted by the previous two maps. This model is expressed by the following formula:

$$PA_j = \frac{\sum_{i=1}^{n} f(d_{ij})\, pop_i}{\sum_{i=1}^{n} f(d_{ij})\, prov_i}$$

PA_j = Potential accessibility for ZIP code j
pop_i = Population of ZIP code i
$prov_i$ = Number of providers or facilities in ZIP code i

$f(d_{ij}) = 1$	for all $0 < d_{ij} < 35$
$f(d_{ij}) = 1/(d_{ij} - 34)$	for all $35 <= d_{ij} <= 100$
$f(d_{ij}) = 0$	for all $d_{ij} > 100$

It is important to note that this is a dual gravity model, one for population (numerator) and one for providers (denominator). The result (PA_j) is expressed as a traditional service capacity ratio. Unlike most traditional gravity models that use an exponential function for distance decay, this model uses a rule-based function that allows for a more gradual distance decay. There is no distance decay within 35 miles. The distance decay is gradual between 35 and 100 miles. Beyond 100 miles this model does not measure the cumulative effects of population or providers. The 35 mile distance is used as a proxy for 45 minutes of travel time which is the geographic access standard specified by a New Mexico Senate Joint Memorial 36 (SJM 36).

Technical Notes and Reference

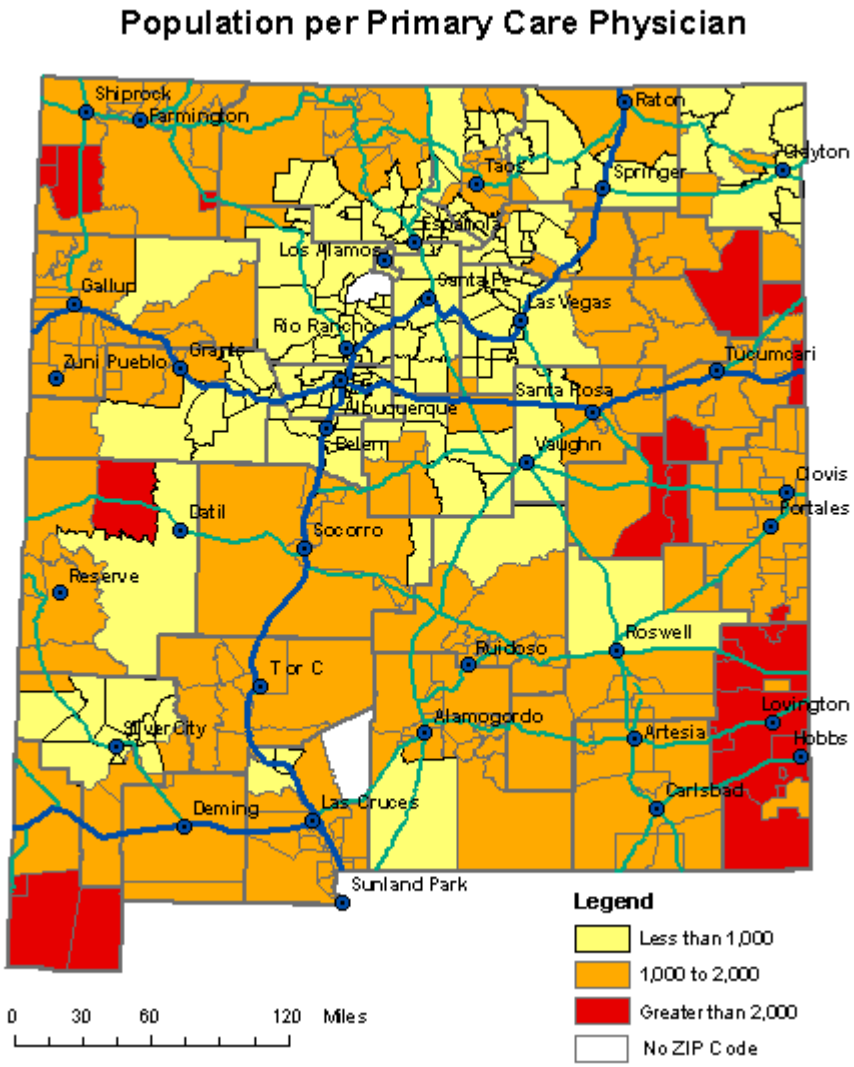
The population estimation and the gravity model were programmed in SAS (Statistical Analysis System – SAS Institute). The results were transferred to ESRI's (Environmental Systems Research Institute) ArcGIS as dBASE files and joined with a ZIP Code shapefile attribute table in ArcMap. The maps were produced in ArcMap.

Senate Joint Memorial 36 sets a service capacity standard of 1 FTE per 1,500 population and a geographic access standard that allows for persons to be within 45 minutes of primary care service.

More information about this potential accessibility gravity model along with this publication (with color maps) and others (as PDFs) is available at http://wwwdgr.unm.edu/hpc/gravmod.htm. The following book is a source of additional information.

Cromley, E.K. and McLafferty, S.L. (2002) *GIS and Public Health*. New York: The Guilford Press.

Gravity Model Map



Interpretation of Results

The results from the potential accessibility gravity model were mapped (see above). This map more clearly displays the relative distribution of population per primary care physician than the previous maps.

The core areas of New Mexico are within the established guidelines for geographic access (SJM 36) to primary care physicians. It is apparent that the north and central portions have greater geographic access than the rest of the state. In general, geographic access seems to decline in some rural ZIP Codes and others that are close to the Arizona and Texas borders.

More applications of this methodology are expected in the future. It will be used to help measure geographic access to other categories of providers and facilities, such as hospitals, clinics, and dentists.