

BALANCING INVESTMENT IN FEDERALLY QUALIFIED HEALTH CENTERS AND MEDICAID FOR IMPROVED ACCESS AND COVERAGE

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ABSTRACT

Two important measures of disparity in health care services are lack of access to care and lack of insurance coverage. The objective of this study is to find a balanced investment between CHC expansion and relaxing Medicaid eligibility to improve both access (by increasing the number of CHCs) and coverage (by CHC and Medicaid expansion). The comparison is achieved by integrating mathematical models with several data sets that allow for specific estimations of healthcare need. In this paper we compare the two programs using the state of Pennsylvania as a test case. Our results have implications for policymakers on how increasing access or increasing coverage affect primary care, and our estimates of healthcare need can also be used for other resource allocation problems.

INTRODUCTION

Providing comprehensive healthcare services to all the members in a community is important for the achievement of health equity and for increasing community members' quality of life. However, there are many disparities that exist in health care services that affect not only individuals but also the entire community. Two important measures of disparity are a lack of access to care and a lack of insurance coverage.

It is well known that having a source of primary care has many health benefits [1] including improvements in health status [2,3], fewer hospitalizations [4], additional physician visits [5], more control over treatable diseases [6,7], and fewer preventable hospitalizations [8,9]. Many people do not have a main source of primary care, however, which may be due to a lack of insurance, the fact that not all doctors take Medicaid patients, or because of a limited supply of primary care physicians where they live. According to "Kaiser Health Facts", the percentage of population in primary care shortage areas is 11.8% in the US [10]. One of the specific goals of the Healthy People 2020 initiative is to "Increase the proportion of persons who have a specific source of ongoing care" [11].

The number of people without health insurance across the nation is rising. Census data show that 50.7 million Americans were uninsured in 2009, an increase of 4.4 million from the number of uninsured in 2008 (16.7% of the US population [10]). This lack of adequate coverage makes it difficult for people to obtain the health care they need and, when they do get care, typically leads to a financial burden on the individual.

Current policy efforts focus on the provision of access to health care and insurance coverage. This includes expanding federally qualified health centers (CHCs) and relaxing eligibility requirements for Medicaid. Healthcare reform will provide \$11 billion to expand CHCs over the next 5 years (2011-2015), and beginning in 2014, Medicaid rules will be modified so that more people will be eligible [12].

The CHC Initiative is one program designed to improve access to primary care, particularly for needy populations. These centers provide primary and preventive healthcare, outreach, dental care, some mental health and substance abuse treatments, and prenatal care, especially for people living in rural and urban medically underserved communities. Over 90% of CHC patients live with incomes below 200% of the federal poverty limits, and over 40% of CHC patients are uninsured. Expanding CHCs could increase access to primary care for those who currently do not have it. In addition, it could increase the availability of free or lower cost services for those who remain uninsured, increasing not only access to primary care but also coverage of insurance. Another alternative for provision of coverage is expanding Medicaid eligibility. Medicaid is a state-administered health insurance program for low-income people, families and children, the elderly and people with disabilities. While it has no effect on increasing access, it would increase the number of people who have health insurance coverage.

The objective of this study is to find a balanced investment between CHC expansion and relaxing Medicaid eligibility to improve both access (by increasing the number of CHCs) and coverage (by CHC and Medicaid expansion). The comparison is achieved by integrating mathematical models with several data sets that allow for specific estimations of healthcare need. There are several tradeoffs. For example, Medicaid has to be offered to all people meeting the income eligibility limits, regardless of their explicit need and may not be sufficient to increase access. On the other hand, CHCs require a fixed cost to build and operate, and may also serve persons living in the area who are not among the neediest.

In this paper we compare the two programs using the state of Pennsylvania as a test case. Our results have implications for policymakers on how increasing access or increasing coverage affect primary care, and our estimates of healthcare need can also be used for other resource allocation problems.

LITERATURE REVIEW

By many measures, CHCs are improving the healthcare of the community. Research has found that they reduced hospitalizations, reduced mortality, reduced usage of emergency rooms, and increased visits to physicians [5, 13, 14]. It has also been found that their quality of service is comparable to other types of primary care [15], and may be cost-effective for Medicaid patients as compared to some other sources of care [14, 16]. While 75% of uninsured persons in the United States report that they have a source of primary care, approximately 99% of CHC users do [17]. In addition, with the implementation of health care reform, the importance of the CHC will be growing [18].

To maximize the improvement from CHCs, Griffin, Scherrer, and Swann [19] developed an optimization model to determine the CHC locations, the services to offer at each, and the capacity level of the services and facilities. This mathematical method can determine the best resource allocation over a network when the demand for a service differs by location. The model incorporates the fixed cost of opening an organization, the variable operating cost according to the level of capacity chosen, and the demand for services from the surrounding area. The objective of the optimization model is to maximize the number of patients served by CHCs. Since this objective is to increase the number of patients with a primary source of care regardless of their current status, some people may be offered a source of care where they did not have one previously, while others may not be part of a medically underserved population and switch from

hospital care to a primary care physician at the CHC. The solution, therefore, may not be good at improving health care disparities for needy populations. In order to consider medical need, we estimate the local demand according to current access and insurance status, and define special target groups. In addition, we develop a multi-objective approach to maximize health care access, coverage, and CHC utilization in order to help reduce the aforementioned disparities.

There are a few studies that explicitly consider how delivering care through CHCs compares to other alternatives. Okada, et al. [5] tried to determine the effect of CHCs and Medicaid service on health care through surveys, and Cunningham, et al. [20] used data from the Community Tracking Study and CHC reports to compare the impact of expanding CHCs to increased insurance coverage. Shi and Stevens [21] also compared the primary care experiences of CHC uninsured and Medicaid insured. Using three aspects of primary care experience: access, longitudinality, and comprehensiveness, they found that CHCs could fill an important gap in primary care for Medicaid and uninsured patients. They also report that Medicaid insurance remains fundamental to accessing high quality primary care, even within CHCs.

However, these comparisons of delivery alternatives do not take into account the specific location of CHCs to improve a particular measure based on geographical and demographic differences in communities. We develop an integrated model to examine the impact of both increasing the current government budget for CHCs in Pennsylvania and expanding Medicaid through relaxing the income eligibility limits. We consider the geographical and demographic differences in our model and find a balanced investment between these two policies.

MULTI OBJECTIVE MODEL for CHC LOCATIONS

The objective of previous work is finding optimal CHC locations to maximize total number of people who can be served throughout CHCs. However, we can reduce health status disparities such as lack of access and coverage more effectively if we categorize the population according to current access and coverage status and give them different priorities. Table 1 shows the six population groups according to their current access status (served and underserved) and coverage status (private, public, and no insurance).

Table1: Population group by access and coverage

Coverage Access	No Insurance	Public Insurance	Private Insurance
Underserved	①	②	③
Served	④	⑤	⑥

We introduce a multi-objective model to decide the optimal CHC locations considering target groups with different priorities. Demand is estimated based on current access and coverage status in order to target groups to be considered preferentially.

Demand Estimation

The possible demand of each facility differs according to the level of need in the community, which may depend on demographics or other characteristics. While national data is publicly available for the

prevalence of health conditions (e.g., National Health and Nutrition Survey (NHANES) [22], there is little data available for smaller regions such as counties or voting districts for several types of conditions. In their previous work, Griffin, Scherrer, and Swann [19] therefore derive local (county level) estimates using a two-stage approach combining data from the NHANES and from the U.S. Census [23]. Figure 1 shows the demand estimation process used. We modify their procedure by applying insurance and access information from CENSUS and MUA (Medically Underserved Area) data [24] in order to divide demand into the 6 different population groups mentioned previously. Insurance information can be found in both NHANES and the CENSUS. Logistic regression was used to estimate the prevalence of a condition. The independent variables were age, gender, race, and insurance status.

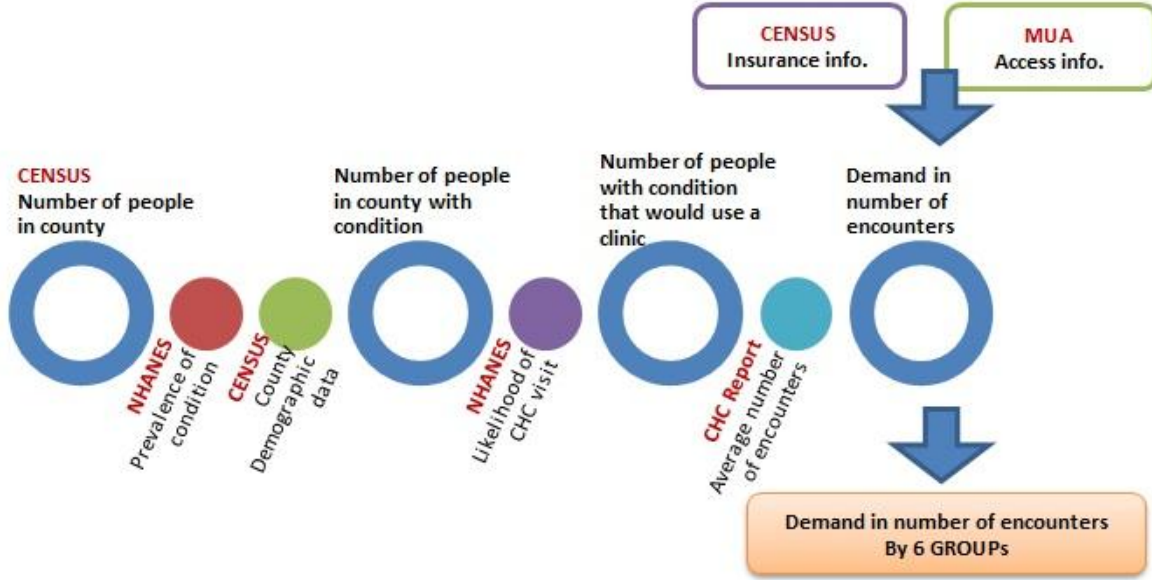


Figure 1: Demand Estimation Process

To estimate access at the county level, we use the data from U.S. Health Resources and Services Administration (HRSA) [24]. They provide Health Professional Shortage Area (HPSA) designation by region. If a county has some HPSA area, population group, or facility, the ratio of the aggregated designation HPSA population to the total population will be assumed as the fraction of the population who do not have access. If a county does not have any HPSA area, the fraction of the population for the county who do not have access is assumed to be zero.

Location and Service Selection Model

Before the impact of investment in CHC expansion can be compared to the alternative of relaxing Medicaid eligibility, we must first determine the best way to invest in CHCs. In this section we present a multi-objective model to determine the location of CHCs and which services should be offered for a particular budget.

The following are the indices and parameters used in the model.

- *Indices*
 - i : CHC location
 - z : Population location

j : Service type (General, OBGyn, Dental, Mental)
 k : Capacity (small, medium, large)
 l : Distance level (0, ~10mile, ~20mile, ~30mile)
 g_1 : Insurance group (Private, Government, None)
 g_2 : Access (access, no access)

- *Parameters*

FL : fixed cost per location
 FS_k : fixed cost per capacity level
 VS_j : variable cost per service
 RB_{g_1} : Reimbursement rate
 CAP_{jk} : Number of patients of service type j that can be served at level k
 P_l : maximum percentage of z 's population that can be served at distance level l
 $n_{zjg_1g_2}$: demand for service j in county z of insurance and access group
 $m_{izjg_1g_2}$: maximum demand of county z can be served CHC located county i
 I_{izl} 1 if distance level between i and z is greater than l , 0 otherwise.

We categorize demand by insurance and access group, which makes it possible to give different priorities for the groups. We set the first priority to maximize insurance coverage (eq1), which is the sum of encounters of the uninsured population ($g_1 = 3$). The second priority is to maximize access (eq2), which is from the underserved population ($g_2 = 2$). Finally, we maximize utilization of CHCs by providing the most weighted services (eq3). Note that this last priority is the same objective used in [19].

Objective:

$$1^{\text{st}} \text{ objective (Max Coverage)} : \max \sum_{g_1=3}^{izjg_2} w_j y_{izjg_1g_2} \quad (\text{Eq.1})$$

$$2^{\text{nd}} \text{ objective (Max Access)} : \max \sum_{g_2=2}^{izjg_2} w_j y_{izjg_1g_2} \quad (\text{Eq.2})$$

$$3^{\text{rd}} \text{ objective (Max Utilization)} : \max \sum_{izjg_1g_2} w_j y_{izjg_1g_2} \quad (\text{Eq.3})$$

To define decision variable $y_{izjg_1g_2}$, we assume that the proportion of CHC encounters in each group will follow the same rate of estimated demand at the population location. This variable is defined by the ratio of each group in the estimated demand ($n_{zjg_1g_2}$) at the location to the total number of encounters (y_{izj}).

$$y_{izjg_1g_2} = y_{izj} \times \frac{n_{zjg_1g_2}}{\sum_{g_1g_2} n_{zjg_1g_2}} \quad \text{for } i, z, j, g_1, g_2 \quad (\text{Eq.4})$$

The remaining constraints follow the work of Griffin et al. [19]. Constraint (5) is the budget constraint and (6) enforces patients can only be served if there is capacity available for them at that service level. Constraint (7) states that there can only be as many locations offering service type j as there are open locations, and, combined with constraint (8), implicitly requires that patients of type j can be served at facility i only if that center is open and offering service j . Constraint (8) only allows the proportion of patients that are eligible based on the distance calculation to be served. Constraint (9) enforces the maximum total percentage of location i 's population served by locations more than each distance level away.

$$\sum_i FL c_i + \sum_{ijk} FS_k s_{ijk} + \sum_{izjg_1g_2} VS_j RB_{g_1} y_{izjg_1g_2} \leq B \quad (\text{Eq.5})$$

$$\sum_z y_{izj} \leq \sum_k CAP_{jk} s_{ijk} \quad \text{for } i, j \quad (\text{Eq.6})$$

$$\sum_k s_{ijk} \leq c_i \quad \text{for } i, j \quad (\text{Eq.7})$$

$$\sum_i I_{izl} y_{izj} \leq P_l \sum_{g_1, g_2} n_{zjg_1g_2} \quad \text{for } l, z, j \quad (\text{Eq.8})$$

$$y_{izj} \leq \sum_{g_1, g_2} m_{izjg_1g_2} \quad \text{for } i, z, j \quad (\text{Eq.9})$$

Results

We solved the model at the county level using data for the state of Pennsylvania. Pennsylvania has 67 counties, and the full data for the model including variable and fixed costs, prevalence estimates, and demand estimates are available from the authors upon request. To see the effect of our multi objective model, we also ran the single objective model (Eq. 3 only) for comparison. The model was solved using SAS/OR. Processing time was approximately 5 minutes for the single objective problem and more than 15 minutes for the multi objective problem.

Table 2: Satisfied demand from optimal solutions (budget \$50M)

		Single Objective	Multi Objective
Total		27.2%	24.8%
Access Group	Served	28.7%	21.7%
	Underserved	6.9%	67.1%
Insurance Group	Private Insurance	29.7%	21.4%
	Public Insurance	25.0%	29.7%
	No Insurance	20.7%	31.1%

Table 2 shows the percent of total demand which can be served by CHCs with a \$50 Million budget across the six different populations. Although the single objective does somewhat better at providing more services overall, the multi-objective model does a much more effective job at satisfying demand from the targeted groups. A map showing the resulting CHC locations for both models is show in Figure 2.

BALANCED INVESTMENT in CHCs and MEDICAID

While CHCs play a vital role in improving public health, Medicaid also remains an important component in reaching those without current access to healthcare. For this reason we built a model to compare the effect of investment in CHC expansion and Medicaid eligibility, considering the appropriate related tradeoffs.

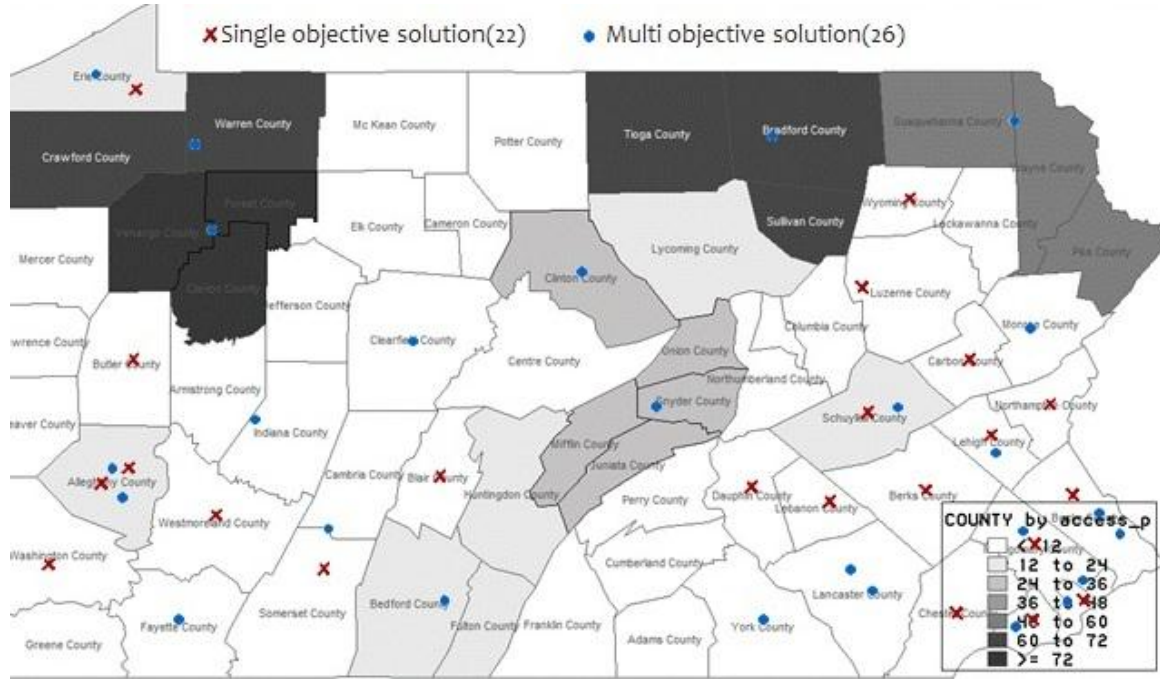


Figure 2: CHC optimal locations comparing current access status

Model

For the multi-objective model, since expanding Medicaid is only related to insurance coverage, the first objective is modified to the following:

$$1^{\text{st}} \text{ objective (Max Coverage)} : \max x + \alpha f \left\{ \sum_{g_1=3} \sum_{i,j,g_2} w_j y_{ijg_1g_2} \right\} \quad (\text{Eq.10})$$

where x is a new decision variable for the number of new Medicaid enrollments and $f(y)$ is a transformation function which converts the number of encounters to the number of people who can be covered by a CHC to make it comparable with the number of Medicaid enrollments. We use weight α to compare coverage between Medicaid and CHCs, compensating for the quality of coverage from those two policies not being equal. For example, $\alpha = 0.5$ implies that CHC coverage for one person has 50% of the value to overall public health coverage objectives as Medicaid coverage for one person would (perhaps due to the additional services available through Medicaid insurance that are not available at a CHC). This weighting factor can be adjusted by policy makers. The Medicaid component is added to the budget constraint (11) where M is average annual cost for a new enrollment of Medicaid (\$3500 for the state of Pennsylvania). Demand constraint (12) is added with the upper limit for new enrollment of Medicaid constrained by d_i , the total uninsured population.

$$\sum_i FL c_i + \sum_{ijk} FS_k s_{ijk} + \sum_{ijg_1g_2} VS_j RB_{g_1} y_{ijg_1g_2} + M x \leq B \quad (\text{Eq.11})$$

$$x \leq \sum_i d_i \quad (\text{Eq.12})$$

According to (12), $x/\sum_i d_i$ fraction of the uninsured population gain government insurance. Therefore we assume that demand from the uninsured group will decrease by the same ratio, and the same amount will move to the demand of the government-insured group. The calculation for the amount of demand moved (A_{zjg_2}) is as follows:

$$A_{zjg_2} = n_{zj(g_1=3)g_2} \times \frac{x}{\sum_i d_i} \quad \text{for } z, j, g_2 \quad (\text{Eq.13})$$

Since the demand for the non-insured population will move to the public insurance population, y for the public insurance group will be increased by A_{zjg_2} while the portion of the no insurance group will be decreased by A_{zjg_2} . Therefore the definition of y will be adjusted as follows.

$$(g_1 = 1): \quad y_{izjg_1g_2} = y_{izj} \times \frac{n_{zjg_1g_2}}{\sum_{g_1g_2} n_{zjg_1g_2}} \quad \text{for } i, z, j, g_2 \quad (\text{Eq.14})$$

$$(g_1 = 2): \quad y_{izjg_1g_2} = y_{izj} \times \frac{n_{zjg_1g_2} + A_{zjg_2}}{\sum_{g_1g_2} n_{zjg_1g_2}} \quad \text{for } i, z, j, g_2 \quad (\text{Eq.15})$$

$$(g_1 = 3): \quad y_{izjg_1g_2} = y_{izj} \times \frac{n_{zjg_1g_2} - A_{zjg_2}}{\sum_{g_1g_2} n_{zjg_1g_2}} \quad \text{for } i, z, j, g_2 \quad (\text{Eq.16})$$

Since x and y are both decision variables, these equations are nonlinear, and the model turns into MINLP. To make the problem tractable, we divide the problem into eleven different problem sets, linearizing the last constraints and studying the resulting shape.

Results

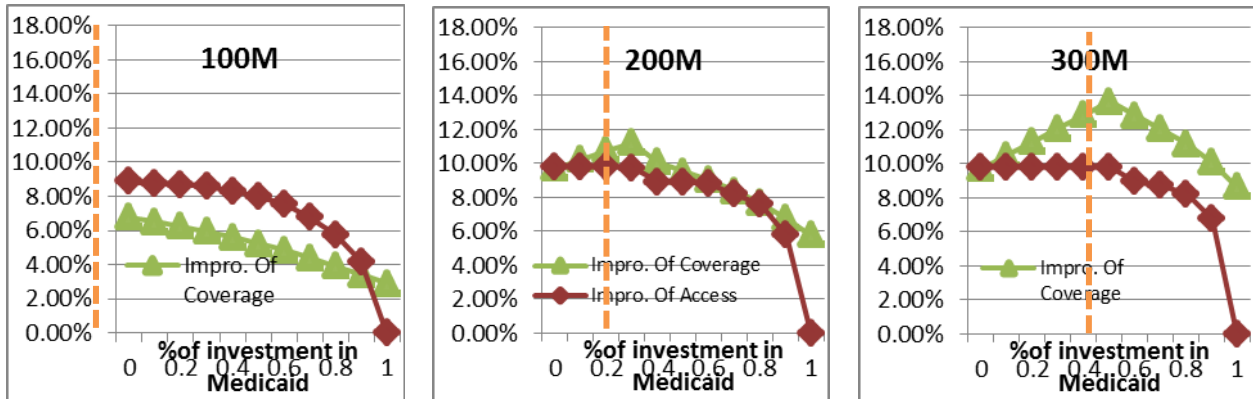
Table 3 shows the results from an example where the total budget for CHC and Medicaid is set at \$100M. Eleven levels of investment for Medicaid ranging from 0% to 100% of the total budget are used. We first determine the number of possible Medicaid enrollments (x) from the amount of Medicaid investment, then make different demand sets considering the demand change (13) from these Medicaid enrollments, and finally apply the remaining budget to CHC expansion. For example, the 5th problem set in Table 3 represents that \$40M will be invested in Medicaid, which means we can support 11,429 new Medicaid enrollments (at the previously mentioned average cost in PA of \$3500 per new enrollment). This number is approximately 1% of the uninsured population of Pennsylvania, so all the demand for the uninsured group will be decreased by approximately 1% and the same amount will be added the government insurance group. We can then solve the problem from Section 3 of this paper using these adjusted demand sets and a \$60M CHC budget.

To see how much the coverage and access improves in each problem, we pick the number of people who gain primary care service from the optimal solution as an indicator. For the coverage improvement, we count both the new Medicaid enrollments and number of people who gain primary care service through CHCs among the uninsured group ($g_1=3$) from the optimal solution, and compare it with the total uninsured population in the state of Pennsylvania. For the access improvement, we count the number of people who gain primary care service among the underserved group ($g_2=2$) and also compare it with the total underserved population.

Table 3: Balanced coverage example with \$100M budget

	Cost			Coverage			Access	
	Total Cost \$100M			Uninsured : #991,388 9.8% of total pop.			No Access : #811,459 6.5% of total pop.	
	%of Medicaid	CHC Cost (\$M)	Medicaid Cost (\$M)	New Medicaid Enrollment x_i	Coverage by CHC	Coverage Imprvmt.	Access by CHC	Access Imprvmt.
1	0	100	0	0	67047.29	6.76%	89248.45	8.89%
2	0.1	90	10	2857	61754.23	6.52%	87907.82	8.75%
3	0.2	80	20	5714	56224.14	6.25%	87363.56	8.70%
4	0.3	70	30	8571	50377.49	5.95%	86307.92	8.59%
5	0.4	60	40	11429	44131	5.60%	83395.54	8.30%
6	0.5	50	50	14286	37640.85	5.24%	79986.34	7.96%
7	0.6	40	60	17143	30796.14	4.84%	75998.85	7.57%
8	0.7	30	70	20000	23733.26	4.41%	67967.3	6.77%
9	0.8	20	80	22857	15858.68	3.91%	57961.87	5.77%
10	0.9	10	90	25714	8140.98	3.41%	41816.31	4.16%
11	1	0	100	28571	0	2.88%	0	0.00%

Figure 3 shows the results from three different total budgets (\$100M, \$200M, and \$300M). For the smallest increase of budget (\$100M), investing the entire budget in CHC is the best solution. However, in the results from larger budgets, the peak on the coverage improvement curve is a balanced investment between the two. This peak is at 30% Medicaid investment for the \$200M problem and 50% for the \$300M problem. This is likely in part because the cost effectiveness of CHCs expanding becomes lower as more clinics are added, making it more cost-effective to reach the additional people with individual insurance.

**Figure 3:** Balanced investment in CHCs and Medicaid for total budgets of \$100M, \$200M, and \$300M.

CONCLUSION

Both Medicaid and CHC expansion can improve health outcomes for populations that are either uninsured or without any source of primary care. With limited budgets for expanding these programs, it is important to know the optimal mix of expansion. Therefore in this work we suggest a multi criteria optimization model for a balanced investment in CHCs and Medicaid expansion. In our test case, CHCs are the more cost effective alternative for increasing both access and coverage for smaller budgets (\$100M), but Medicaid becomes a beneficial alternative for larger budgets. We plan to expand this work substantially, and include sensitivity analysis.

This model also has the advantage of being able to find the optimal CHC locations specifically to improve access and coverage. A benefit of the optimization model used in this work is that it considers the entire CHC organizational network in its solutions - geographical information, local estimates of need, and also current health care access and coverage status.

There are several limitations to this study. First, we assume there is enough physician capacity. In reality, either Medicaid or CHC expansion would require additional medical personnel capacity. For CHCs, the issue is recruiting physicians to work, some in rural settings. For Medicaid, the issue is physician participation in the Medicaid program - whether they are willing to accept new Medicaid patients and, if so, how many. In addition, we do not explicitly model other safety net providers such as hospital sponsored outpatient clinics, rather assuming that the services they provide would be independent of CHC or Medicaid expansion.

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