Does the National Health Service Corps Help Underserved Areas?

Medically underserved areas are communities with a high levels of unmet healthcare needs, often secondary to insufficient access to primary care physicians (Shi et al., 2005; Starfield, Shi, & Macinko, 2005). Formal designations of underserved areas began in the late 1970s and are based on the index of medical underservice, a weighted score of census or county-level infant mortality rate, primary care provider to population ratio, percent of population older than 65, and percent of population below the federal poverty line (“Development of the index of medical underservice.,” 1975). Although primary care recruitment to and subsequent health improvement in underserved areas are often cited targets for healthcare and physician workgroups, medically underserved areas are consistently faced with physician shortages, due to a range of factors such as lack of exposure to rural health in medical school, individual preferences, and hospital closures (Fagan et al., 2015; Parlier, Galvin, Thach, Kruidenier, & Fagan, 2018; Rabinowitz, Diamond, Markham, & Paynter, 2001).

To increase physician supply to underserved areas, several loan repayment and subsidized training programs for primary care practitioners have been instituted, including the National Health Service Corps (NHSC) through the Department of Health and Human Services (National Health Service Corps Scholarship Program, 2003) and the Public Service Loan Forgiveness (PSLF) program through the Department of Education (Friedman, Grischkan, Dorsey, & George, 2016). The NHSC grants primary care physicians up to $50,000 in medical school loan forgiveness in exchange for two years of service in a medically underserved area, although select states offer additional compensation, and the PSLF excuses remaining student loans (typically ~$150,000 for medical school graduates) in exchange for 10 years of monthly payments and practice at a nonprofit organization (Friedman et al., 2016). Unlike for the NHSC, participation in the PSLF program is not restricted to primary care physicians nor to those working in high needs communities, but it may similarly reduce shortages by providing a safety net for physicians working in lower paying specialties or geographic areas (Grischkan, George, Dorsey, & Asch, 2018).

Early assessments of the NHSC have shown its success in recruiting physicians to areas of high need (Holmes, 2005); unfortunately, less than half of participating physicians remain in their initial area of service after completion of the program, leading to high rates of turnover and lack of continuity in the care of underserved community members (Heisler, 2017; Pathman, Konrad, Dann, & Koch, 2004). Further, despite the purported goal of primary care recruitment programs in improving population health, few evaluations have explored the effects of the NHSC or PSLF on area health indicators. Of these limited studies, Basu and colleagues used purchasing power of PSLF awards as an instrument of primary care supply to predict county-level increases in life expectancy and reductions in mortality, finding that an increase in 10 primary care physicians per 100,000 population was associated with an average increase of 51 days of life and 1-2% decrease in cancer and cardiovascular disease mortality (Basu et al., 2019). However, as the authors noted, the validity of this approach depends on the purchasing power sharing no common cause with the outcome mortality and having no influence on the outcome except through primary care supply. While the authors adjusted for potential confounders that could violate these assumptions, namely, uninsurance, high school completion, age, race, and rurality, because the PSLF funds professionals other than physicians (e.g. social workers, educators, epidemiologists) who also contribute to area health (Beck & Boulton, 2012), it is probable that the instrument conflated the effect of primary care supply with the that of the health workforce more generally. The aim of this analysis is to test whether previously observed effects of physician supply on mortality hold when tested with alternative identification strategies, namely, regression discontinuity and difference-in-difference models based on NHSC eligibility.

**Method**

Data for this study come from four sources. For the ratio of primary care physicians-to-population, I used the Area Health Resource Files (US Department of Health and Human Services, 2014b). For infant, and age-standardized and crude all-cause, cancer, and heart disease mortality rates, I used the Centers for Disease Control Wide-ranging Online Data for Epidemiologic Research (Centers for Disease Control and Prevention, 1995). For obesity and smoking rates, I used the Behavioral Risk Factor Surveillance Survey (US Department of Health and Human Services, 2014a), and for population estimates and poverty and unemployment rates I used the American Community Survey (U.S. Census Bureau; American Community Survey, 2014).

*Regression Discontinuity Design*

As mentioned previously, eligibility to participate in the NHSC is determined by a county’s index of medical underservice score. Because scores are only publicly available for counties which have received NHSC funding in the past decade, I regenerate scores for each county in the U.S. using the Health Resources and Service Administration guidelines (U.S. Department of Health and Human Services, 2015). Briefly, scores are a weighted sum of primary care physician-to-population ratio, percentage of residents age 65 or older, percentage of population at or below the federal poverty level, and infant mortality rate or, in instances where infant mortality rates were suppressed due to small sample sizes, rates of low birthweight. All subcomponents are based on five-year averages to prevent substantial year-to-year variation in program eligibility for treated counties (e.g. the average of 2009-2014 components would be used to calculate 2014 scores). A complete description of subcomponents and weighting procedures is listed in Table 1.

While program eligibility for a given county *i* is a deterministic function of index of medical underservice score , not all eligible counties receive physician trainees due to budget constraints. Thus, if treatment is defined as actual participation in loan repayment programs (; where 1 = treatment and 0 = control), is a probabilistic function for counties below the cutoff, and deterministic for counties above:

However, note also that state governors may grant exemptions for ineligible rural counties with primary care shortages in order to receive funding for rural health clinics. A total of 5 counties were exempted in 2014, all with index of medical underservice scores greater than 80. I exclude all such counties from further analyses, given that these localities represent a known violation of the treatment assignment mechanism.

*Model Specification*

such that the average treatment effect of on age-standardized mortality rate can be estimated as \_\_\_. I use the Imbens and Kalyanarman approach to select the optimal bandwidth for estimation of the local average treatment effect (Imbens & Kalyanaraman, 2012), and additionally present results based on bandwidths one-half or double the optimal size.

For the purposes of precision, I adjust models for county-level adult obesity and smoking rates, percentage of adults without health insurance, and unemployment rate.

I do not weight observations for population size in primary analyses because I am interested in county-level, rather than individual-level, effects; however, weighted estimates are presented in Supplementary Table 1.

*Sensitivity Analyses*

To assess potential manipulation of the running variable , I use the approach detailed by McCrary and check for discontinuity in the density of observations just above and below the cutoff score (McCrary, 2008). I also perform placebo tests, using \_\_\_\_\_\_ as alternative outcomes, and using a range of different (false) cutoff values of to estimate treatment effects at different points along the running variable.

with scores greater than 66 to participate in the NHSC, I will also conduct sensitivity analyses comparing results with and without exempted counties included. Second, I will use a staggered difference-in-differences model, where the time of intervention is defined as date of entry into the NHSC program, to compare trends in age-standardized mortality rates between participating counties and never-participating counties after program implementation. Potential confounders that I will control for include the percentage of county residents who are Black or African American, percentage of county residents with a college degree or higher, and degree of rurality based on USDA ERS codes. I may also adjust for county-level poverty rates and number of practicing primary care physicians, depending on the level of variation observed in underserved counties (these factors are used by HRSA to determine eligibility, so conditioning on them may violate positivity).

References

Basu, S., Berkowitz, S. A., Phillips, R. L., Bitton, A., Landon, B. E., & Phillips, R. S. (2019). Association of Primary Care Physician Supply With Population Mortality in the United States, 2005-2015. *JAMA Internal Medicine*, *179*(4), 506–514. doi: 10.1001/jamainternmed.2018.7624

Beck, A. J., & Boulton, M. L. (2012). Building an Effective Workforce: A Systematic Review of Public Health Workforce Literature. *American Journal of Preventive Medicine*, *42*(5, Supplement 1), S6–S16. doi: 10.1016/j.amepre.2012.01.020

Centers for Disease Control and Prevention. (1995). *CDC Wonder.* Retrieved from http://wonder.cdc.gov/

Development of the index of medical underservice. (1975). *Health Services Research*, *10*(2), 168–180.

Fagan, E. B., Gibbons, C., Finnegan, S. C., Petterson, S., Peterson, L. E., Phillips Jr, R. L., & Bazemore, A. W. (2015). Family Medicine Graduate Proximity to Their Site of Training. *Family Medicine*, *47*(2), 124–130.

Friedman, A. B., Grischkan, J. A., Dorsey, E. R., & George, B. P. (2016). Forgiven but not Relieved: US Physician Workforce Consequences of Changes to Public Service Loan Forgiveness. *Journal of General Internal Medicine*, *31*(10), 1237–1241. doi: 10.1007/s11606-016-3767-2

Grischkan, J. A., George, B. P., Dorsey, E. R., & Asch, D. A. (2018). Medical Education and the Public Service Loan Forgiveness Program: Unnecessary Uncertainties. *Annals of Internal Medicine*, *169*(8), 566. doi: 10.7326/M18-1511

Heisler, E. (2017). *The National Health Service Corps* (No. CRS Report R44970). Washington, DC: Congressional Research Service.

Holmes, G. M. (2005). Increasing physician supply in medically underserved areas. *Labour Economics*, *12*(5), 697–725. doi: 10.1016/j.labeco.2004.02.003

Imbens, G., & Kalyanaraman, K. (2012). Optimal bandwidth choice for the regression discontinuity estimator. *The Review of Economic Studies*, *79*(3), 933–959.

McCrary, J. (2008). Manipulation of the running variable in the regression discontinuity design: A density test. *Journal of Econometrics*, *142*(2), 698–714.

National Health Service Corps Scholarship Program. , 42 U.S.C. § 2541 (2003).

Parlier, A. B., Galvin, S. L., Thach, S., Kruidenier, D., & Fagan, E. B. (2018). The Road to Rural Primary Care: A Narrative Review of Factors That Help Develop, Recruit, and Retain Rural Primary Care Physicians. *Academic Medicine*, *93*(1), 130–140. doi: 10.1097/ACM.0000000000001839

Pathman, D. E., Konrad, T. R., Dann, R., & Koch, G. (2004). Retention of Primary Care Physicians in Rural Health Professional Shortage Areas. *American Journal of Public Health*, *94*(10), 1723–1729. doi: 10.2105/AJPH.94.10.1723

Rabinowitz, H. K., Diamond, J. J., Markham, F. W., & Paynter, N. P. (2001). Critical Factors for Designing Programs to Increase the Supply and Retention of Rural Primary Care Physicians. *JAMA*, *286*(9), 1041–1048. doi: 10.1001/jama.286.9.1041

Shi, L., Macinko, J., Starfield, B., Politzer, R., Wulu, J., & Xu, J. (2005). Primary Care, Social Inequalities, and All-Cause, Heart Disease, and Cancer Mortality in US Counties, 1990. *American Journal of Public Health*, *95*(4), 674–680. doi: 10.2105/AJPH.2003.031716

Starfield, B., Shi, L., & Macinko, J. (2005). Contribution of Primary Care to Health Systems and Health. *The Milbank Quarterly*, *83*(3), 457–502. doi: 10.1111/j.1468-0009.2005.00409.x

U.S. Census Bureau; American Community Survey. (2014). *2014 American Community Survey 1-Year Estimates, Table S0103; generated by Sarah Van Alsten; using American FactFinder;* Retrieved from http://factfinder.census.gov

US Department of Health and Human Services. (2014a). Centers for Disease Control and Prevention (CDC) Behavioral Risk Factor Surveillance System Survey Questionnaire. *Atlanta: CDC*.

US Department of Health and Human Services. (2014b). *Health Resources and Services Administration. Area Health Resources Files (AHRF)*.

U.S. Department of Health and Human Services. (2015, November). *Shortage Designation Management System (SDMS): Manual for Policies and Procedures*. Retrieved from http://contentmanager.med.uvm.edu/docs/sdms\_manual\_/ahec-documents/sdms\_manual\_.pdf?sfvrsn=10

**Table 1.** Description of index of medical underservice score subcomponents and weighting.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Infant Mortality1** | | **Percent Over 652** | | **Primary Care Ratio3** | | **Percent in Poverty4** | |
| **Maximum Value** | **Score** | **Maximum Value** | **Score** | **Maximum Value** | **Score** | **Maximum Value** | **Score** |
| ≤8 | 26.0 | ≤7 | 20.2 | ≤0.05 | 0.0 | ≤0.1 | 25.1 |
| ≤9 | 25.6 | ≤8 | 20.1 | ≤0.10 | 0.5 | ≤1 | 24.6 |
| ≤10 | 24.8 | ≤9 | 19.9 | ≤0.15 | 1.5 | ≤4 | 23.7 |
| ≤11 | 24.0 | ≤10 | 19.8 | ≤0.20 | 2.8 | ≤6 | 22.8 |
| ≤12 | 23.2 | ≤11 | 19.6 | ≤0.25 | 4.1 | ≤8 | 21.9 |
| ≤13 | 22.4 | ≤12 | 19.4 | ≤0.30 | 5.7 | ≤10 | 21.0 |
| ≤14 | 20.5 | ≤13 | 19.1 | ≤0.35 | 7.3 | ≤12 | 20.0 |
| ≤15 | 20.5 | ≤14 | 18.9 | ≤0.40 | 9.0 | ≤14 | 18.7 |
| ≤16 | 19.5 | ≤15 | 18.7 | ≤0.45 | 10.7 | ≤16 | 17.4 |
| ≤17 | 18.5 | ≤16 | 17.8 | ≤0.50 | 12.6 | ≤18 | 16.2 |
| ≤18 | 17.5 | ≤17 | 16.1 | ≤0.55 | 14.8 | ≤20 | 14.9 |
| ≤19 | 16.4 | ≤18 | 14.4 | ≤0.60 | 16.9 | ≤22 | 13.6 |
| ≤20 | 15.3 | ≤19 | 12.8 | ≤0.65 | 19.1 | ≤24 | 12.2 |
| ≤21 | 14.2 | ≤20 | 11.2 | ≤0.70 | 20.7 | ≤26 | 10.9 |
| ≤22 | 13.1 | ≤21 | 9.8 | ≤0.75 | 21.9 | ≤28 | 9.3 |
| ≤23 | 11.9 | ≤22 | 8.9 | ≤0.80 | 23.1 | ≤30 | 7.8 |
| ≤24 | 10.8 | ≤23 | 8.0 | ≤0.85 | 24.3 | ≤32 | 6.6 |
| ≤25 | 9.6 | ≤24 | 7.0 | ≤0.90 | 25.3 | ≤34 | 5.6 |
| ≤26 | 8.5 | ≤25 | 6.1 | ≤0.95 | 25.9 | ≤36 | 4.7 |
| ≤27 | 7.3 | ≤26 | 5.1 | ≤1.00 | 26.6 | ≤38 | 3.4 |
| ≤28 | 6.1 | ≤27 | 4.0 | ≤1.05 | 27.2 | ≤40 | 2.1 |
| ≤29 | 5.4 | ≤28 | 2.8 | ≤1.10 | 27.7 | ≤42 | 1.3 |
| ≤30 | 5.0 | ≤29 | 1.7 | ≤1.15 | 28.0 | ≤44 | 1.0 |
| ≤31 | 4.7 | ≤30 | 0.6 | ≤1.20 | 28.3 | ≤46 | 0.7 |
| ≤32 | 4.3 | >30 | 0.0 | ≤1.25 | 28.6 | ≤48 | 0.4 |
| ≤33 | 4.0 | -- | -- | >1.25 | 28.7 | >48 | 0.1 |
| ≤34 | 3.6 | -- | -- | -- | -- | -- | -- |
| ≤35 | 3.3 | -- | -- | -- | -- | -- | -- |
| ≤36 | 3.0 | -- | -- | -- | -- | -- | -- |
| ≤37 | 2.6 | -- | -- | -- | -- | -- | -- |
| ≤39 | 2.0 | -- | -- | -- | -- | -- | -- |
| ≤41 | 1.4 | -- | -- | -- | -- | -- | -- |
| ≤43 | 0.8 | -- | -- | -- | -- | -- | -- |
| >43 | 0.2 | -- | -- | -- | -- | -- | -- |
| 1. Infant mortality rate (or low birthweight rate in lieu of mortality) come from CDC WONDER and | | | | | | | |
| are defined as total infant deaths per 1000 live births or total infants born weighting < 5.5 lbs per | | | | | | | |
| 100 live births. | |  |  |  |  |  |  |
| 2. Percentage of elderly residents comes from the American Community Survey, and includes all | | | | | | | |
| non-institutionalized adults aged 65 or older living in the county. | | | | | |  |  |
| 3. Primary Care to Population Ratio comes from the Area Health Resource Files and equals | | | | | | | |
| total full-time equivalent non-federally employed primary care providers employed in non-research, | | | | | | | |
| patient care roles divided per 1000 population. | | | |  |  |  |  |
| 4. Poverty rate comes from the American Community Survey and is defined as percentage | | | | | | | |
| of population living households with annual incomes at or below the federal poverty level. | | | | | | | |

Table 2.