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Modeling Future Health Care Workforce Adequacy to Inform Policy

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Abstract

Purpose of Study

Adequacy of the US health care workforce is in flux, with demand increasing and physicians retiring as the population ages, improved access to care due to the 2010 Affordable Care Act, and differential population growth and decline across geographic areas. Of concern for New Mexico (NM), a large rural and frontier state, is health care workforce sufficiency in rural areas: 32 of NM's 33 counties are partially or wholly medically underserved. This study combines population and physician workforce modeling to inform policy by estimating future shortages.

Methods

Using US Census population data for NM by county, we defined initial population and rates of fertility, mortality, and both domestic and international migration. These data were used to parameterize our model implemented in Vensim to project future county-level population counts. These projections include demographic categorizations, such by sex, age, race and ethnicity, as well as health care workforce groups, including primary care physicians (MDs) and advanced practice registered nurses (APRNs). Demographic population counts and rates for projections are parameterized from the US Census, and health care workforce counts are from NM health care workforce surveys. From this survey data we also estimate rates for incoming and outgoing health care workforce professionals (using changes in licensing due to graduation and/or retiring), with respect to NM, as well as migration into and out of NM and within NM from county to county. Our model consists of a time-variant linear system of equations for each subpopulation category tracked, including all demographic and health care workforce groups. Productivity weighting of health professional counts workforce group by hours worked per week, and through practice size and setting.

Key Findings

Projection of health care workforce needs is easily done using model projected population values in conjunction with national standard rates for each category of health care workforce professionals. Sufficiency values (positive or negative) for each of these health care workforce groups can then be determined by comparing to projection population counts for these groups from our model. The population in rural counties is shrinking and the population is aging. Intrastate migration is higher for rural serving physicians. Interstate migration of physicians tends to be to and from urban settings. Increased practice as employed physicians, as opposed to independent practice, is likely to increase practice migration.

Implications

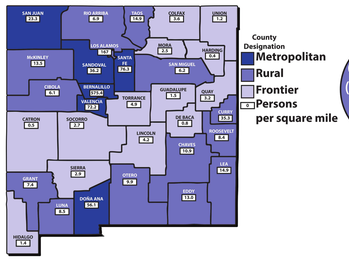
Our results indicate the NM has a shortage of health care workforce professionals and a dramatic maldistribution of that workforce. Implications are that 1) NM needs to increase incentives for rural practice; 2) NM needs to obtain more doctors in general, not just for rural areas; 3) adequacy of workforce varies by specialty and geography. This research highlights the importance of dynamic, not just static, workforce analysis in order to initiate recruitment and retention efforts prior to crises in health care workforce adequacy. Modeling also allows us to understand potential effects, specifically with respect to health care workforce adequacy, from changes to any rates or parameters in our model, which can come from enactment policy or recruitment incentives.

Introduction

How can NM Best Prepare for Future Health Care Needs?

Figure 1. NM is largely *rural* and *frontier*.

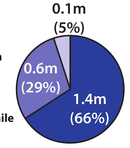
A. Metropolitan, Rural, and Frontier Status of New Mexico Counties



County Designation
- Metropolitan
- Rural
- Frontier

Persons per square mile

B. Population Distribution



Health care delivery in NM is complicated by the population's sparsity and uneven distribution. Seven metropolitan counties account for two-thirds of the state's 2.1 million inhabitants (US Census), with the remainder spread across 26 counties classified as rural by the Office of Rural Health Policy (Figure 1).

NM faces a critical maldistribution of medical practitioners, with hundreds of providers estimated necessary to bring all NM counties to national averages for practitioner-to-population ratios (Table 1) (NM Health Care Workforce Committee).

We expect that optimizing practitioner-to-population ratios will minimize health disparity between urban and rural environments, but how best to achieve this remains untested. Static and retrospective research on health care workforce recruitment and retention has identified variables related to health services personnel migration, including RN wages, quality of school systems and of professional relationships, sense of belonging, and vacation and on-call time (Tellez et al., MacDowell et al., Singer et al., Sargeant et al.).

We modeled changes in NM population and health care workforce to project future need.

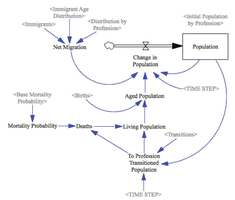
Table 1. Present workforce is drastically maldistributed.

Health Care Providers	# Practicing in NM	Surplus (+) or Shortage (-)	Shortage without Redistribution*
Primary Care Physicians (MDs, DOs)	1957	+306	**-153**
Certified Nurse Practitioners and Clinical Nurse Specialists	1089	-121	**-271**
Obstetricians/Gynecologists	256	+36	**-40**
General Surgeons	179	+43	**-21**
Psychiatrists	321	-1	**-104**

* These values reflect the number of practitioners necessary to bring all shortage counties to benchmarks without redistributing doctors from counties with sufficient or surplus practitioners

Methods

Figure 2. Conceptual model for projecting county-level health care workforce and population



The model simulates the effects of changes in effective numbers of primary care physicians (MDs) and advanced practice registered nurses (APRNs) within a projected statewide general population over time. The current formulation of the model can be used to compare the effects of various potential scenarios such as those involving incentives for health care workers to practice in rural counties.

Conceptual Model

The model, shown conceptually in Figure 2, tracks the size and characteristics of a population, as well as health care workforce members within that population. The model is initiated with a starting population, divided into subgroups defined by county, age, sex, and health care workforce profession (MD, APRN, non-workforce). The model updates the population at each time step through births, net international migration, and deaths.

The model uses a discrete Markov process to update the size of health care workforce population subgroups at each time step based on changes in incoming and outgoing rates calculated from NM Medical Board licensure and survey data compiled by the NM Center for Workforce Analysis over 2009 - 2013 for APRNs and 2012 - 2013 for MDs.

Model Mathematics

The model is implemented as a discrete dynamical systems model that tracks the number of persons in the population and its constituent subpopulations over time. Each subpopulation is defined by a unique combination of county, age, sex, and health care workforce profession. Age and time are characterized by single year, although this aspect of the model can be modified if desired. Each health care workforce subpopulation has specified rates for incoming new members and outgoing existing members. At each discrete time step in a simulation, the model updates the number of members of each health care workforce subpopulation by calculating the number of individuals that come into to the subpopulation due to issuance of practice license and those that leave the subpopulation due to expiration of license during the time step. The size of the subpopulations are also updated by births, deaths and net migration. This calculation is represented by the following equation:

$$Pop(t_{k+1}) = A(t_{k+1})Pop(t_k) + B(t_{k+1}) - D(t_{k+1}) + M(t_{k+1})$$

Where

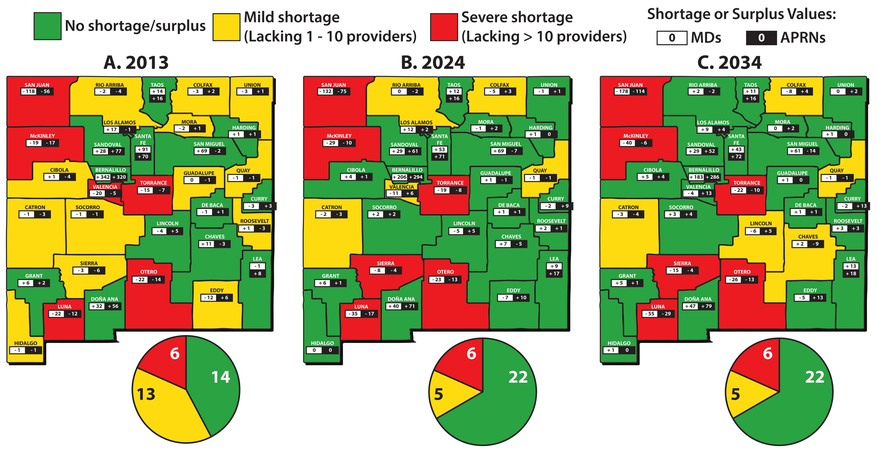
$Pop(t_{k+1})$ is the number of people in the population at time t_{k+1},
$A(t_{k+1})$ is the matrix determining incoming and outgoing rates for the healthcare workforce subpopulations at time t_{k+1},
$Pop(t_k)$ is the number of people in the population at time t_k,
$B(t_{k+1})$ is the number of births at time t_{k+1},
$D(t_{k+1})$ is the number of deaths at time t_{k+1}, and
$M(t_{k+1})$ is the net number of migrants at time t_{k+1}.

Results

Projected County-Level Changes in Health Care Workforce Adequacy

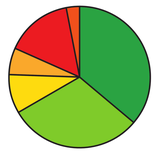
Figure 3 illustrates our county-level predictions for workforce adequacy at three selected timepoints, with workforce needs calculated using 2013 national averages of 0.79 primary care physicians per 1,000 population and 0.58 APRNs per 1,000 population (NM Health Care Workforce Committee).

Figure 3. Projected sufficiency of the NM health care workforce (MDs and APRNs, primary care)



Results, Cont.

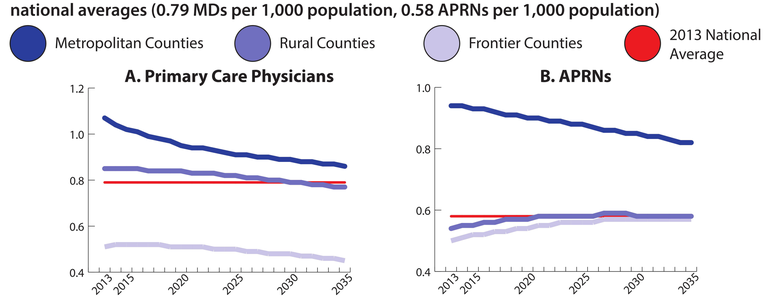
Figure 4. Insufficient health care workforce is projected for one-third of NM counties.



Over the modeled time period (2013 to 2035):
- 12 counties (36%) were projected to retain adequate to surplus providers,
- 10 counties (30%) were projected to reach sufficient providers,
- 3 counties (9%) were projected to remain mildly short of providers,
- 2 counties (6%) were projected to decline into a mild shortage of providers,
- 5 counties (15%) were projected to remain severely short of providers, and
- 1 county (3%) was projected to decline into a severe shortage of providers.

Model Projections for Metropolitan, Rural, and Frontier Counties

Figure 5. Across frontier counties, MDs, but not APRNs, are projected to remain far below 2013 national averages (0.79 MDs per 1,000 population, 0.58 APRNs per 1,000 population)



It is clear from our model that frontier counties are projected to fare the worst with respect to workforce adequacy over the next twenty years. The number of primary care physicians per 1,000 population is projected to decline further. Our projections with respect to APRNs are somewhat more optimistic, with APRN workforce approaching the current national average of 0.58 per 1,000 population in all three types of counties.

However, these projections mask a great deal of variation. For example, San Juan county, a metropolitan county in the northwest corner of the state, is projected to lack 178 MDs and 114 APRNs by 2034.

Discussion

Our research adds a prospective viewpoint to existing research by providing a dynamic platform upon which to forecast county-level changes in health care workforce driven by population changes. In future iterations, demographic changes, disease distribution, and recruitment and retention policies will be modeled and tested.

It is clear from our results that recruiting and retaining primary care physicians in frontier counties should be a legislative priority. In addition, special attention should be paid to the counties projected to remain severely short of providers or decline in workforce sufficiency: Chaves, Lincoln, Luna, McKinley, Otero, San Juan, Sierra, and Torrance.

Future Iterations of the Model will Incorporate:

1. Modeling healthcare workforce needs based upon demographics such as age, gender, and ethnicity;
2. Modeling county-by-county needs and trends associated with public health issues such as obesity;
3. Modeling incentives for recruiting and retaining healthcare workforce throughout NM; and
4. Modeling dynamics and effects of health care workforce composition.

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