The Cost of Doing Business: Developing a Cost Model for the Minimum Local Public Health Services Package in Ohio

Prepared for the
Association of Ohio Health Commissioners (AOHC)
and Ohio Research Association for Public Health Improvement (RAPHI).
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This report is the product of a number of people whose help and attention to detail was invaluable, including:

- Joe Mazzola, Local Health Department Liaison, Ohio Department of Health, who obtained the Ohio data sources for this study.
- Members of the AOHC Public Health Futures Financing Workgroup, who provided valuable insights into findings and ultimately made the model more accurate.

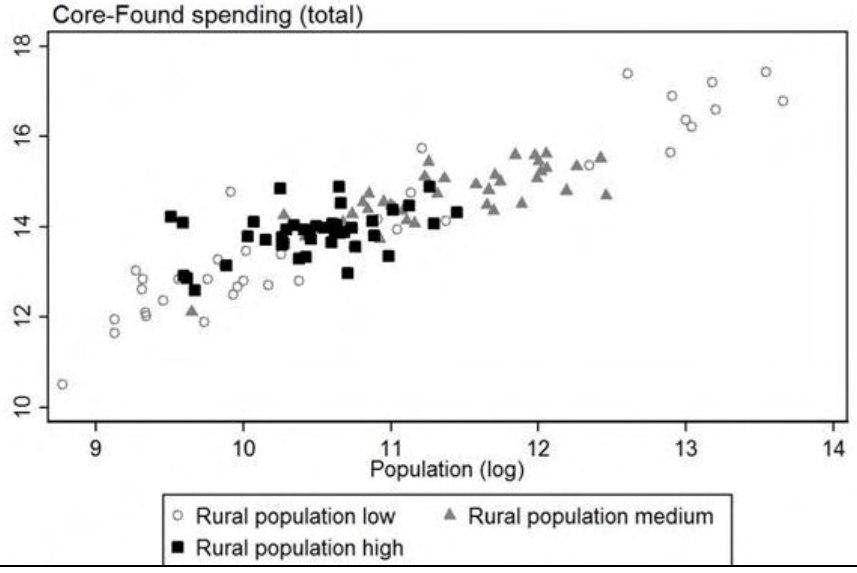
1 Executive Summary

In its October 31, 2012 report, the Ohio Legislative Committee on Public Health Futures recommended that the Association of Ohio Health Commissioners (AOHC) "should continue the work of the Public Health Futures Financing Workgroup to identify cost estimates for the Minimum Package (Core Services and Foundational Capabilities)"[1]. Following the release of this report, AOHC requested funds from the Robert Wood Johnson Foundation through Ohio's public health practice-based research network – the Research Association for Public Health Improvement (RAPHI) to create a scalable cost estimation model and an application that local health departments (LHDs) could use to estimate the resources needed to provide core services and foundational capabilities in Ohio.

The resources needed to provide core services and foundational capabilities in Ohio can be estimated with a formula based on actual performance. Operating data from the 2011 Annual Financial Report of Local Health Departments and the 2008 and 2010 National Association of County and City Health Officials (NACCHO) Profile of Local Health Departments serve as the basis for this cost model, which also incorporates the impact of demographics, agency characteristics and service need.

Although care must be taken when using any model, the models for core and foundational resource use are able to predict both staffing and spending with extremely high accuracy. The graph in Exhibit 1 shows the association between population and resource use for core services (there are similarly tight graphs in later sections).

Exhibit 1. Population, resource use and rural setting.



Although showing just two dimensions of an 11-dimensional model, the strength of association is evident in the tight clustering of points about the diagonal. Approximately 90% of variance is explained by the models of spending and staffing for core services.

Among the factors that influence resources use in these cost models:

- Higher **population** is associated with higher resource use.
- **City agencies** are associated with lower resource use than County agencies.
- Areas with more **non-whites** and more **uninsured** are associated with higher resource use. Those with more **non-English speakers** tend to have lower resource use.
- **Rural** areas are associated with higher resource use. This can be observed in the graph in Exhibit 1. Predominantly rural areas (designated with a ■ in the graph) are almost never on the lower edge, meaning rural LHDs almost always incur higher costs to provide core services to a given population.
- Areas with higher proportions of people over **age** 65 are associated with lower clinical spending.
- Neither **income** nor **physician supply** was strongly related to staff or spending differences, through it appear this may be due to the strong relationship between income, physician supply, and race.
- Health districts that provide a broader **range of services** were associated both with higher spending and higher staff. The same is true for health districts providing a greater **proportion of core services**.
- Health districts with higher **proportions of clinical care spending** were associated with higher staff and spending.

The relationship between population and resource use appears linear, meaning the cost per person neither decreases nor decreases with size. This might be thought of as an indication that there is neither advantage nor disadvantage to combining LHDs. However, the variance in resource use declines with size; meaning that larger LHDs are less likely to differ far from average. One possible explanation for the tightness of this relationship draws on simple economics. In highly competitive markets, most firms adopt similar practices and operate with similar efficiency. Although LHDs do not compete against one another, increased budget constraints can have the same impact; pushing all districts down toward that efficiency frontier.

The model has been summarized into an easy-to-use spreadsheet template provided with this report (see Exhibit 2). Simply enter eleven pieces of information about an LHD, and the template provides estimates of average core staff and spending, as well as clinical staff and spending.

Exhibit 2. Resource use template

Key information	**Enter Actual (all required)**	
Type of agency =city	0	**=1 if CITY**; =0 if COUNTY or CITY/COUNTY
Type of agency =county	1	**=1 if COUNTY**; =0 if CITY or CITY/COUNTY
Population	42,394	US Census (*1)
Percent population rural	0.6922	US Census (*1)
Percent population nonwhite	0.0216	US Census (*1)
Percent non-English speaking	0.0060	US Census (*1)
Percent 65+years old	0.1505	US Census (*1)
Income per capita ($100,000)	0.2290	US Census (*1)
Percent uninsured	0.1160	County Health Status Indicators (*2)
Physicians per 100,000 population	19.2000	County Health Status Indicators (*2)
NACCHO # of Core Services	24	NACCHO (*3)

	Enter Actual (optional)	Full Estimate (*4)	Quick Estimate (*4)
Core staffing	23.06	18.48	16.55
Core spending	1,046,414	1,217,264	1,195,338
Clinical staffing	2.81	4.13	4.30
Clinical spending	347,017	299,774	262,478

This model must be used carefully. It is based on averages and incorporates only factors listed above. Factors outside the model can still impact costs. If, for example, a hospital clinic provides free care to the poor in an LHD's area, that LHD would have costs below those of the average LHD (which does not have a hospital helping provide core services).

Some findings did not make it into the final model, but might deserve more attention in future analysis.

- Providing a broader range of services was generally associated with higher resource use.
- LHDs with a higher proportion of administrators seemed to operate with lower costs.
- LHDs that provide more clinical care services also spend more on core services, indicating potential spill-over.
- A narrow classification of minimum Improvement Standards may be associated with higher staffing.

As strong as this model is, this project highlights the need for improved operating and financial reporting. Although we tried to make the model as precise as possible, some classifications were not as tight as optimal because Ohio financial and operating data is not precisely mapped to core and foundational services. Greater specificity would allow much more precise measure of individual program effectiveness.

This model is a first step towards a deeper understanding of the cost of providing public health services. With more work, this model could be extended to answer other important questions:

- Is there an optimal staffing mix?
- Have budget changes impacted operating efficiencies?
- What is the link between resource use and public health outcomes?
- Are budget changes associated with changes in public health?
- Does accreditation require higher staffing and spending?

This document starts with a detailed description of the models behind the estimation worksheet template. The data behind our findings are then defined, followed by an explanation of the statistical modeling process and our findings.

1.1 Recommended cost models

- Models for computing costs and staffing are described in this section. These models were selected based on the estimate accuracy, parsimony, data availability, and other factors.

- Three types of models are recommended for each cost or staff:
    - A-Models are useful for estimating the impact of agency features on costs and staffing. These models were built from regressions that gave each health district equal weight (regardless of size). It is not recommended that these models be used to estimate costs and requirements. These models should be used only to estimate the impact of agency characteristics (positive or negative) on those resources.
    - B-Models are useful for computing slightly more accurate estimates of resource use. These models were built from regressions that weighted each health district according to its population size. These models tend to use a number of variable inputs in order to achieve greater accuracy. These B-models are, in effect, gold standard estimates.
    - C-Models are useful for quick and moderately accurate thumbnail estimates of resources. Requiring just three or four variables, the computations are easy and fast. In many cases, the results are surprisingly accurate also. These models are best for quick estimates.

- The model for estimating core staff requirements is in Exhibit 3.
  - The adjusted R-squared of the B-model is 0.90, meaning that this model explains about 90% of all the variation in core staff levels. This is an extremely accurate model.
  - The adjusted R-squared of the C-model for thumbnail sketches is 0.82 which is also very accurate and close enough to the full B-model to justify using the simpler C-model most of the time.

Exhibit 3. Model of Core Staffing.

Core staffing	Multipliers			Sample Computation		
	A	B	C	D	E= B * D	F = C * D
	Estimated impact of agency features	Estimated impact of population features	Quick estimate	Actual	Computed estimate B	Computed estimate C
Type of agency =city	-0.4106	0.1423		0.0000	0.0000	
Type of agency =county	0.0000	0.0000		1.0000	0.0000	
Population size (log)	0.7144	0.8509	0.8482	10.4096	8.8573	8.8299
Percent population rural	0.3165	0.7458	0.9019	0.6458	0.4816	0.5824
Percent population nonwhite	2.2761	2.2242	2.2816	0.0291	0.0648	0.0665
Percent non-English speaking	-4.2765	-14.0307		0.0050	-0.0702	
Percent 65+years old (%)	2.2638	0.4221		0.1407	0.0594	
Income per capita ($100,000)	-1.5500	-0.3990		0.1984	-0.0791	
Percent uninsured (%)	0.9089	7.2237		0.1095	0.7912	
Physicians per 100,000 population	0.0000	-0.0015		27.1000	-0.0394	
NACCHO % of Core Svc	1.4088	1.7237		0.6500	1.1204	
Constant	-5.9868	-8.4460	-6.9052		-8.4460	-6.9052
Total				**15.1250**	**15.4884**	**13.1130**
adjusted r2	0.8271	0.9012	0.8246			
Model source	13. Non-weighted	13. Pop-weighted	13c. Pop-weighted			

- To use these models, do the following:
  - Gather all of the variables listed (such as agency type, LHD population, and NACCHO % of Core service fulfillment).
  - Compute the E and F columns as indicated, then summing each column. (Because estimates were computed using logged staff and spending figures, the column sum must be computed using Excel's, EXP(<column sum>) function.)
  - In this example, the health districts actual staffing was 15.1250 full-time equivalents. The B-model estimated 15.4884 FTEs and the C-model estimated 13.1130 FTEs.
  - Another way to understand these estimates is as the best estimate of resources used by the average LHD with similar characteristics and a similar population. In effect, it could serve as a benchmark for comparing resource use.

- The model for estimating core spending is in Exhibit 4.
  - The adjusted R-squared of the B-model is 0.92, meaning that this model explains about 92% of all the variation in core staff levels. This is an extremely accurate model.
  - The adjusted R-squared of the C-model for thumbnail sketches is 0.90 which is also very accurate and close enough to the full B-model to justify using the simpler C-model most of the time.

Exhibit 4. Model of Core Spending.

Core spending	Multipliers			Sample Computation		
	A	B	C	D	E= B * D	F = C * D
	Estimated impact of agency features	Estimated impact of population features	Quick estimate	Actual	Computed estimate B	Computed estimate C
Type of agency =city	-0.4340	0.0000		0.0000	0.0000	
Type of agency =county	0.0000	0.0024		1.0000	0.0024	
Population size (log)	0.8572	0.9053	0.9701	10.4096	9.4235	10.0979
Percent population rural	0.2747	0.5795	0.7892	0.6458	0.3742	0.5097
Percent population nonwhite	2.5749	2.7096	2.9770	0.0291	0.0790	0.0868
Percent non-English speaking	1.0886	-5.5211		0.0050	-0.0276	
Percent 65+years old (%)	-2.1059	0.3036		0.1407	0.0427	
Income per capita ($100,000)	-2.3900	-1.1500		0.1984	-0.2281	
Percent uninsured (%)	-1.3601	3.4406		0.1095	0.3768	
Physicians per 100,000 population	0.0006	0.0004		27.1000	0.0120	
NACCHO % of Core Svc	1.0009	1.4116		0.6500	0.9175	
Constant	4.9783	2.9009	3.0476		2.9009	3.0476
Total				**1,127,485**	**1,059,516**	**929,085**
adjusted r2	0.8450	0.9215	0.9000			
Model source	13. Non-weighted	13. Pop-weighted	13c. Pop-weighted			

- In situations such as the one above, where the models estimate the average LHD would cost less than this LHD's actual expenditures ($1,127,485), there are several ways to interpret this:
    - First of all, the model estimates are based on averages. If there are other health districts of a similar size with similar population demographics and similar agency characteristics, the model should be fairly accurate in its estimates. But if there are special characteristics about an LHD that do not appear in the key variables list, it might explain why there resource use is higher or lower than average. Models were built as carefully as possible, but ultimately models can only incorporate the impact of factors for which information is available.
    - For variables already in the model however, those are not likely sources of variation from average. For example, percent rural is already in the model so a health district cannot claim that their costs are different than average because they are more or less rural. Since it is already in the model, it is already accounted for.

- The model for estimating clinical staffing is in Exhibit 5.
  - The adjusted R-squared of the B-model is 0.58, meaning that this model explains about 58% of all the variation in core staff levels.
  - The adjusted R-squared of the C-model for thumbnail sketches is 0.56 which is also moderately accurate and close enough to the full B-model to justify using the simpler C-model most of the time.

Exhibit 5. Model of Clinical Staffing.

Clinical staffing	Multipliers			Sample Computation		
	A	B	C	D	E= B * D	F = C * D
	Estimated impact of agency features	Estimated impact of population features	Quick estimate	Actual	Computed estimate B	Computed estimate C
Type of agency =city	0.0000	0.4627		0.0000	0.0000	
Type of agency =county	0.7285	0.0000		1.0000	0.0000	
Population size (log)	0.6326	0.9010	0.6328	10.4096	9.3787	6.5873
Percent population rural	0.0119	1.0063	0.9357	0.6458	0.6499	0.6043
Percent population nonwhite	1.8216	-0.2840	2.0219	0.0291	-0.0083	0.0589
Percent non-English speaking	-3.7959	-15.9341		0.0050	-0.0797	
Percent 65+years old (%)	4.6595	3.5911		0.1407	0.5052	
Income per capita ($100,000)	-5.8400	-3.6300		0.1984	-0.7200	
Percent uninsured (%)	2.5576	8.8801		0.1095	0.9726	
Physicians per 100,000 population	0.0006	0.0038		27.1000	0.1022	
NACCHO % of Core Svc	1.6855	2.6639	2.2611	0.6500	1.7315	1.4697
Constant	-6.7568	-11.1871	-7.3324		-11.1871	-7.3324
Total				**2.2750**	**3.8384**	**4.0061**
adjusted r2	0.3765	0.5783	0.5615			
Model source	13. Non-weighted	13. Pop-weighted	13b. Pop-weighted			

- Although the purpose of this project was to estimate resource use for core and foundational services, models were also developed for clinical resource use. As evidenced above, these models are not as accurate. There are several possible reasons for this:
    - It could be that the variables important to predicting resource use for core services are not entirely appropriate for doing the same with clinical services. That said, the models did include poverty, physician supply and race which are important determinants of the demand for clinical services.
    - Alternatively, it could just be that there is more variation in the supply of clinical services. Some health districts may benefit from hospitals and other partner organizations directly providing some of those clinical services on their own.

- The model for estimating clinical spending is in Exhibit 6.
  - The adjusted R-squared of the B-model is 0.57, meaning that this model explains about 57% of all the variation in core staff levels.
  - The adjusted R-squared of the C-model for thumbnail sketches is 0.40 which is moderately accurate, but far below that of the B-model, making this C-model a poor substitute.

Exhibit 6. Model of Clinical Spending.

Clinical Spending	Multipliers			Sample Computation		
	A	B	C	D	E= B * D	F = C * D
	Estimated impact of agency features	Estimated impact of population features	Quick estimate	Actual	Computed estimate B	Computed estimate C
Type of agency =city	0.0000	0.0000		0.0000	0.0000	
Type of agency =county	2.1836	1.5704		1.0000	1.5704	
Population size (log)	-0.2748	0.3513	0.0678	10.4096	3.6565	0.7063
Percent population rural	-0.9962	-1.2960	1.0946	0.6458	-0.8370	0.7069
Percent population nonwhite	9.6466	7.8788	6.0793	0.0291	0.2296	0.1772
Percent non-English speaking	-7.7105	-28.8221		0.0050	-0.1441	
Percent 65+years old (%)	-6.6977	-23.6448		0.1407	-3.3262	
Income per capita ($100,000)	1.4000	-7.0700		0.1984	-1.4023	
Percent uninsured (%)	-4.9265	12.3733		0.1095	1.3552	
Physicians per 100,000 population	-0.0016	-0.0140		27.1000	-0.3802	
NACCHO % of Core Svc	2.7921	2.0848	4.0866	0.6500	1.3551	2.6563
Constant	13.0025	10.9583	8.4141		10.9583	8.4141
Total				**155,081**	**458,376**	**315,124**
adjusted r2	0.2665	0.5728	0.3937			
Model source	13. Non-weighted	13. Pop-weighted	13b. Pop-weighted			

2 Data

2.1 Overview

- Data for this study came from the following sources: Annual Financial Reports of local health departments to the Ohio Department of Health (AFR), the NACCHO Profile Study, the OHD LHD Improvement Standards (IS) and the US Census.
- Annual financial data were complemented with LHDs' survey responses to the 2008 and 2010 NACCHO Profile Studies. Both the 2008 and the 2010 NACCHO Profile Studies contain detailed information on the funding, staffing, governance, and activities of LHDs across the United States. Survey response rates varied across states and years.
- In Ohio, the number of LHDs that provided complete survey responses amounted to 103 (81%) in 2010 and 98 (76%) in 2008. For the purpose of this study, we used data from the 2010 Profile Study, whenever available. For LHDs that did not respond to the NACCHO survey in 2010, we obtained data from the 2008 Profile Study. This approach resulted in complete data for 115 Ohio LHDs (2010 data was used for 103 LHDs and 2008 data was used for 12 LHDs).
- In addition, we used data from the ODH LHD Improvement Standards (IS) in our analyses. The IS survey was conducted in 2011 and is identical to Public Health Advisory Board (PHAB) accreditation standards.
- The final data source used for this study was the US Census. Using NACCHO's LHD-to-FIPS code reference, we compiled demographic data for all 124 of the 125 LHDs in Ohio that submitted ARF and IS reports. Using Census data as opposed the demographic data contained in NACCHO's Profile Studies allowed us to use the full range of variables collected by the Census, and not just those contained in the Profile Studies.

2.2 AFR. Revenues, expenditures and staffing

LHDs	All (the number varied from year to year)
Years	FY 2008-2011
Data organization	By LHD, by year

Content	• **Expenditures** by service class
	• **Revenues**
	  ○ partial alignment to expenditure service class
	• **FTE Staff**
	  ○ jobs do not align to expenditure service class
	  ○ jobs DO align to AOHC Salary Survey job categories

Dataset	AFR. oafd1.dta

- Ohio local health departments submit Annual Financial Reports (AFR) to the Ohio Department of Health. These reports contain detailed information on LHDs' revenues, expenditures, and staffing.

- This study uses 2011 data, the most recent year for which data was available at the time of the study.

- Epidemiology and Emergency Preparedness expenditures and service counts may not be properly aligned. There is no easy solution, so the problem will be noted as a limitation in final reports.

2.3 ODH LHD Improvement Standards (IS)

LHDs	124
Years	2011 (one-time survey)
Data organization	By LHD
Content	• **Identical to PHAB accreditation measures**. • Services do not align to AFR service classes
Dataset	Improvement Standards. OISd1.dta

- Epidemiology and Emergency Preparedness expenditures and improvement standards counts may not be properly aligned. There is no easy solution, so the problem will be noted as a limitation in final reports.

2.4 NACCHO Profile of Local Health Departments

LHDs	103 in 2010; 98 in 2008 (net of 113 between the two) • Most of the missing LHDs are likely rural and small, making NACCHO a 'biased sample'.
Years	2008, 2010
Data organization	By LHD, by year
Content	• Organization form • Service classifications Do not align to AFR expenditure, revenue classes • Expenditures, revenues Do not align to AFR Staffing classes
Dataset	NACCHO. PNP010D1.dta

- Since ODH LHD Improvement Standards have broader participation, we will rely more on Improvement Standards. Models will be run for both Improvement Standards and NACCHO data.
- Prior studies find that many agency characteristics (such as governance and structure) are associated with whether and LHD performs a broader range of services[2].

2.5 Census

LHDs	All 125
Years	2000-2010
Data organization	Assemble Census data using NACCHO FIPS cross reference. (Some Ohio LHDs do not follow county boundaries.)
Content	Demographics.
Dataset	Census. cend10.dta

- Census data will be built to match LHD service areas as closely as possible.
  - Using NACCHO's LHD-to-FIPS code reference, we will build area demographics from each individual FIPS code in an LHD.
  - This saves us from using county measures which may combine multiple LHDs. In addition to making the demographic data as accurate as possible, this also allows us to use the full range of variables collected by the Census; not just those entered into NACCHO.

- Census data has been used in prior studies to explain health district performance:
  - Population size, race and income are all associated with breadth of services offered[3].

2.6 Community Health Status Indicators

LHDs	All 125
Years	2010
Data organization	Data organized by county.
Content	Percent uninsured (%) (rchv8025) Physicians per 100,000 population (rchv8029)
Dataset	From www.communityhealth.hhs.gov

- Community Health Status Indicators (CHSI) are linked to LHDs as closely as possible:
  - CHSI data is available only at the county level.
  - So all LHDs operating within a county are assigned same outcomes. This may not be accurate if city outcomes differ from those of the rest of the county. But there is no data source that provides outcomes at a finer level of detail.
  - For LHDs that span county lines, the LHD is given the population-weighted average of all counties in which they operate.

2.7 Define Included Health Districts

- The unit of analysis for this study was the local health district.
- To develop a unified list of local health districts in Ohio, we used the following sources:
    - NACCHO-defined local health districts,
    - Ohio-defined health districts,
    - NACCHO-defined geographic alignments (FIPS).

- Based on careful analysis of these sources, 124 local health districts were identified and included in this study.

- The final samples used in our analyses, however, did not include all 124 local health districts due to missing data. Sample sizes ranged from 83 to 115, depending on the exact model specifications (for details see the regression results below).

- See separate document on "Aligning NACCHO to Census Data" for a definition of LHD alignments.
    - For example, some NACCHO LHDs are merged to align more cleanly with Ohio-defined health districts.

2.8 Key Variables: Core-Plus Scale

- Classify LHDs based on the degree to which they fulfill core public health services and possibly assume additional services. It is hard to compare otherwise.

2.8.1 Measure 1 - NACCHO breadth of coverage

- Count the number of services performed

Dataset	NACCHO. [PNP010D1.dta] • Use 2010 data [PNF] where available. Otherwise use 2008 [PNE] data.
Fields	• For all services [c6q55a, through c6q141b], count PERFORM BY or CONTRACT BY as 'yes'. Otherwise count as 'no, the LHD does not'. • Sum up across all services and compute %-of-all done.
Variable	pnfv055w

2.8.2 Measure 2 - ODH LHD Improvement Standards breadth of coverage

- Similar to NACCHO; a long list of services and an indication of whether the LHD meets all standards.

Dataset	Improvement Standards. [OISd1.dta]
Fields	• For all standards [oiaq0111a through oiaq1233c], count the number of standard met. • Sum up across all standards and compute %-of-all done.
Variable	oiaq0111w

2.8.3 Measure 3 - AFR breadth of expenditures

- Use the 9 categories to see the range of spending (as a Herfindahl)

Dataset	AFR. [oafd1.dta]
Fields	• Compute Herfindahl using Total expenditures for each category [oafxtph through oafxtla].
Variable	oafxtehw

2.8.4 Measure 4 - NACCHO % of Core Services

- Count the number of core services performed.

Dataset	NACCHO. [PNP010D1.dta] • Use 2010 data [PNF] where available. Otherwise use 2008 [PNE] data.
Fields	• Select NACCHO services, such as certain immunization and screening programs, are considered core services (full list in Exhibit 7). • Count the number of services for which PERFORM BY or CONTRACT BY is a 'yes'. • Sum up across all services and compute %-of-all done.
Variable	vlncore1

- These categorizations are based on a 2009 study by Mays & Smith[4].

- As a percent of all other services, how much is dedicated to patient care positions. The following service classes are considered 'patient care':
  - Medical treatment services
  - Specialty care services

Exhibit 7. Service classifications.

Composite Variable	Services Included (dataset. NACCHO. [PNP010D1.dta])	
Clinical preventive services	Adult immunizations,	pnfv055a.b
	Childhood immunizations,	pnfv056a.b
	HIV screening,	pnfv057a.b
	STD screening,	pnfv058a.b
	Tuberculosis screening,	pnfv059a.b
	Cancer screening,	pnfv060a.b
	Cardiovascular disease screening,	pnfv061a.b
	Diabetes screening,	pnfv062a.b
	Blood pressure screening,	pnfv063a.b
	Family planning,	pnfv068a.b
	EPSTD services,	pnfv073a.b
Medical treatment services	HIV treatment,	pnfv065a.b
	STD treatment,	pnfv066a.b
	Tuberculosis treatment,	pnfv067a.b

Composite Variable	Services Included (dataset. NACCHO. [PNP010D1.dta])	
	Prenatal care,	pnfv069a.b
	Obstetrical services,	pnfv070a.b
	Primary care services,	pnfv075a.b
	Home health care,	pnfv076a.b
	School based clinics	pnfv136a.b
Specialty care services	Dental services,	pnfv077a.b
	Substance abuse treatment,	pnfv079a.b
Population-based activities	Tobacco prevention,	pnfv107a.b
	Injury prevention,	pnfv087a.b
	Occupational safety,	pnfv132a.b
	Emergency Preparedness	pnfv130a.b
	School health,	pnfv137a.b
	Health education,	pnfv118a.b
	Epidemiological investigation	pnfv080a.b - pnfv086a.b
Regulatory-licensing activities	Swimming pool inspection,	pnfv106a.b
	food inspection,	pnfv110a.b
	food service licensing,	pnfv114a.b
	private drinking water inspection,	pnfv113a.b
Environmental health activities	Indoor air quality monitoring,	pnfv117a.b
	animal control,	pnfv131a.b
	vector control,	pnfv120a.b
	ground water protection,	pnfv122a.b
	surface water protection,	pnfv123a.b

2.9 Key Variables: Scope of service (Clinical Patient Care Focus)

- The model being developed should not include spending on clinical patient care because it is considered an "optional service" and not a component of "core public health services". So we need a way to identify spending on those non-core services. AFR expenditure categories and classifications are summarized in Exhibit 8.

2.9.1 Measure 1 - Percent of Spending on Clinical patient care

- Compute using AFR expenditures and classifications from Exhibit 8

Exhibit 8. Expenditure classifications[5].

AFR Category	Classification	Variable Dataset. AFR.[oafd1.dta]
Environmental Health		oafxteh
General Administration		oafxtga
Health Promotion		oafxthp
Home Health	Clinical patient care	oafxthh
Personal Health	Clinical patient care	oafxtph
Personal Health - Other	Clinical patient care	
Laboratory (Clinical and Environmental)		oafxtlc, oafxtle oafxtla
Vital Statistic		oafxfvs

- Although clinical patient care is not considered a core service, the model estimating the cost of providing core services should acknowledge the potential interaction between core and clinical services. For example, doctors and nurses needed to do clinical patient care may informally help with health promotion and prevention activities indirectly, effectively lowering the cost of core services.

2.9.2 Measure 2 - Staffing Mix

- By collapsing the large number of staff positions down to a handful of generic types, we may be able to detect how staffing mix impacts the cost of delivering services. Exhibit 9 shows how staff will be classified.

- Rather than classify/categorize all staff positions, we will just focus on a few (environmental health, nursing, support) to see if those relative proportions impact the cost of delivering services.

Exhibit 9. Staff Classifications[6].

Job Category	% of all 2009 staff
Nurses • Nurse Practitioner • Public Health RN (I, II, etc.) • Nursing Director • Dental Assistants • Licensed Practical Nurse • Home Health Care Aide	23%
Support • Secretary/Clerk (I, II, etc.) • Accounts/Payroll Clerk • Computer Administrator • Data Processing Clerk • Fiscal Officer • Legal Counsel/Departmental Attorney • Personnel Officer • Receptionist • Senior Billing Clerk	20%
Environmental health • Sanitarian in Training (SIT) • Registered Sanitarian (I, II, etc.) • Registered Sanitarian (Supervisory) • Plumbing Inspector (I, II, etc.) • Plumbing Program Supervisor	16%
Administration • Administrator • Administrative Assistant • Health Commissioner • Assistant Health Commissioner	4%
All other	36%

2.9.3 Measure 3 - Percent of Spending on Clinical patient care

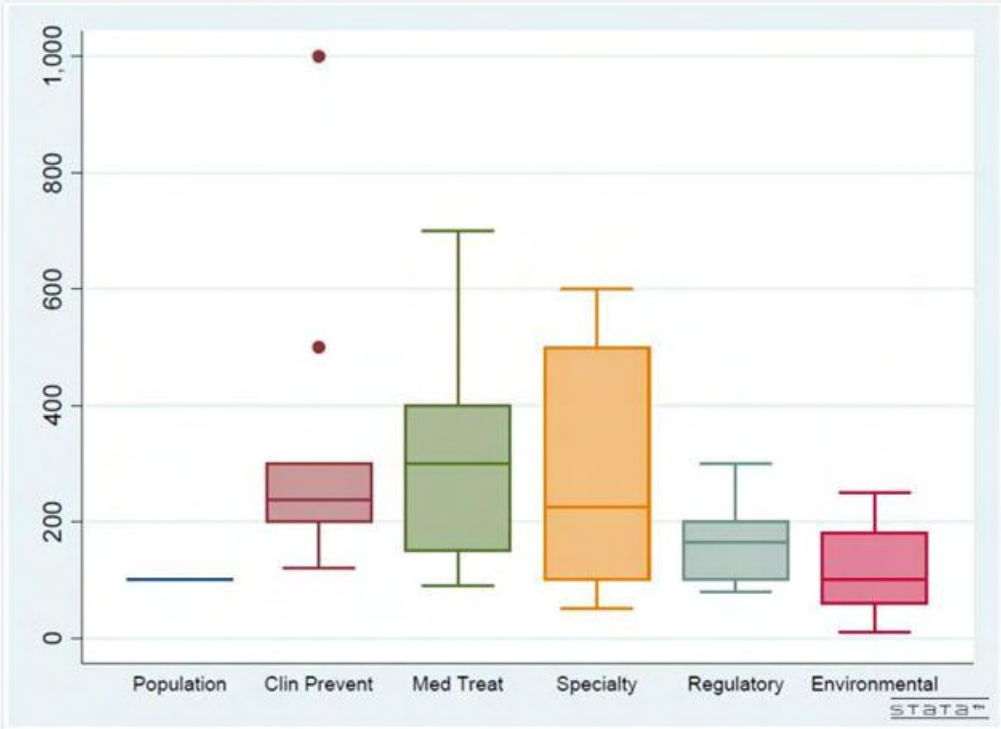
- As a percent of all other staffing, how much is dedicated to patient care positions. Exhibit 10 shows which positions are considered 'patient care':
- For the "Public Health RN (I, II, etc.)" and "Licensed Practical Nurse" positions, 91% of the FTEs will be considered clinical patient care. This estimate provided by the AOHC Public Health Futures Financing Workgroup based on nursing FTE allocations in their health departments to communicable disease control services and enabling services (the core public health service of "linking people to health services"). Although "vaccination capacity" is a core public health service in the Ohio Minimum Package of Local Public Health Services, we did not attempt to estimate the FTE allocation for this function. Hence, vaccination capacity and the actual provision of immunizations ("other public health services" in the Minimum Package) are both considered to be clinical patient care. This estimate can be fine tuned in future analysis if detailed staff assignment information is available.
- For the "Licensed Practical Nurse" position, 91% of the FTEs will be considered clinical patient care. This estimate provided by the AOHC Public Health Futures Financing Workgroup.

Exhibit 10. Patient care staff positions.	
Dataset	AFR. [oafd1.dta]
Clinical Supervisor	oafsp05
Dentist	oafsp08
Home Health Care Aide	oafsp17
Hygienist	oafsp18
Licensed Practical Nurse *0.91	oafsp20
Medical Transcriptionist	oafsp23
Nurse Practitioner	oafsp24
Physician	oafsp32
Public Health RN (I, II, etc.) *0.91	oafsp35
Dental Assistants	oafsp46

2.9.4 Measure 4 - Case Complexity

- AOHC Public Health Futures Financing Workgroup has assigned weights representing labor and cost intensity to each service class. These weights are displayed in Exhibit 11.

Exhibit 11. Service resource weights.



- Service classes are ranked in an "all other things being equal" scenario. Using population services (arbitrarily set at a weight of 100), Medical Treatment is deemed to consume 3 times the resources (it average bar is at about 300). This concept is similar to case mix index weighting hospital discharges.

- This index will be used to weight the service mix by expected difficulty. Specifically, weights in Exhibit 11 will be applied to "Measure 4 - NACCHO % of Core Services " (section 2.8.4) Exhibit 12 shows an example computation. The number itself (674) means nothing on its own, but is a way of comparing LHDs to see which perform the more resource-consuming mix of services.

Exhibit 12. Service intensity weight computation

Composite Variable	# NACCHO standards	# fulfilled	% fulfilled	median weight	weight *%fulfilled
Clinical preventive services	11	8	73%	238	173
Medical treatment services	8	5	63%	250	156
Specialty care services	2	2	100%	75	75
Population-based activities	7	6	86%	100	86
Regulatory-licensing activities	4	3	75%	165	124
Environmental health activities	5	3	60%	100	60
			highest possible	**928**	
				actual	**674**

- As demonstrated in the broad range of some of the bars in Exhibit 11, AOHC Public Health Futures Financing Workgroup input sometimes varied widely.
    - This is a new measure and may not prove helpful in analyzing costs. But we will try it out in the model nonetheless.

- This weight will be applied to the NACCHO service classification counts based on Exhibit 7.
    - For each service category, the proportion of total services performed is computed. That proportion is then weighted using Exhibit 11.
    - Since it relies on NACCHO services, this weight can only be used in models that include NACCHO data (which results on a large proportion of missing LHDs).

2.9.5 Measures 5 & 6 - Foundational Capability Strength and Mix

- The ODH LHD Improvement Standards survey has a number of measures that relate to foundational capabilities. 107 of the 192 required documents are considered related.
- Standards are aligned to Foundational Capabilities in Exhibit 13.

- The strength of an LHD's foundational capability will be measured in two ways:
  - **Strength**, The percent of these requirements that the LHD satisfies. This is similar to other studies that measure health department breadth of services by simply counting the number of services performed in the nature of survey (denomination is 159) **Mix**. For each foundational capability, measure the percent of all requirements *within that capability* that the LHD satisfies.

[Dataset. Improvement Standards. - OISd1.dta; selected variable in range oiaq0111a through oiaq1233c based on categories in table]

Exhibit 13. Foundational Capability and Improvement Standards.	
Quality assurance	• Accreditation • Quality improvement and program evaluation • Identification of evidence-based practices
9.1.1	Engage staff at all organizational levels in establishing or updating a performance management system
9.1.2	Implement a performance management system
9.1.3	Use a process to determine and report on achievement of goals, objectives, and measures set by the performance management system
9.1.4	Implement a systematic process for assessing customer satisfaction with health department services
9.1.5	Provide staff development opportunities regarding performance management
9.2.1	Establish a quality improvement program based on organizational policies and direction
9.2.2	Implement quality improvement activities
10.1.1	Identify and use applicable evidence-based and/or promising practices when implementing new or revised processes, programs and/or interventions
10.2.2	Maintain access to expertise to analyze current research and its public health implications
Information management and analysis	• Data analysis expertise for surveillance, epidemiology, community health assessment, performance management, and research • Information technology infrastructure • Interface with health information technology
1.2.1	Maintain a surveillance system for receiving reports 24/7 in order to identify health problems, public health threats, and environmental public health hazards
1.2.2	Communicate with surveillance sites at least annually
1.2.3	Collect additional primary and secondary data on population health status
1.2.4	Provide reports of primary and secondary data to the state health department and Tribal health departments in the state
1.3.1	Analyze and draw conclusions from public health data
1.3.2	Provide public health data to the community in the form of reports on a variety of public health issues, at least annually

Exhibit 13. Foundational Capability and Improvement Standards.	
1.4.2	Develop and distribute Tribal/community health data profiles to support public health improvement planning processes at the Tribal or local level
11.1.6	Use information systems that support the health department mission and workforce by providing infrastructure for data collection/analysis, program management, and communication
Policy development	• Policy analysis and planning • Expertise for policy, systems, and environmental change strategies
1.4.1	Use data to recommend and inform public health policy, processes, programs, and/or interventions
4.1.2	Link stakeholders and partners to technical assistance regarding models of engaging with the community
5.1.1	Monitor and track public health issues that are being discussed by individuals and entities that set public health policies and practices
5.1.2	Engage in activities that contribute to the development and/or modification of public health policy
10.2.3	Communicate research findings, including public health implications
Resource development	• Grant writing expertise and grant seeking support • Workforce development (training, certification, recruitment) • Service reimbursement, contracting, and fee collection infrastructure (interface with third party payers)
11.1.4	Maintain a human resources system
11.2.2	Maintain written agreements with entities providing processes, programs and/or interventions delegated or purchased by the public health department
11.2.4	Seek resources to support agency infrastructure and processes, programs, and interventions
8.2.1	Maintain, implement and assess the health department workforce development plan that addresses the training needs of the staff and the development of core competencies
8.2.2	Provide leadership and management development activities
Legal support	• Specialized consultation and analysis on public health law
6.1.1	Review laws to determine the need for revisions
6.1.2	Inform governing entity and/or elected/appointed officials of needed

Exhibit 13. Foundational Capability and Improvement Standards.	
	updates/amendments to current laws and/or proposed new laws
6.2.1	Maintain agency knowledge and apply public health laws in a consistent manner
Laboratory capacity	• Environmental health lab • Clinical lab services (as appropriate)
2.3.2	Maintain 24/7 access to laboratory resources capable of providing rapid detection, investigation and containment of health problems and environmental public health hazards
2.3.3	Maintain access to laboratory and other support personnel and infrastructure capable of providing surge capacity
Support and expertise for LHD community engagement strategies	• Community and governing entity engagement, convening, and planning • Public information, marketing, and communications • Community health assessment and improvement planning • Partnerships to address socio-economic factors and heath equity
1.1.1	Participate in or conduct a Tribal/local partnership for the development of a comprehensive community health assessment of the population served by the health department
1.1.2	Complete a Tribal/local community health assessment
1.1.3	Ensure that the community health assessment is accessible to agencies, organizations, and the general public
2.4.1	Maintain written protocols for urgent 24/7 communications
2.4.2	Implement a system to receive and provide health alerts and to coordinate an appropriate public health response
2.4.3	Provide timely communication to the general public during public health emergencies
3.1.1	Provide information to the public on protecting their health
3.2.1	Provide information on public health mission, roles, processes, programs and interventions to improve the public's health
3.2.2	Establish and maintain communication procedures to provide information outside the health department
3.2.3	Maintain written risk communication plan
3.2.4	Make information available through a variety of methods
3.2.5	Provide accessible, accurate, actionable, and current information in

Exhibit 13. Foundational Capability and Improvement Standards.	
	culturally sensitive and linguistically appropriate formats for populations served by the health department
4.1.1	Establish and/or actively participate in partnerships and/or coalitions to address specific public health issues or populations
4.2.1	Engage with the community about policies and/or strategies that will promote the public's health
4.2.2	Engage with governing entities, advisory boards, and elected officials about policies and/or strategies that will promote the public's health
5.2.1	Conduct a process to develop community health improvement plan
5.2.2	Produce a community health improvement plan as a result of the community health improvement process
5.2.3	Implement elements and strategies of the health improvement plan, in partnership with others
12.2.1	Communicate with the governing entity regarding the responsibilities of the public health department
12.2.2	Communicate with the governing entity regarding the responsibilities of the governing entity
12.3.1	Provide the governing entity with information about important public health issues facing the health department and/or the recent actions of the health department
12.3.3	Communicate with the governing entity about assessing and improving the performance of the health department

2.10 Descriptive Statistics

- Descriptive statistics for all variables used in the analyses are presented in Exhibit 14.
- We calculated means and standard deviations for the following subsets of LHDs in our dataset:
    - All LHDs in the state of Ohio
    - All LHDs with complete data on all variables of interest for this study
    - All LHDs serving populations of less than 195,000. This level was selected arbitrarily because half of the state population lives in the 14 LHDs with populations above 195,000 and the other half lives in the other LHDs with population below that level.
    - All LHDs serving populations of more than 195,000

- We also conducted t-tests for differences in means for the last two subsets (LHDs serving populations of less than 195,000 and LHDs serving populations of more than 195,000). Results of all tests are presented in Exhibit 14.

- We summarized key findings for all variables below:

- Average total spending on core activities by all Ohio LHDs amounted to $3.1 million. Average total spending on clinical activities amounted to $511,000. LHDs with complete data on all variables of interest spent substantially more ($3.8 million and $740,000 on core and clinical activities, respectively). As expected, total spending by LHDs serving populations of more than 195,000 was significantly larger than total spending by LHDs serving populations of less than 195,000. In terms of per capita spending, however, there were no statistically significant differences in spending between LHDs serving populations of more than 195,000 and LHDs serving populations of less than 195,000.

- The average number of FTEs dedicated to core activities was 30; the average number of FTEs dedicated to clinical services was 9. Again, LHDs with complete data on all variables of interest employed more FTEs than those with missing data as did LHDs serving larger populations. When comparing the number of FTEs per capita, however, LHDs serving larger populations did not employ more staff than LHDs serving smaller populations.

- Approximately 25 percent of Ohio LHDs were city LHDs while the remaining 75 percent represented county LHDs. LHDs with complete data were more likely to be county LHDs. There was no significant difference in the proportion of city and county LHDs among counties serving larger populations compared to counties serving smaller populations.

- The average size of population served by Ohio LHDs was 93,000. LHDs with complete data served somewhat larger populations with an average of 112,000 served.

- LHDs with complete data differed from all Ohio LHDs with respect to a number of additional population characteristics. Most interestingly, LHDs with complete data served higher proportions of rural populations and lower proportions of nonwhite citizens.

- LHDs serving larger populations differed from LHDs serving smaller populations with respect to almost all population characteristics included in this study. For instance, LHDs serving larger populations served significantly fewer rural but more nonwhite and non-English speaking residents. Average years of education of residents was higher for LHDs serving larger populations as was income per capita. LHDs serving larger populations also tended to be in areas with a substantially higher supply of physicians.

- When examining our four breadth of service coverage measures, LHDs with complete data provided had a somewhat greater breadth of coverage than all Ohio LHDs. LHDs serving larger populations tended to have greater breadth of service coverage than LHDs serving smaller populations.

- LHDs in Ohio spent an average of 24 percent on clinical activities and dedicated an average of 19 percent of their staff to clinical activities. An average of 10 percent of staff was administrative staff. LHDs with complete data dedicated more dollars and staff to clinical activities and fewer staff to administrative activities. There were no statistically significant differences between LHDs servings larger vs. smaller populations.

- In terms of foundational capabilities strength, LHDs with complete data scored somewhat higher. These LHDs also scored higher on all measures of foundational capabilities mix. There were few differences in foundational capabilities between LHDs serving larger and LHDs serving smaller populations.

Exhibit 14. Descriptive Statistics.

	All LHDs		LHDs with complete data		LHDs with pop<195K		LHDs with pop>195K		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Expenditures and staffing									
Core spending (total)	3,086,185	6,003,795	3,764,114	6,813,185	1,561,320	1,410,554	15,100,000	12,300,000	***
Core spending per capita	31.38	21.14	32.49	18.05	30.93	20.09	34.95	28.78	
Core FTEs (total)	30.63	48.17	38.35	55.20	18.77	15.13	123.80	97.46	***
Core FTEs per capita	0.00038	0.00025	0.00041	0.00021	0.00039	0.00025	0.00030	0.00021	
Clinical spending (total)	511,361	1,001,351	740,138	1,145,362	356,557	603,080	1,727,682	2,154,430	***
Clinical spending per capita	7.79	15.21	9.92	12.53	8.26	16.01	4.07	4.97	
Clinical FTEs (total)	8.99	17.60	11.75	20.53	6.00	7.49	32.48	42.33	***
Clinical FTEs per capita	0.00014	0.00028	0.00015	0.00018	0.00014	0.00030	0.00008	0.00013	
Agency characteristics									
Type of agency =city	25.2%	43.6%	13.3%	34.1%	25.7%	43.9%	21.4%	42.6%	
Type of agency =county	74.8%	43.6%	86.7%	34.1%	74.3%	43.9%	78.6%	42.6%	
Population characteristics									
Population size	92,948	138,770	112,253	158,004	51,751	40,513	416,641	203,085	***
Percent population rural	36.9%	30.5%	43.4%	27.9%	40.6%	30.3%	7.3%	7.8%	***
Percent population nonwhite	9.7%	10.7%	7.7%	7.9%	8.1%	8.7%	22.1%	16.6%	***
Average years of education	12.92	0.60	12.91	0.49	12.85	0.59	13.48	0.40	***
Percent non-English speaking	1.1%	1.5%	1.0%	1.4%	0.9%	1.3%	2.4%	2.2%	***
Percent 65+years old (%)	14.9%	2.4%	14.9%	2.2%	15.1%	2.3%	13.1%	2.6%	***
Income per capita	23,077	5,424	23,585	4,206	22,501	5,242	27,603	4,808	***
Percent uninsured (%)	10.6%	1.6%	10.5%	1.7%	10.5%	1.2%	11.4%	3.5%	*
Physicians per 100,000 population	61.45	35.08	60.70	32.78	55.20	29.52	110.54	37.59	***
Core-Plus Scale measures									
NACCHO breadth of coverage	39.17	12.48	40.58	12.33	38.27	12.31	45.50	12.24	*
Improvement Standards breadth	47.3%	12.3%	49.8%	9.4%	46.7%	12.1%	52.3%	12.9%	
AFR - Breadth of expenditures	17.5%	14.5%	14.2%	11.8%	17.6%	14.9%	16.7%	11.1%	
NACCHO % of Core Svc	56.0%	22.2%	62.9%	15.9%	54.1%	22.3%	70.5%	14.4%	**
Scope of Service									
% spending on direct patient care	24.4%	48.6%	33.8%	55.2%	26.2%	51.3%	10.7%	9.7%	
Staffing Mix - Admin	9.7%	11.1%	6.9%	5.4%	10.2%	11.7%	5.1%	2.8%	
% staffing on direct patient care	19.2%	13.6%	22.0%	12.9%	19.5%	14.0%	16.6%	8.9%	
Case complexity	21.9%	12.9%	22.3%	12.5%	21.0%	12.7%	28.4%	13.1%	*
Foundational Capability Strength	47.3%	12.3%	49.8%	9.4%	46.7%	12.1%	52.3%	12.9%	
Foundational Capability Mix									
QA	24.0%	20.1%	26.4%	19.5%	22.3%	19.2%	37.8%	22.4%	**
Information Mgt	55.7%	15.2%	58.9%	11.3%	55.0%	15.1%	60.8%	14.9%	
Policy Development	35.4%	14.8%	38.1%	12.9%	34.5%	14.8%	42.9%	13.8%	*
Resource Development	48.0%	13.0%	50.5%	10.8%	47.8%	13.3%	50.0%	11.0%	
Legal Support	40.1%	17.9%	41.0%	17.0%	39.5%	18.0%	44.9%	16.7%	
Lab Capacity	56.7%	25.3%	58.4%	24.1%	55.4%	25.6%	67.1%	20.2%	
Comm Engage	53.3%	11.9%	55.9%	8.4%	53.2%	11.8%	54.5%	12.8%	

*=p<.05; **=p<.01; ***=p<.001

3 Model

3.1 Overview

3.1.1 Dependent variables

- The dependent variables of interest for this study included indicators of both LHD spending and staffing (see Exhibit 8). Spending is expressed in terms of both total spending in dollars and spending per capita. Similarly staffing is expressed in terms of both total staff FTEs and staff FTEs per capita. Data on both spending and staffing was obtained from LHDs' annual financial reports. Population size estimates were obtained from the Census.

- For all four spending and staffing indicators, we run separate regressions for core (foundational) public health services and clinical patient care activities. Core services include environmental health, health promotion, laboratory, vital statistics, and general administration. Clinical services include personal health and home health services. While clinical patient care services are generally not considered a core service, they nonetheless represent a significant portion of many LHDs' activities and expenditures. By separating clinical patient care services from a LHD's core (foundational) services we are able to predict the costs of providing only core (foundational) services, which was the purpose of this study.

- Although clinical patient care is not considered a core service, it is nonetheless a significant portion of many LHDs' total expenditures. By breaking it out, the model is more precise and better able to predict the cost of providing only core services.

- The model will be used to estimate the variables listed in Exhibit 15:

Exhibit 15. Dependent variables
Clinical Patient Care spending (total dollars)
Clinical Patient Care spending per capita.
Clinical Patient Care FTEs
Clinical Patient Care FTEs per capita (per 100,000 lives)
Core and foundational Patient Care spending (total dollars)
Core and foundational Patient Care spending per capita.
Core and foundational Patient Care FTEs
Core and foundational Patient Care FTEs per capita

- Technical data definitions:
  - Spending from Dataset. AFR. [oafd1.dta].
    - Clinical = oafxthh + oafxtph
    - Core and foundational = oafxter - Clinical
    - Expense classifications (clinical/core and foundational) in Exhibit 8)
  - Staffing from Dataset. AFR. [oafd1.dta].
    - See Exhibit 10.
  - Per capita computed using
    - Dataset census. [cend10.dta]
    - cxa0010

3.1.2 Analytic strategy

- Multivariate linear regression was used to analyze our research questions. We first estimated a base model (see section 3.2), which was then expanded to control for additional variables of interest (sections 3.3 and 3.4).

- For all models, we ran both non-weighted and population-weighted regressions. Population weighting was used to account for the fact that LHDs in Ohio differed substantially in terms of the size of population served. Non-weighted regression analysis weights each observation, i.e., each LHD, equally, irrespective of the size of the population served. As a result, LHDs serving smaller populations have equal weight in the regression analysis as LHDs serving larger populations. Population-weighted regression analysis, on the other hand, weights each observations based on the size of the population served. LHDs serving larger populations thus have more weight in the regression analysis than LHDs serving smaller populations. Results from both non-weighted and population-weighted regression analysis are reported in the study.

3.2 Models 01-03. Agency & Population Demographics

- For the base models, we followed the model developed in Mays 2009[7] to predict public health expenditures. We regressed each of our eight dependent variables on a set of agency and population characteristics, including type of agency, size of the population served, urban/rural location, and other factors (see Exhibit 16).

- Results of these runs can be found in section 6.1 (Exhibit 50, Exhibit 51, Exhibit 52, Exhibit 53).

- Run 1 included all agency characteristics and population characteristics listed in Exhibit 16. Tests of multicollinearity using variance inflation factors, however, indicated that two variables (average years of education and income per capita) were highly correlated. As a result, we decided to exclude one of them from our model.

- Run 2 included all agency characteristics and population characteristics listed in Exhibit 16 with the exception of average years of education. We excluded average years of education from this run due to multicollinearity concerns.

- Run 3 included all agency characteristics and population characteristics listed in Exhibit 16 with the exception of average years of education and percent population nonwhite. We excluded percent population nonwhite to assess whether race was indeed an independent predictive factor of our dependent variables of interest.

Exhibit 16. Base model.	
Agency characteristics	
Type of agency	• City or township • Combined or multicounty • County NACCHO. [PNP010D1.dta] .pnfa033 .or.pnev001 if 2010 not available. (pne."city/county" = pnf."county")
Population characteristics	
Population size	census. [cend10.dta]. cxa0010
Population per square mile	Use % rural census. [cend10.dta]. cxa2230 / cxa2200
Percent population nonwhite	census. [cend10.dta]. 1- cxa0200
Percent with college education	Use years of education. census. [cend10.dta]. cxa1090
Percent non-English speaking	census. [cend10.dta].cxa0490
Percent 65+years old (%)	census. [cend10.dta].cxa0040
Income per capita (log)	census. [cend10.dta].cxa2040
Percent uninsured (%)	CHSI.[rci303d1.dta]. rchv8025 / rchv1009
Physicians per 100,000 population	CHSI.[rci303d1.dta]. rchv8029
Metropolitan area	N/A (see population per square mile)
Year	Not in initial cross-sectional analysis.

3.3 Models 10-13. Core-Plus Scale

- One of the challenges of working with the Ohio data is that there is no service count. It is like trying to estimate nurse productivity when the number of patients is not known. As a proxy, several 'core-plus scale' measures were developed to approximate level of effort spent on core and other services (see section 2.8).

- Results of these runs can be found in section 6.1 (Exhibit 54, Exhibit 55, Exhibit 56, Exhibit 57).

- Basic model (02) was extended to recognize that LHDs performing only core services require fewer resources than those performing a broader range of services (as measured by the Core-Plus scale). Technically this is done by estimating spending and FTEs (Clinical Patient Care, and core and foundational) using the base model (in Exhibit 16), then adding one measure at a time of the Core-Plus scale (listed in Exhibit 17) in each run.

Exhibit 17. Core-Plus Scale models.

Run	Variable	Description
10	Measure 1 - NACCHO breadth of coverage	Simple % of all possible services (performed)
11	Measure 2 - ODH LHD Improvement Standards performance standards	similar to NACCHO; a long list of services and an indication of whether the LHD performs that service
12	Measure 3 - AFR - Breadth of expenditures	Use the ~8 categories to see the range of spending (as a Herfindahl)
13	Measure 4- NACCHO % of Core Services	Simple % of all possible core services (performed), where 'core services' are defined in Exhibit 18.

Exhibit 18. NACCHO Core Services.		
adult iz	child iz	screen hiv aids
screen stds	screen tb	screen high bp
screen blood lead	epi comm	epi chronic
epi injury	epi behavioral	epi environ
epi syndromic	epi mch	prev injury
prev chronic programs	prev nutrition	prev physical activity
prev violence	prev tobacco	solid waste disposal
septic systems	public pools	private drinking water
food service	indoor air quality	food safety educ
vector control	land use planning	groundwater protection
surface water protection	air pollution	asthma prevention
vital records	body art	smoke free
lead inspection	public drinking water	laboratory services
outreach and enrollment		

- Run 10 included all agency characteristics and population characteristics from Run 2 as well as Measure 1 (NACCHO breadth of coverage) (see Section 2.8.1). The rationale for adding this variable was that we recognized that LHDs performing fewer services (as defined by the list of services contained in the NACCHO Profile Studies) required fewer resources than those performing a broader range of services.

- Run 11 included all agency characteristics and population characteristics from Run 2 as well as Measure 2 (ODH LHD improvement standards performance standard) (see Section 2.8.2). Again, the rationale for adding this variable was that we recognized that LHDs performing fewer services required fewer resources than those performing a broader range of services. Unlike Measure 1 above, Measure 2 was defined in terms of LHD improvement standards performance standards, based on a survey of LHDs in Ohio.

- Run 12 included all agency characteristics and population characteristics from Run 2 as well as Measure 3 (AFR – Breadth of expenditures) (see Section 2.8.3). The rationale for adding this variable was the same as above. The measure we used to control for breadth of coverage, however, was defined in terms of spending on various categories of activities rather than a count of the number of services provided.

- Run 13 included all agency characteristics and population characteristics from Run 2 as well as Measure 4 (NACCHO % of Core Services) (see Section 2.8.4). While the rationale for including this measure was the same as for the other three measures used in Runs 10 to 12, Measure 4 was defined as the percentage of core services that a LHD provided (as identified in the NACCHO Profile Studies). Unlike the other measures, Measure 4 thus more specifically addresses core and foundational activities as opposed to all activities (including both core and clinical) that a LHD may engage in.

- Comparing the results for Runs 10 to 13 indicated that Model 10 performed better than, or at least equally as, the other three models in terms of model fit. As a result, we chose Model 10 as the basis for our second set of expanded models.

3.4 Models 21-26. Adjustments for Service Mix, Staff Mix and Capabilities

- Another way to gauge effort, and thus more fairly compare LHDs, it to adjust for the scope of services provided. LHDs that do more complex services, for example, will naturally use more resources.

- Here, we add other explanatory variables to see if the mix of services and/or staff impacts costs and staffing. Adjustors will be added one at a time, to see which improve model accuracy the most (new models summarized in Exhibit 19).

- Results of these runs can be found in section 6.1 (Exhibit 55, Exhibit 56, Exhibit 57, Exhibit 58).

- Run 21 used Model 10 as a basis and included one additional explanatory variable, percent spending on direct patient care (see section 2.9.1). The rationale for adding this variable was that we wanted to determine whether providing a higher share of clinical services would be associated with an increase or decrease in expenditures and staffing levels.

- Run 22 again used Model 10 as a basis and included one additional explanatory variable, staffing mix (see section 2.9.2) . The rationale for adding this variable was that we wanted to determine whether having a certain mix of staff, such as higher proportions of clinical staff or administrative staff would be associated with an increase or decrease in expenditures and staffing levels.

- Run 23 also used Model 10 as a basis and included one additional explanatory variable, percent staffing on direct patient care (see section 2.9.3). The rationale for adding this variable was that we wanted to determine whether certain types of staff, such as clinical workers, are more or less effective than others.

- Run 24 again used Model 10 as a basis and included one additional explanatory variable, case complexity (see section 2.9.4). Like case mix index in the case of hospitals, case complexity was added as an explanatory variable to determine whether providing a more complex mix of services is more or less expensive than providing a less complex mix of services.

- Run 25 also used Model 10 as a basis and included one additional explanatory variable, foundation capability strength (see section 2.9.5). The rationale for adding this variable was that we wanted to determine whether LHDs that fulfill a higher share of foundational capabilities incur higher expenses and require more staff.

- Run 26 again used Model 10 as a basis and included one additional explanatory variable, foundational capability mix (see section 2.9.5). The rational for including this variable was that we wanted to determine whether the mix of foundational capabilities of a LHD was associated with its staffing and expenditures.

- Comparing the results for Runs 21 to 26 indicated that Model 23 performed better than, or at least equally as, the other three models in terms of model fit. As a result, we chose Model 23 as the model that was able to explain most of the variation in the data.

Exhibit 19. Scope of service models.		
Model	Description	
21	% spending on direct patient care	• See if providing more clinical care increases costs and to what extent. • Variable from section 2.9
22	Staffing Mix	• Are certain proportions of administration, scientist and clinical workers more effective than others? • Variable from section Exhibit 9.
23	% staffing on direct patient care	• Are certain proportions of administration, scientist and clinical workers more effective than others? • Variable from Exhibit 10.
24	Case complexity	• Like case mix index adjusting, weight service mix by complexity of services to see if it is more expensive to provide a more complex mix of services. • Do only if get consistent weighting in section 2.9.4.
25	Foundational Capability Strength	• Do LHDs that fulfill more foundational capabilities cost more or less? The extra cost associated with fulfilling additional foundational capabilities may (or may not) be offset by economies gained through those capabilities (perhaps with more specialized staff). • See section 2.9.5
26	Foundational Capability Mix	• Does the mix of capabilities impact costs, and if so, which capabilities are associated with lower costs? For example, do LHDs that score high in "Information management and analysis" have lower costs? • See section 2.9.5

3.5 Additional Considerations

- For the purpose of the analysis, all dependent variables were transformed using the natural logarithm. Visual inspection of all dependent variables indicated that they were highly skewed to the right (positive skew). Most financial data, such as expenditures, tend to be highly skewed to the right. In such cases, taking the logarithm reduces the skewness, and the resulting distribution is often symmetric and normal. Transforming highly skewed dependent variables using a log transformation has a number of statistical advantages, among them improved model fit and more efficient estimators.

- In addition transforming all dependent variables we also applied a log transformation to some of our independent variables, in particular population size. Using the log of population rather than population is commonly done in the published literature (Mays and Smith, 2009[8]). The reason for this transformation is that the relationship between population and our dependent variables is not linear (as is assumed by the linear OLS model we fitted) but there are significant non-linear effects. In particular, serving a larger population increases expenditures substantially. In our analysis, we conducted likelihood ratio tests to test whether using log population rather than population improved model fit and the test results indicated that log population was the preferred specification.

- We were also concerned about potential heteroskedasticty in the data. We therefore ran White tests[9] to test for heteroskedasticity in all our models. In cases where the White test indicated significant heteroskedasticity, we reported White heteroskedasticity-robust standard errors.

4 Findings

4.1 Models

4.1.1 Overview

- Many models were tested to identify the combination of variables that best estimates the staff and expense of delivering public health services in Ohio. Exhibit 49 lists all models explored as part of this analysis.

- Of the many models tested, four were identified as best according to the following criterion:
    - **Accuracy**. How accurate was the model at predicting actual LHD staffing and spending? (Technically, what was the R-squared of the model?)
    - **Parsimony.** Fewer variables makes for a simpler model. If two models have similar accuracy, the model with fewer variables would be preferred.
    - **Data availability.** If a variable is missing for many LHDs, it means model results cannot be used to estimate their costs or compare them to peers. These are two of the primary purposes of making a model. In addition, the model is likely not as accurate if it had to be built using fewer cases. (Technically, models developed with a larger N are superior.)
    - **Unrelated variables.** To as much an extent as possible, explanatory factors should be unrelated to each other. Going back to a desire for parsimony, why have two variables when one is just as accurate? (Technically, this is also known as multicolliniarity.)

- The next sections review the ability of these four models to estimate core staffing, core spending, clinical staffing and clinical spending. The same four models are tested against all resource measures.

- Each of the four models is run twice: once wherein each LHD carries an equal weight, and again with each LHD weighted by population. Each type has weighting has its own advantages. As discussed in section 3.1.2, non-weighted models are more appropriate for gauging the impact of agency characteristics, while population models are more accurate at predicting actual costs and staff levels.

4.1.2 Core Staffing

- Four models of core staffing are displayed in Exhibit 20.
  - Model 01 starts with a very small number of variables as a test the accuracy of even a simple model.
  - Model 03 drops race to determine if other variables can 'tell the same story'. None do, so it is put back in other models.
  - Model 13 adds the percent of all NACCHO core services on the idea that performing more types of core services will be more expensive.
  - Model 23 looks at it another way, asking whether performing more of the entire range of all services (core and clinical) can predict core resource use. It also looks whether spending on clinical services spills over into higher resource use for core services.

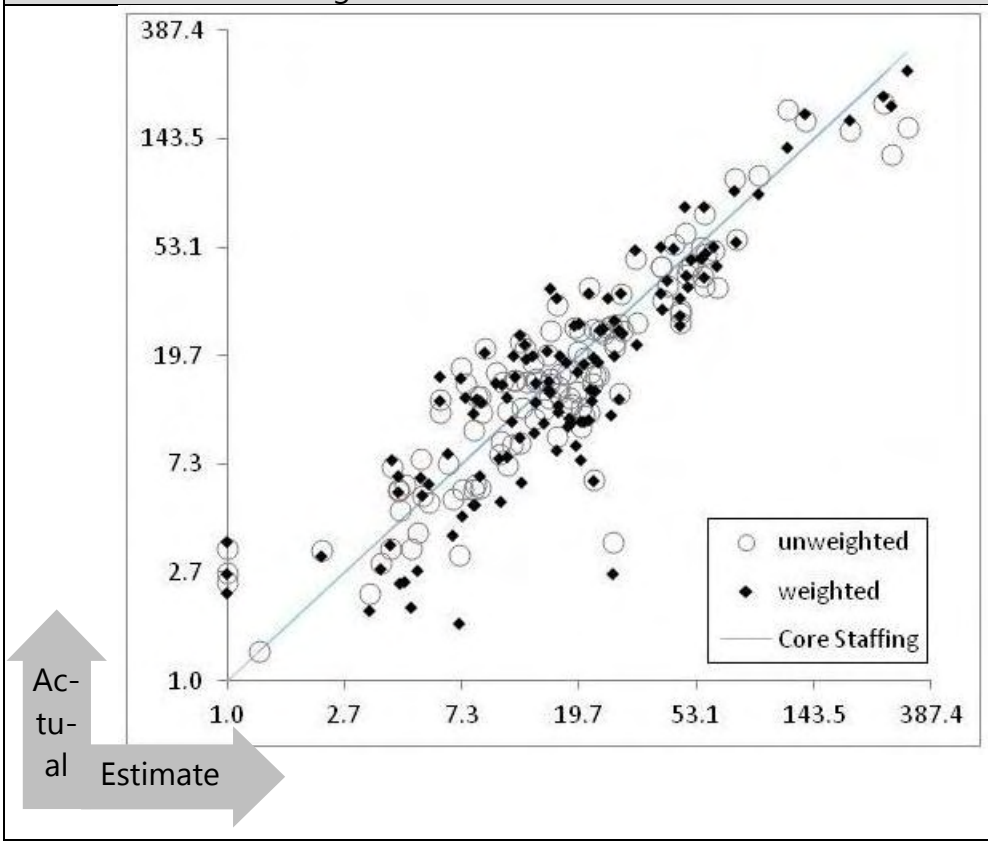
Exhibit 20. Model Summary. Core Staffing.

Core & Foundational FTEs	Non-weighted (each LHD = 1) _01	_03	_13	_23	Population-weighted _01	_03	_13	_23
Agency characteristics								
Type of agency =city	-0.45 *	-0.03	-0.41	-0.43 *	0.26	0.64 ***	0.14	0.21
Type of agency =county	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Population characteristics								
Population size (log)	0.82 ***	0.93 ***	0.71 ***	0.72 ***	1.01 ***	1.10 ***	0.85 ***	0.92 ***
Percent population rural	0.36	0.54 *	0.32	0.29	0.90 ***	0.86 **	0.75 ***	0.75 ***
Percent population nonwhite	2.75 ***		2.28 ***	2.26 ***	2.55 ***		2.22 ***	1.67 **
Percent non-English speaking	-4.74	-1.85	-4.28	-3.36	-19.86 ***	-21.18 ***	-14.03 ***	-13.74 ***
Percent 65+years old (%)	1.41	1.22	2.26	1.91	1.28	-0.09	0.42	0.18
Income per capita ($100,000)	-1.51	-2.01 *	-1.55	-1.21	0.10	-1.50	-0.40	0.10
Percent uninsured (%)	0.51	-1.23	0.91	0.37	7.88 ***	8.49 ***	7.22 ***	6.18 ***
Physicians per 100,000 population	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Core-Plus Scale measures								
NACCHO breadth of coverage				0.02 ***				0.02 ***
NACCHO % of Core Svc			1.41 ***				1.72 ***	
Scope of Service								
% staffing on direct patient care				0.69 **				0.68 *
Run summary								
Constant	-5.56 *	-7.14 ***	-5.99 ***	-5.93 ***	-9.84 ***	-10.02 ***	-8.45 ***	-8.96 ***
adjusted r2	0.79	0.78	0.83	0.83	0.86	0.85	0.90	0.90
N	113.00	113.00	111.00	111.00	113.00	113.00	111.00	111.00
FTEs per capita								
Population size (log)	-0.18 **	-0.07	-0.29 ***	-0.28 ***	0.01	0.10	-0.15 **	-0.08
Run summary								
F	3.73 ***	2.96 ***	6.91 ***	6.52 ***	8.99 ***	9.35 ***	17.48 ***	14.96 ***
adjusted r2	0.20	0.12	0.35	0.36	0.42	0.37	0.60	0.58

- The population-weighted Model 13 was deemed the best mix of accuracy (with an R-squared of 0.90) and parsimony (requiring just 11 variables; only 4 of which were significant).

- Exhibit 21 shows just well the model predicts actual resource use. The graph has two points for each LHD: ○ hollow circles are estimates from the unweighted model, and ◆ black diamonds are estimates from the population weighted model. Each point shows an LHDs estimated use (horizontal) relative to actual (vertical). If a point is above the 45° line, the health district's actual resource use was higher than estimated. And if below the line, actual resource use was lower than estimated. In a perfect model, all points would line up on the 45° line. That the points line up so close to the diagonal is an indication of just how well this model fits.

Exhibit 21. Core staffing model. Goodness of fit.



- The strength of these models might be partly attributable to the funding formulas behind public health expenditures. Funding formulas frequently include adjustments for population size, poverty, race, rural, and other characteristics[10].
    - That said, each funding formula gives those factors different weights. In addition, health districts do not get equal proportions of funding from each program because some funding, such as local contributions, is often neither based on a formula nor equal among all LHDs. So basically, it is unlikely that each health district's funding would arrive at similar levels through so many different paths.
    - An interesting alternative explanation for the strength of the models comes from economics. In tight economic times, all companies have to operate with extremely thin margins. If they are all using roughly similar production processes, then most would be clustered near the efficiency frontier. Such clustering would remove much variation in operating efficiencies. As such this might be the cause of strong models[11].

4.1.3 Core Spending

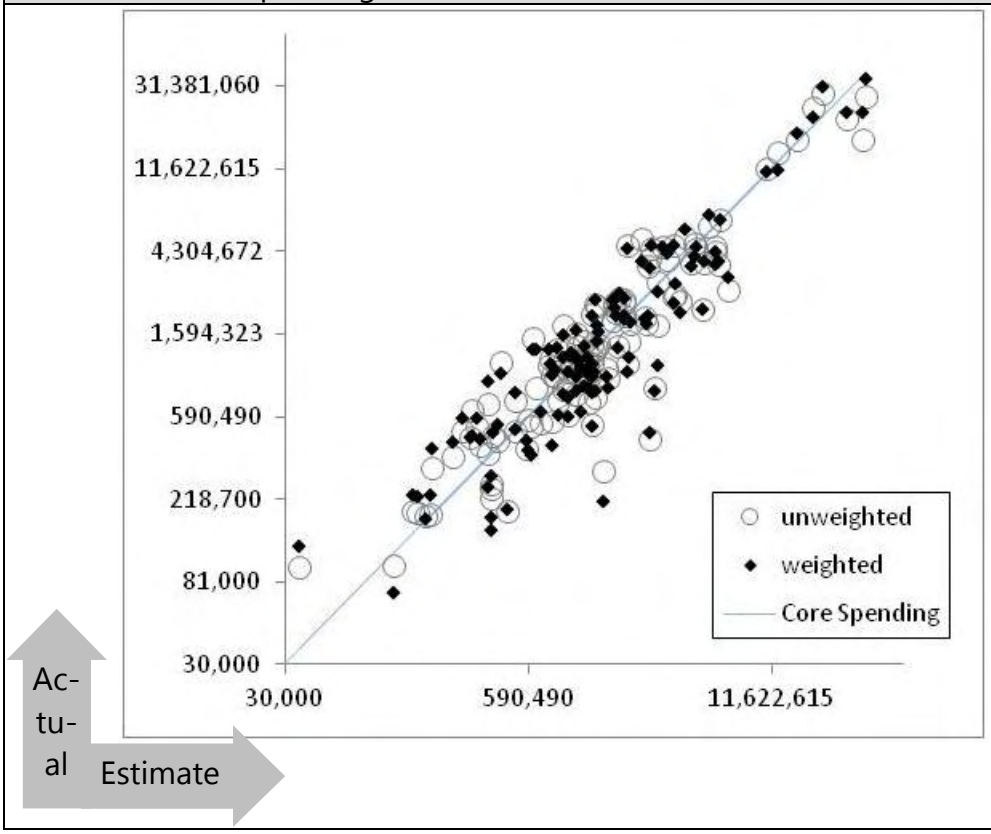
- Four models of core spending are displayed in Exhibit 22. The population-weighted Model 13 was deemed the best mix of accuracy (with an R-squared of 0.92) and parsimony (requiring just 11 variables; only 4 of which were significant).
- This is the same model as used for core staffing, which makes sense. Since a large share of public health spending is for staffing, it only follows that predictions of staff also predict expenses.

Exhibit 22. Model Summary. Core Spending.

Core & Foundational Spending	Non-weighted (each LHD = 1) _01	_03	_13	_23	Population-weighted _01	_03	_13	_23
Agency characteristics								
Type of agency =city	-0.46 *	-0.03	-0.43	-0.40	0.00	0.00	0.00	0.05
Type of agency =county	0.00	0.00	0.00	0.00	-0.08	-0.53 ***	0.00	0.00
Population characteristics								
Population size (log)	0.92 ***	1.04 ***	0.86 ***	0.85 ***	1.03 ***	1.14 ***	0.91 ***	0.95 ***
Percent population rural	0.31	0.47	0.27	0.23	0.73 **	0.66 *	0.58 **	0.51 *
Percent population nonwhite	2.83 ***		2.57 ***	2.45 ***	2.99 ***		2.71 ***	2.31 ***
Percent non-English speaking	0.97	3.71	1.09	2.33	-9.91 **	-11.77 ***	-5.52	-5.30
Percent 65+years old (%)	-2.66	-3.04	-2.11	-2.33	1.19	-0.58	0.30	-0.14
Income per capita ($100,000)	-2.60	-2.64 **	-2.39 **	-1.95 *	-1.28	-2.69 **	-1.15	-0.60
Percent uninsured (%)	-1.92	-3.39	-1.36	-1.82	3.75	4.65 *	3.44	2.65
Physicians per 100,000 population	0.00	0.00 *	0.00	0.00	0.00	0.01 ***	0.00	0.00
Core-Plus Scale measures								
NACCHO breadth of coverage				0.01 ***				0.01 ***
NACCHO % of Core Svc			1.00 ***				1.41 ***	
Scope of Service								
% staffing on direct patient care				1.26 ***				1.22 ***
Run summary								
Constant	4.90	3.88 ***	4.98 ***	4.93 ***	1.20	1.99 *	2.90 ***	2.49 **
adjusted r2	0.84	0.82	0.85	0.86	0.90	0.89	0.92	0.93
N	114.00	114.00	112.00	111.00	114.00	114.00	112.00	111.00
Spending per capita								
Population size (log)	-0.08	0.04	-0.14	-0.15 *	0.03	0.14 *	-0.09	-0.05
Run summary								
F	3.05 ***	2.16 **	4.11 ***	5.54 ***	8.31 ***	7.79 ***	13.08 ***	13.42 ***
adjusted r2	0.15	0.08	0.22	0.31	0.39	0.32	0.52	0.55

- Exhibit 23 shows just well the model predicts actual resource use. The points are tightly clustered around the 45° line, indicating a close match between estimated and actual core spending.

Exhibit 23. Core spending model. Goodness of fit.



4.1.4 Clinical Staffing

- Four models of clinical staffing are displayed in Exhibit 24. The population-weighted Model 13 was deemed the best mix of accuracy (with an R-squared of 0.58) and parsimony (requiring just 11 variables; only 4 of which were significant).
- Although the R-squared for model 23 was higher (0.89), this model included a variable that measured percent of staffing used for direct patient care. Although the model is predicting total staff and this variable looks at percent of staff, there is not quite a direct relationship between the two variables. That said, all other things being equal a health district with a higher percent of staff dedicated to clinical services will also have a higher level of clinical staffing. Because of this, the inclusion of the percent of staff dedicated to direct patient care is too close to a self-fulfilling prophecy. For this reason, model 23 was not used.

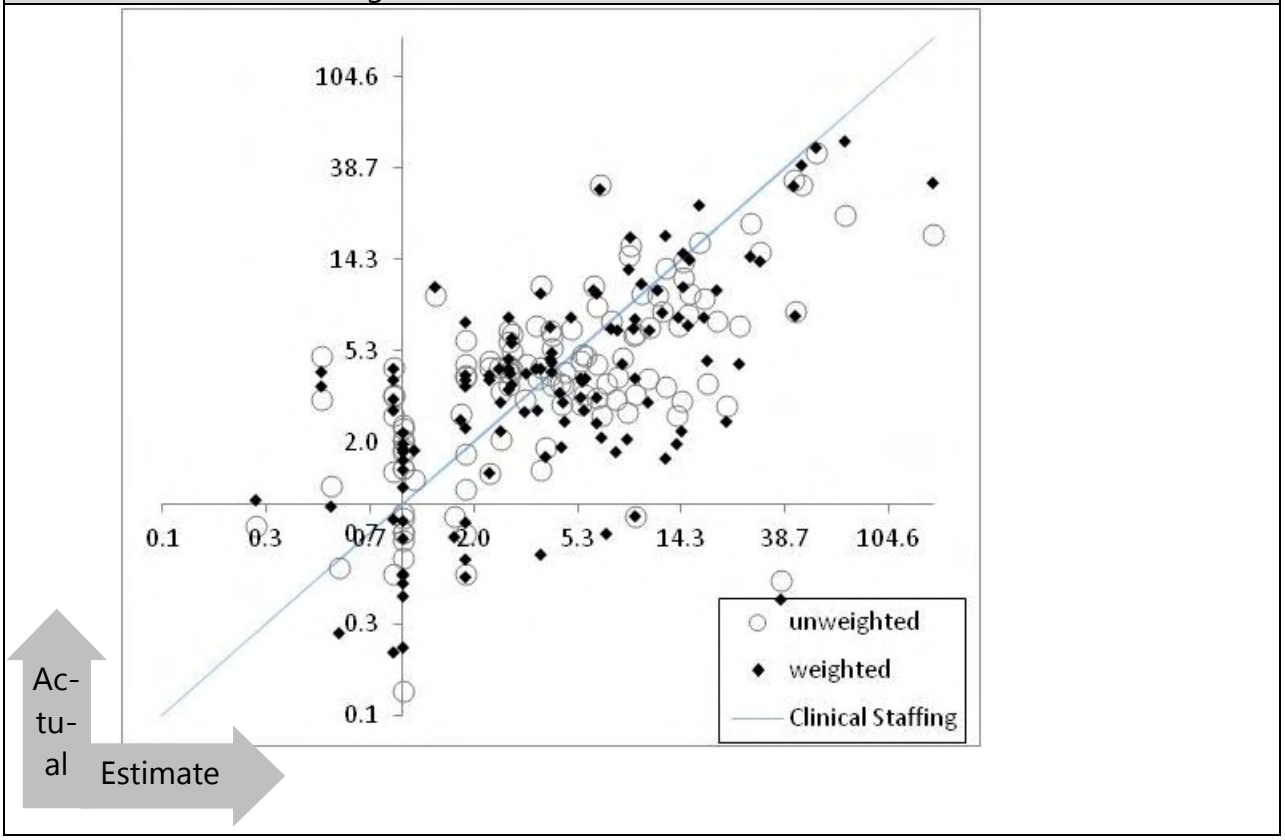
Exhibit 24. Model Summary. Clinical Staffing.

Clincial FTEs	Non-weighted (each LHD = 1) _01	_03	_13	_23	Population-weighted _01	_03	_13	_23
Agency characteristics								
Type of agency =city	-0.98	-0.47	0.00	0.00	0.41	0.68	0.46	0.42 *
Type of agency =county	0.00	0.00	0.73	0.50	0.00	0.00	0.00	0.00
Population characteristics								
Population size (log)	0.68 ***	0.83 ***	0.63 ***	0.78 ***	1.05 ***	1.16 ***	0.90 ***	1.07 ***
Percent population rural	-0.14	0.10	0.01	0.17	1.66 **	1.25	1.01	0.76 **
Percent population nonwhite	2.64		1.82	1.25	0.74		-0.28	-0.07
Percent non-English speaking	-5.60	-5.68	-3.80	-3.52	-18.41 *	-26.06 ***	-15.93 *	-17.42 ***
Percent 65+years old (%)	2.82	2.86	4.66	1.82	8.29 *	4.70	3.59	-0.04
Income per capita ($100,000)	-5.65	-5.86 **	-5.84 **	-3.30 **	-11.85 **	-2.72	-3.63	-1.09
Percent uninsured (%)	2.42	1.64	2.56	0.44	6.13	10.46 *	8.88	8.23 ***
Physicians per 100,000 population	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Core-Plus Scale measures								
NACCHO breadth of coverage				0.01 ***				0.02 ***
NACCHO % of Core Svc			1.69 **				2.66 ***	
Scope of Service								
% staffing on direct patient care				6.55 ***				7.46 ***
Run summary								
Constant	-4.87	-6.79 **	-6.76 **	-9.23 ***	-24.80 ***	-13.02 ***	-11.19 ***	-13.40 ***
adjusted r2	0.34	0.34	0.38	0.84	0.53	0.51	0.58	0.89
N	102.00	102.00	101.00	101.00	102.00	102.00	101.00	101.00
FTEs per capita								
Population size (log)	-0.32	-0.17	-0.37 *	-0.22 *	0.05	0.16	-0.10	0.07
Run summary								
F	2.11 **	2.40 **	2.74 ***	32.85 ***	2.98 ***	3.08 ***	4.47 ***	37.60 ***
adjusted r2	0.10	0.10	0.15	0.78	0.16	0.14	0.26	0.80

- Exhibit 25 shows a loose fit between model predictions and actual resource use.

- When points are far away from the 45° line, this indicates that the model did not accurately predict resource use. There are two general reasons that this might occur:
    - First, the model might not include all the relevant variables needed to estimate resource use. For example, an LHD might have a large hospital offering free clinic services. This would reduce the demand for public health clinics for that LHD. But another health district that did not have such a neighbor would have to provide all public health services on their own; using more resources in doing so.
    - Alternatively, it could just be that some health districts work more efficiently than others. The model is based on averages which includes efficient and inefficient districts. An LHD that is significantly more or less efficient than average will appear to be a "bad fit" according to the model.
    - Lastly, quality may differ from one health district to another. Providing a higher quality product will naturally cost more.

Exhibit 25. Clinical staffing model. Goodness of fit.



4.1.5 Clinical Spending

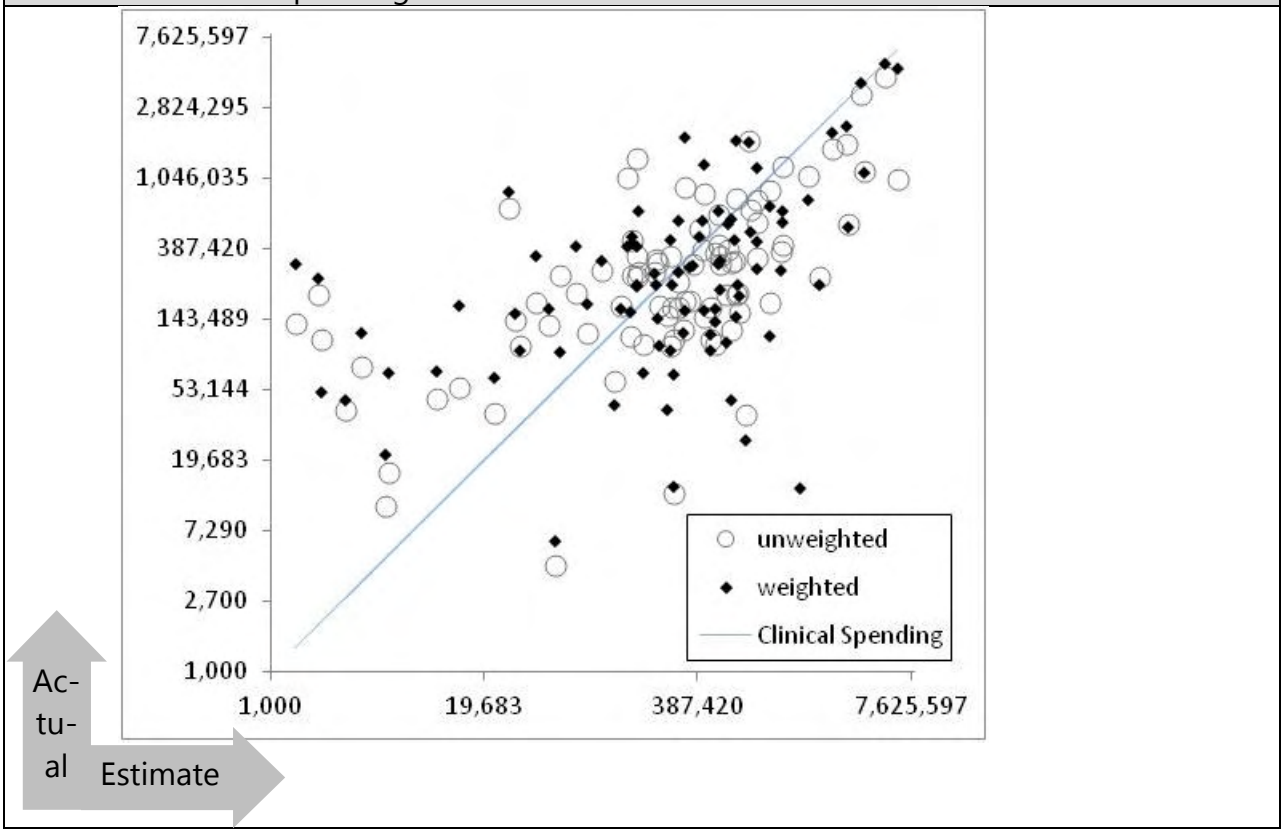
- Four models of clinical spending are displayed in Exhibit 26. The population-weighted Model 13 was deemed the best mix of accuracy (with an R-squared of 0.57) and parsimony (requiring just 11 variables; only 4 of which were significant).
- In this case, the R-squared for model 23 was only marginally higher (0.59). Since model 23 required more variables, it is not as simple to use and so was dropped from consideration.
- Note that Model 13 was determined to be the best model for both clinical and core staffing and spending. Note also that the most significant variables in those models are based on population demographics. This makes sense since much of the need for public health services is based on the size and needs of the population for which they care.

Exhibit 26. Model Summary. Clinical Spending.

Clinical Spending	Non-weighted (each LHD = 1) _01	_03	_13	_23	Population-weighted _01	_03	_13	_23
Agency characteristics								
Type of agency =city	-2.12 **	-1.07	0.00	-2.33 **	-1.44 *	-0.37	0.00	0.00
Type of agency =county	0.00	0.00	2.18 **	0.00	0.00	0.00	1.57 **	1.44 **
Population characteristics								
Population size (log)	-0.03	0.48	-0.27	-0.02	0.54	0.90 ***	0.35	0.57 *
Percent population rural	-1.38	-0.86	-1.00	-0.94	-1.20	-1.38	-1.30	-1.28
Percent population nonwhite	11.43 ***		9.65 **	8.37 **	8.78 ***		7.88 **	5.97 *
Percent non-English speaking	-21.26	-16.04	-7.71	-12.92	-34.20 **	-43.60 ***	-28.82 **	-30.14 **
Percent 65+years old (%)	-11.06	-12.01	-6.70	-10.94	-22.99 ***	-27.77 ***	-23.64 ***	-25.94 ***
Income per capita ($100,000)	13.72	-2.81	1.40	0.66	-4.80	-11.78 ***	-7.07	-5.72
Percent uninsured (%)	-2.09	-2.45	-4.93	1.14	11.29	17.16 *	12.37	12.29
Physicians per 100,000 population	0.00	0.00	0.00	0.00	-0.02 **	0.00	-0.01 *	-0.01 *
Core-Plus Scale measures								
NACCHO breadth of coverage				0.03 *				0.02 **
NACCHO % of Core Svc			2.79 **				2.08 **	
Scope of Service								
% staffing on direct patient care				4.09 ***				2.63 *
Run summary								
Constant	28.38 **	10.33 *	13.00 ***	12.44 **	11.81	8.95 *	10.96 ***	8.61 **
adjusted r2	0.20	0.13	0.27	0.35	0.53	0.50	0.57	0.59
N	84.00	84.00	83.00	82.00	84.00	84.00	83.00	82.00
Spending per capita								
Population size (log)	-1.03 **	-0.52	-1.27 ***	-1.02 ***	-0.46	-0.10	-0.65 **	-0.43
Run summary								
F	1.74 *	0.99	2.61 ***	3.55 ***	8.67 ***	9.14 ***	10.29 ***	10.00 ***
adjusted r2	0.08	0.00	0.16	0.26	0.48	0.44	0.53	0.55

- Exhibit 27 shows how the model predicts actual resource use.
  - It is interesting that much of the variation away from the line appears to be at the lower levels of total spending.
  - This means that the model is better at predicting clinical expenditures for mid-sized and large health districts. This is not surprising, because at the small health district level, the need to do an extra type of service might represent a significant percentage change. But in the larger district, the same extra service would represent a very small proportion of the total budget.

Exhibit 27. Clinical spending model. Goodness of fit.



4.2 Factors that impact staff and spending

- This section reviews how various factors influence staffing and spending.
  - Red down-arrows (↓) indicate an association with lower costs. For example, higher levels of per capita income are associated with lower public health costs.
  - Green up-arrows (↑) indicate an association with higher costs. For example, larger populations are associated with higher public health costs.
  - The number of arrows varies from 0 to 3:
    - 0 = no significant relation.
    - 1 = mild association.
    - 2 = medium-strong association.
    - 3 = strong association.

4.2.1 Agency type (city, county, shared)

- There does not appear to be a distinct advantage for any particular agency type and a lot depends on other characteristics. Smaller city agencies appear to use less staff and spend less than other agency types. County agencies seem to have lower costs for core services but not for clinical services. (See Exhibit 28)

- Core. City agencies in smaller cities have lower staff and spending than other types of agencies. But as population increases, County agencies become lower-cost.

- Clinical. City agencies in smaller cities appear to have similar staffing levels but cost less. County agencies have similar staff levels, but cost more.
  - This could occur if counties paid staff more or needed more overhead than city agencies.

Exhibit 28. Impact of agency type.

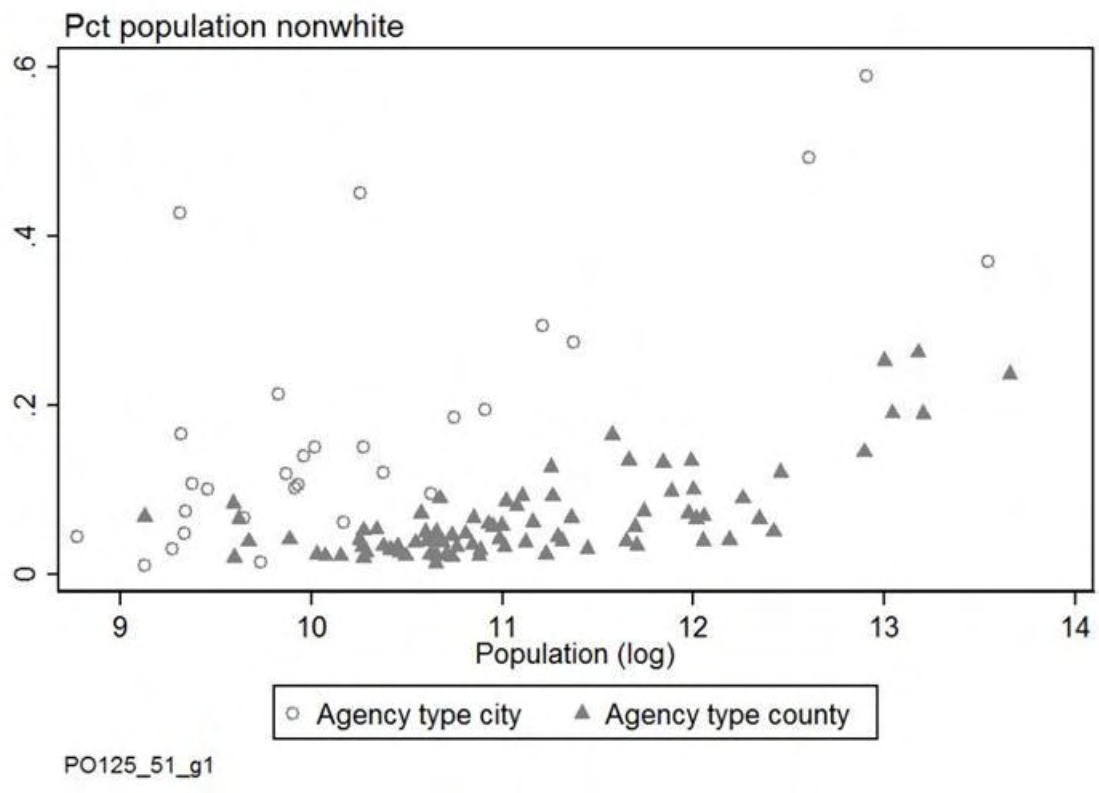
	Non-weighted	Population-weighted
Core Staff	City ↓	*City-race interaction*
Core Spending	City ↓	County ↓↓↓
Clinical Staff		City ↑
Clinical Spending	City ↓↓↓ County ↑↑	County ↑↑ *City-scope/scale interaction*

- City agencies appear to have broader coverage of core and clinical services.
    - This would explain the significance of the city agency coefficient for clinical spending that disappears once core plus scale measures are brought into the model.

- City agencies appear to be the more common agency type for health districts with large non-white populations.
    - This would explain the fleeting significance of the city agency coefficient in population weighted models that exclude race compared to models that include race.
    - This relationship is confirmed in Exhibit 29 showing that City LHDs tended to have a higher proportion on non-whites.

- Quirks in accounting for shared services may result in inaccurate expenses (where some are overstated and others under report). This is discussed further in section 4.3.

Exhibit 29. Graph: Race and Agency Type.



4.2.2 Population size

- Higher population is associated with higher core staffing and spending. There is no indication of economies or diseconomies of scale. So although caring for a larger population alone does not seem to decrease unit costs, neither does it increase those costs. (See Exhibit 30)

- Core. Higher population is associated with higher core staffing and spending.
  - The tight relationship is evidenced by graphs in Exhibit 31 which show LHD population-staffing and population-spending clustered about a straight line.

- Clinical. Higher population is associated with higher staffing but not significantly different spending.
  - This could occur if areas with larger populations had lower salaries and or lower overhead costs. As noted in agency type findings, cities often did have lower costs.
  - In Exhibit 32, the population-staffing graph shows LHDs roughly organized along on diagonal, but the population-spending graph shows no clear pattern.

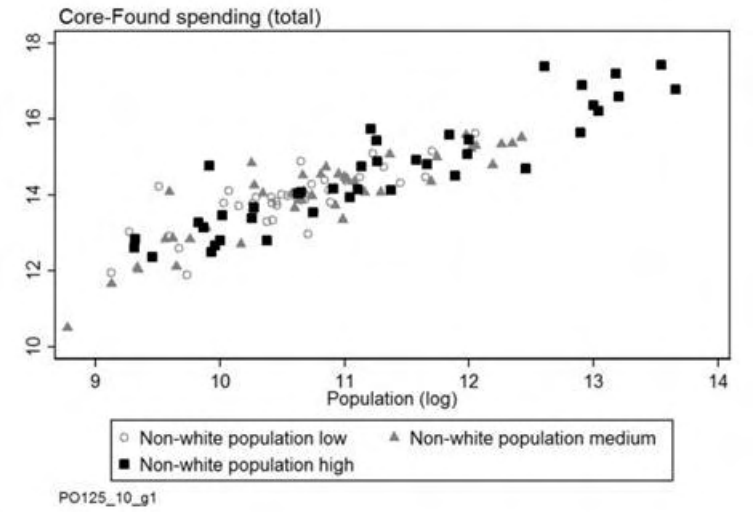
Exhibit 30. Impact of population size.

		Non-weighted	Population-weighted
Core Staff	Total	↑↑↑	↑↑↑
Core Spending	Total	↑↑↑	↑↑↑
Clinical Staff	Total	↑↑↑	↑↑↑
Clinical Spending	Total		*Population-Race interaction.*
Core Staff	Per Capita	↓↓↓	↓
Core Spending	Per Capita		
Clinical Staff	Per Capita	↓	
Clinical Spending	Per Capita	↓↓↓	↓

- Economies of scale
  - There is no strong indication of economies or diseconomies of scale. Cost and staff appear to be almost directly related to population size.
    - We also tried models using unlocked population and a population squared variable to see if the function turned above a certain level, but found no such results.
    - The per capita models showed negative coefficients on population, indicating economies of scale. However, these models had much lower adjusted R-squared then models of total staff and spending. As such, the strength of evidence favors models with a linear relationship between population and resources.
  - Visually, economics or diseconomies of scale would be demonstrated by a bend upward or downward in total costs at higher population levels. But the graphs in Exhibit 31 or Exhibit 32 show no such bend, meaning there is no evidence of either economies or diseconomies of scale.

- Population-race interaction.
  - The size of the coefficient increases in models without race. This would happen if non-whites were more common in areas of population.
  - LHDs with higher proportions of non-whites are identified with a "■" in Exhibit 31 and Exhibit 32. Note that while these LHDs are scattered across the entire range of LHD population ranges, they tend to be the ONLY LHDs in the high population range. There are two ways to interpret this:
    - The impact of race might weaken with higher population. At lower populations, a higher proportion of non-whites is associated with higher staffing and spending. But at higher levels that does not appear to be the case.
    - Alternatively, it could be that economies of scale occur at higher populations, but these efficiency gains are masked because the higher population areas also have higher non-white proportions. While economies of scale are pushing down on staff and spending at higher populations, the higher proportion of non-whites in canceling out those gains.
  - This is also evidenced in the change in significance of non-weighted per capita models.

Exhibit 31. Graph: Population - Core Spending / Staffing.



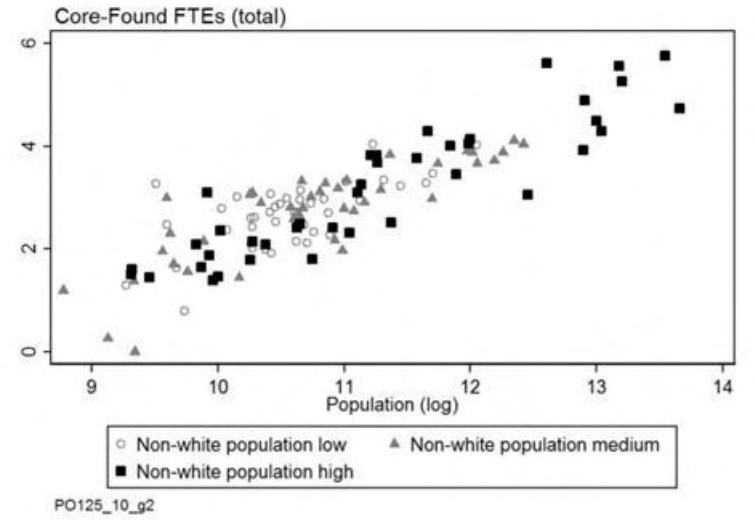
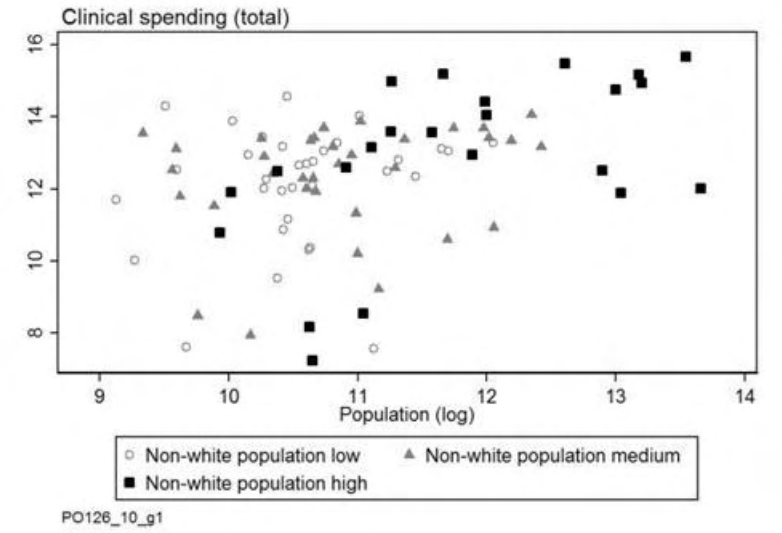
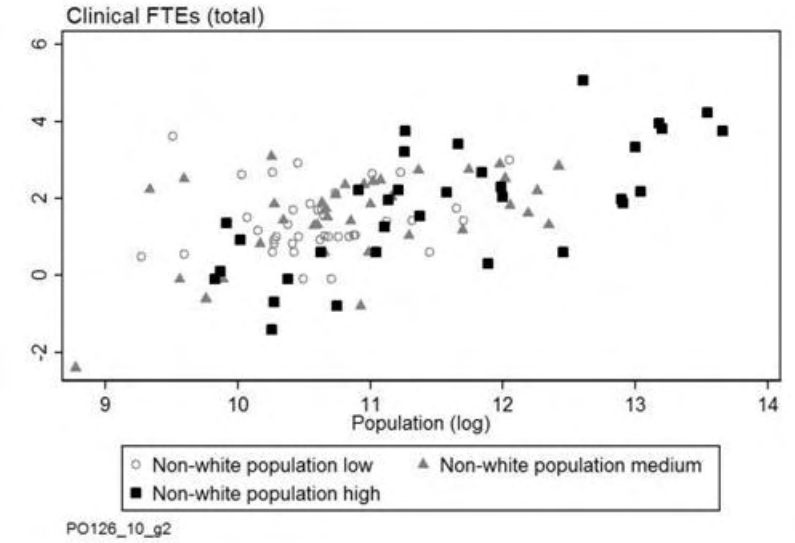


Exhibit 32. Graph: Population - Clinical Spending / Staffing.





4.2.3 Rural setting

- Rural settings require more staff and generally entail higher costs. (See Exhibit 33)

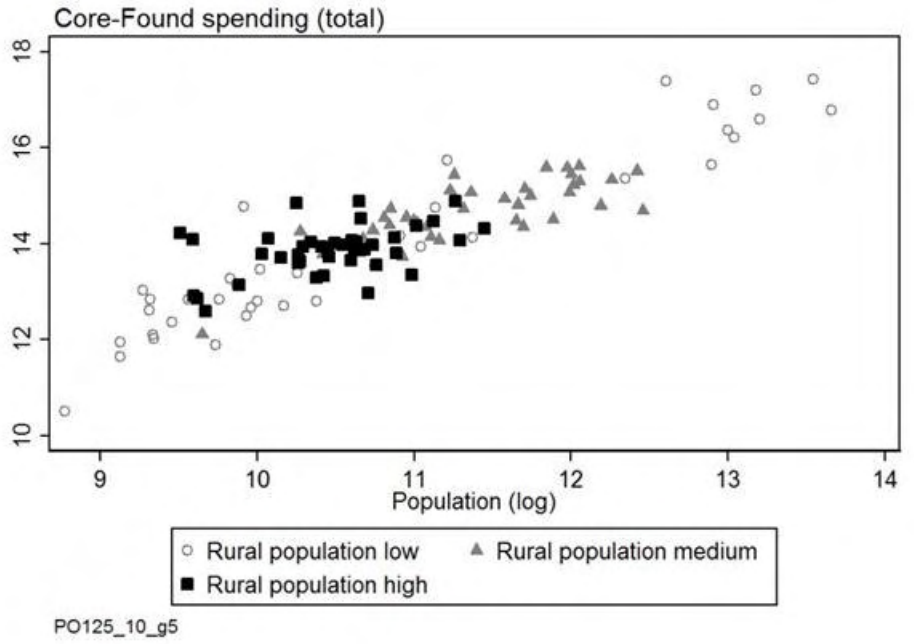
- Core. Rural health districts have proportionately more staff and higher spending.

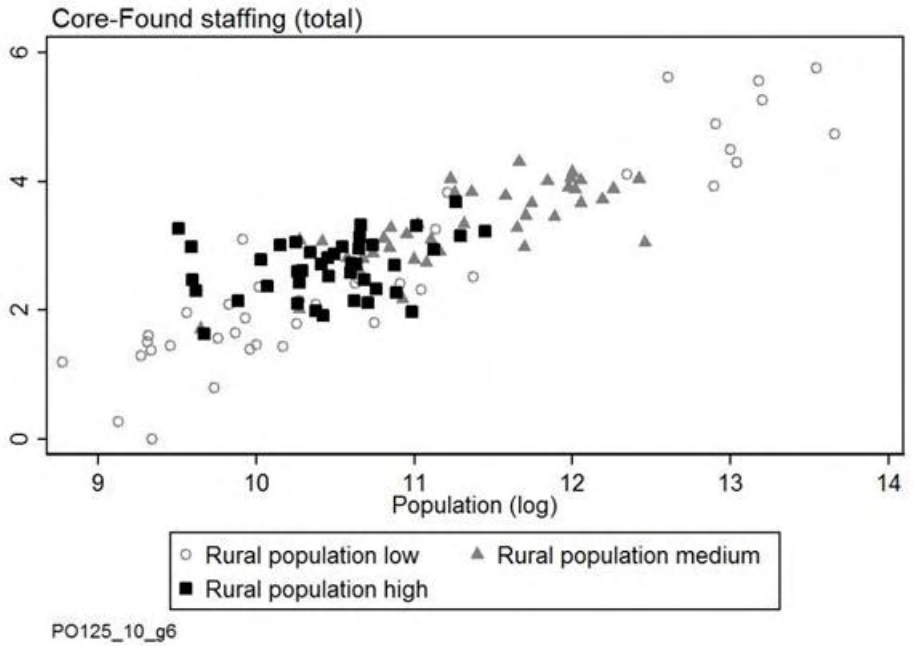
- Clinical. Rule health districts have proportionately more staff, but spending is not significantly different.
    - Since most clinical services require that patients come to the health center, travel time may be less of an issue for clinical services.

Exhibit 33. Impact of rural setting.		
	Non-weighted	Population-weighted
Core Staff		↑↑↑
Core Spending		↑↑
Clinical Staff		↑↑
Clinical Spending		

- The impact of a rural setting can be found in the graphs in Exhibit 34. Showing the familiar relationship between population and spending staffing, LHD's are coded by a portion of a rural population (more rural signified with a "■"). The interpretation is subtle.
    - That any given population level, there are a number of LHDs above that population. Higher LHDs have higher costs or staffing for the same population. In other words, LHDs on the lower edge of the cluster use fewer resources to take care of the same number of people.
    - Since rural LHDs are almost never on this lower edge, it indicates that they generally cost more to take care of a given level of population.

Exhibit 34. Graph: Rural impact.





4.2.4 Race

- Districts with a higher proportion of non-whites have higher costs and higher core staffing. (See Exhibit 35)

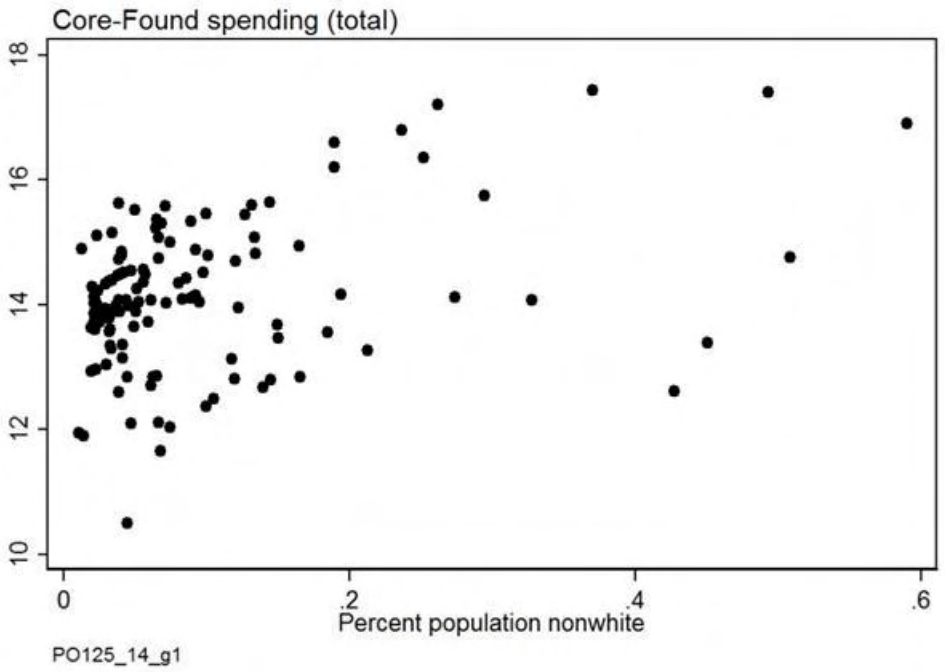
- Core. Districts with a higher proportion of non-whites have higher staffing and higher costs.
  - This is true even in models that have population, rural and income. So the impact of race could not be attributed to possible clustering of non-whites in large, urban, poor cities.

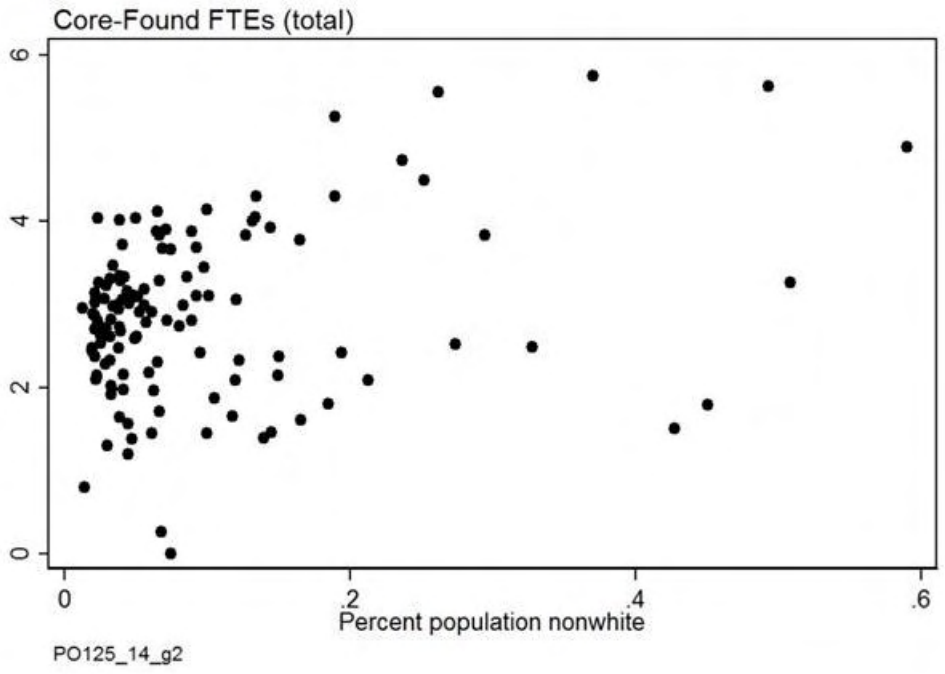
- Clinical. Districts with higher proportion of non-whites have higher clinical costs.
  - It appears that these higher clinical costs do not result from more staff, so perhaps the difference is attributable to higher overhead costs.

Exhibit 35. Impact of race.		
	Non-weighted	Population-weighted
Core Staff	↑↑↑	↑↑↑
Core Spending	↑↑↑	↑↑↑
Clinical Staff		
Clinical Spending	↑↑	↑↑

- These conclusions are visually supported by general upward slopes in Exhibit 36.

Exhibit 36. Graph of Race and Resource Use.





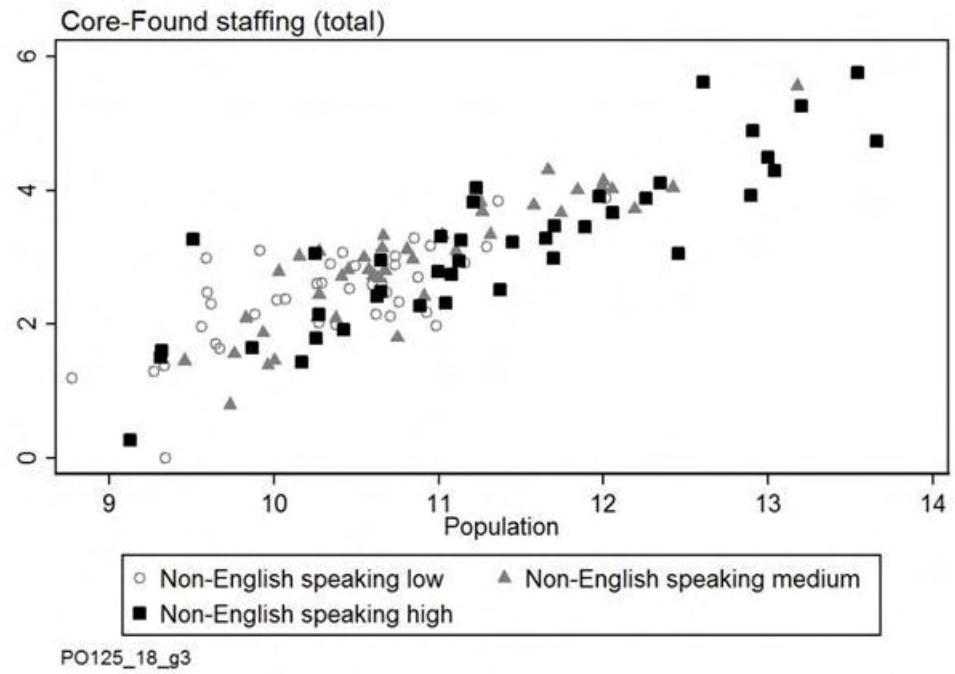
4.2.5 Non-English speaking

- Health districts with higher proportions of non-English speaking people have lower levels of staff and spend less. (See Exhibit 37.) This is true for both core services and clinical services.
    - The finding is confirmed in the graph in Exhibit 38. Health districts with higher proportions of non-English speakers tend to be on the lower edge of the line. This means that for any given level of population, health districts with more non-English speakers have lower staff levels.
    - This finding is surprising in light of traditional measures of public health need.

Exhibit 37. Impact of language.		
	Non-weighted	Population-weighted
Core Staff		↓↓↓
Core Spending		↓↓
Clinical Staff		↓↓
Clinical Spending		↓↓

- Language-population interaction.
    - It appears that non-English speakers are concentrated in a small number of health districts. This would explain the lack of significance on all non-weighted regressions but significance on the population weighted regressions. This suspicion is supported by the graph in Exhibit 38, which shows that most health districts with large populations also have a higher proportion of non-English speakers.

Exhibit 38. Graph: Language and Staffing.



4.2.6 Age

- Health districts with a higher proportion of people over the age of 65 have lower clinical spending. (See Exhibit 39)
    - This is not surprising, since most such people would have Medicare and could access clinical services through private means.

- Core. The age of people living in the health district had no impact on core staff or spending.

- Clinical. Health districts with older populations had lower clinical spending.
    - Since clinical staff was not significantly different, this might indicate that overhead costs were lower in areas with older populations.

Exhibit 39. Impact of age.		
	Non-weighted	Population-weighted
Core Staff		
Core Spending		
Clinical Staff		
Clinical Spending		↓↓↓

- Age-population interaction.
    - It appears that people over the age of 65 are slightly clustered. This would explain the fact that none of the non-weighted regressions were significant but some of the population weighted ones were.

4.2.7 Income

- Spending is slightly lower in districts with high incomes. (See Exhibit 40)

- Core. Both spending and staffing were lower in richer health districts (in non-weighed models).

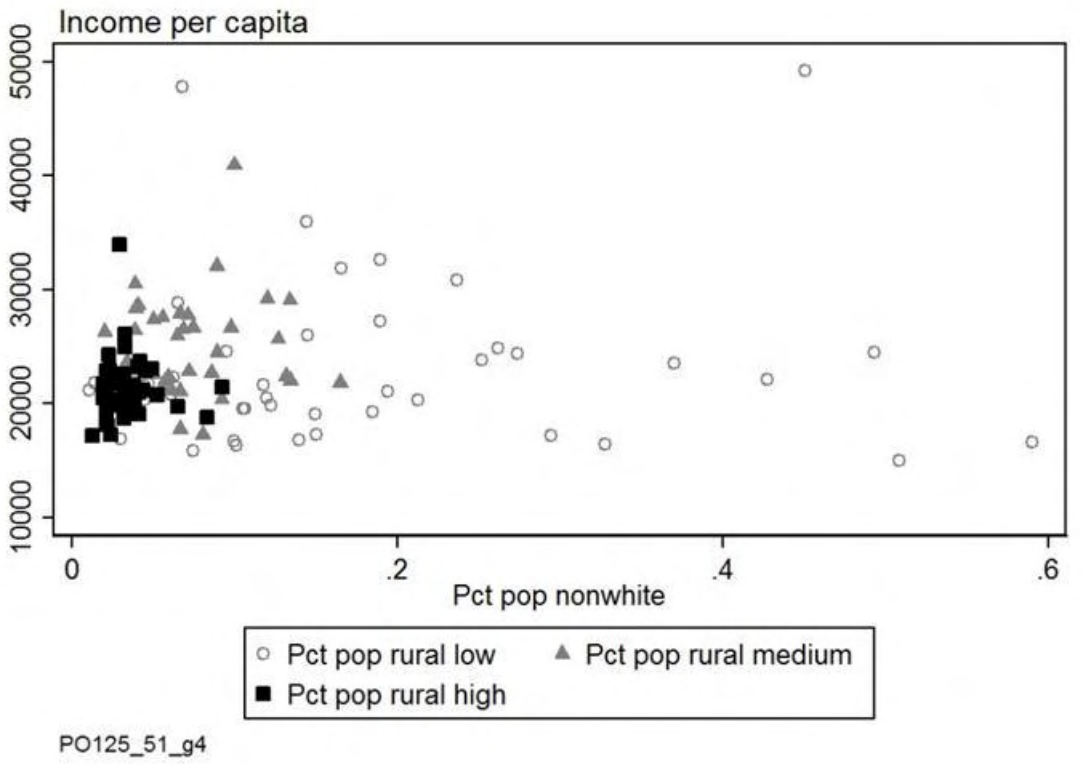
- Clinical. Staffing was lower in richer health districts in (non-weighted models).

Exhibit 40. Impact of income.		
	Non-weighted	Population-weighted
Core Staff	↓	
Core Spending	↓↓	*Race-Income interaction.*
Clinical Staff	↓↓	↓
Clinical Spending		*Race-Income interaction.*

- Race-Income interaction.
  - Core and clinical spending our both lower in areas with higher income only when race is removed from the model. The most likely explanation for this is that areas with high income are more white.
  - This is confirmed in Exhibit 41, which shows income per capita is almost always lower as the percent nonwhite increases.

- Income -Population interaction.
  - Population weighted coefficients were generally insignificant but non-weighted models did show significance. This is most likely because richer health districts spend proportionately less and have lower populations.

Exhibit 41. Graph: Income and Race.



4.2.8 Uninsured

- Areas with more uninsured needed slightly higher staff from both core and clinical services. (See Exhibit 42)

- Core. Districts with high proportions of uninsured people required proportionately more staff.
  - That these higher staff levels did not carry through to costs is curious. It likely indicates strong association between race, rural, English-speaking, and uninsured.
  - That these higher staff levels occurred in core services and not clinical services is also surprising. More analysis will be needed to explore this relation.

- Clinical. Districts with a high proportion of uninsured people required slightly more staff but did not have significantly different costs. The need for higher staff is expected given that the uninsured are more likely to use clinic services.

Exhibit 42. Impact of uninsured.		
	Non-weighted	Population-weighted
Core Staff		↑↑↑
Core Spending		
Clinical Staff		↑
Clinical Spending		

- Race-uninsured interaction.
  - Several models show uninsured to be significant only when race is removed. This would occur if areas with high rates of insurance also had more non-whites.

- Population -uninsured interaction.
  - It appears that uninsured people are concentrated in areas with higher populations. This would explain the lack of significance in non-weighted models.

4.2.9 Physician supply

- Spending on clinical services is lower in areas with a high physician supply. (See Exhibit 43)

- Core. Staffing and spending on core services were not impacted by physician supply. Given that physician supply likely has more to do with clinical services, this is not surprising.

- Clinical. Clinical spending was slightly lower in areas with higher physician supply.
    - Staffing levels were not significantly different in areas with higher physician supply. The fact that spending was lower might indicate that the mix of professionals was different. In areas with higher physician supplies, clinics can probably get by with fewer doctors and more nurses.

Exhibit 43. Impact of physician supply.		
	Non-weighted	Population-weighted
Core Staff		
Core Spending	*Race interaction*	*Race interaction*
Clinical Staff		
Clinical Spending		↓↓

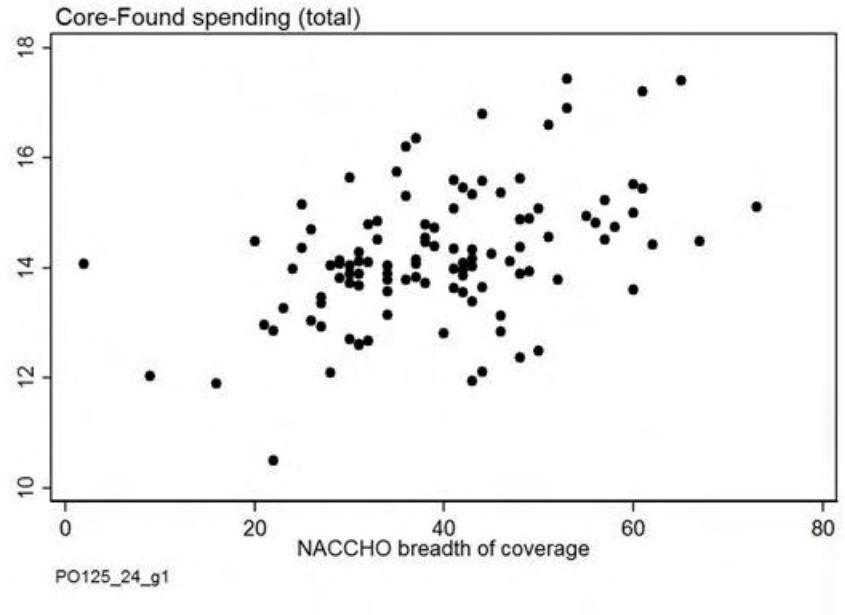
- Race-Physician-supply interaction.
    - Core spending was only significant when race was removed from the models. Since the coefficient was positive in situations that indicates that districts with more non-whites also had relatively more physicians.

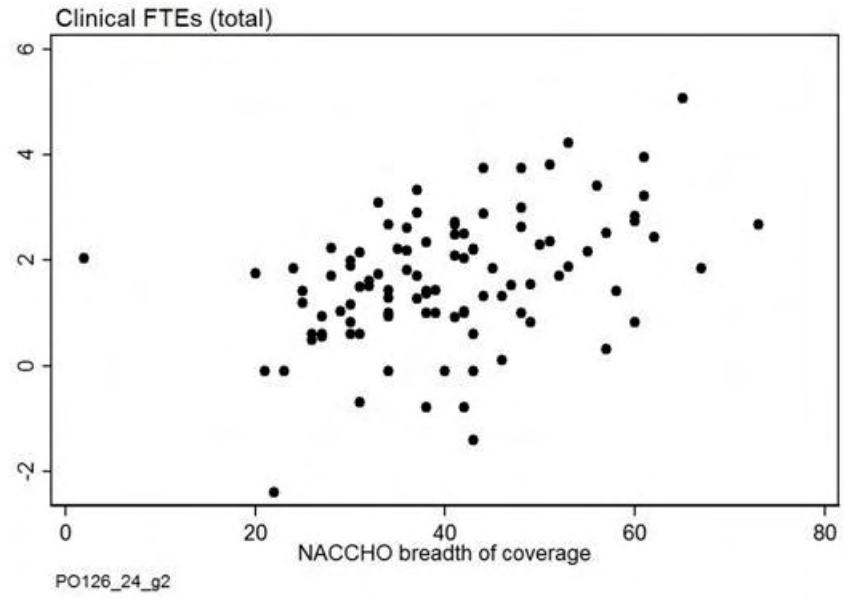
4.2.10 Breadth of services offered

- Districts with a broader range of services offered had higher staff and spending. (See Exhibit 44). This was true for both core and clinical services. This is not surprising; the more health district does, more people they need and the more it's going to cost.
    - The graphs in Exhibit 45 demonstrate that both staff and spending are generally higher in health districts that provide a broader range of services.

Exhibit 44. Impact of breadth of services offered.		
	Non-weighted	Population-weighted
Core Staff	↑↑↑	↑↑↑
Core Spending	↑↑↑	↑↑↑
Clinical Staff	↑↑↑	↑↑↑
Clinical Spending	↑	↑↑

Exhibit 45. Graph: Breadth and Resource Use.





4.2.11 Core service coverage

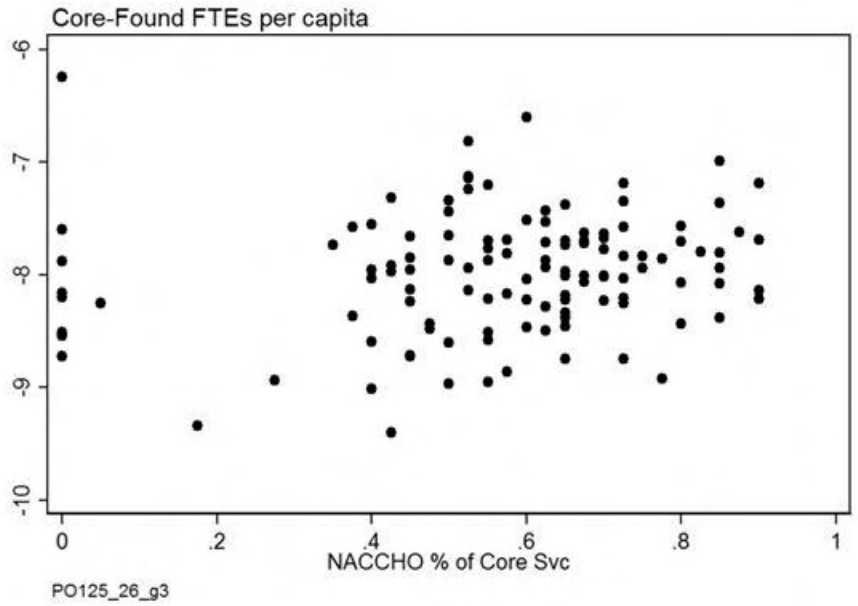
- Districts that perform a greater proportion of nature core services have higher levels of staff and spending. (See Exhibit 46)

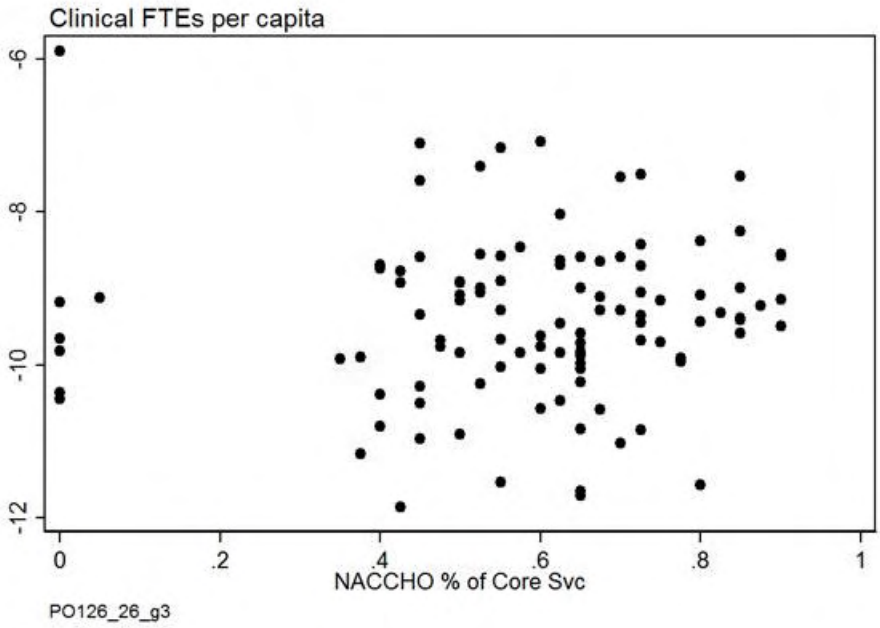
- Core. Districts that perform a greater portion of NACCHO core services not surprisingly have higher staff and spending.
    - The upper graph in Exhibit 47 demonstrates that health districts that fulfill a greater proportion of core services also require more staff or those core areas. The lower graph in the same exhibit shows that there is no demonstrable spillover because clinical staff does not seem to be related to core service fulfillment.

- Clinical. Districts that perform a greater proportion of NACCHO core services also have higher staffing and spending on clinical services.
    - This is most likely because districts that perform a broad range of the core services also perform a broad range of clinical services.

Exhibit 46. Impact of cover service coverage.		
	Non-weighted	Population-weighted
Core Staff	↑↑↑	↑↑↑
Core Spending	↑↑↑	↑↑↑
Clinical Staff	↑↑↑	↑↑↑
Clinical Spending	↑↑	↑↑

Exhibit 47. Graph: Core Service Fulfillment and Resource Use.





4.2.12 Clinical care focus

- Districts that spend a greater proportion of their total funds on clinical care also spend more on core services. This is clear indication of spillover from clinical services to core services. Spending more on clinical services is unequivocally associated with relatively higher spending on core services. (See Exhibit 48)
- This variable did not make it into the final models, but it seems possibly important.

- Core. Districts that stand a greater proportion of their total funds on clinical care also require more staff and spending for their core services.
    - This is surprising since these districts already spending a greater proportion of their funds on clinical care. The most likely explanation for this is that the overall spending for districts that spend a higher proportion of clinical care is disproportionately greater. In other words, they spend more on everything.

- Clinical. Districts that spend a greater proportion of their total funds on clinical care not surprisingly have higher levels of staff and spending for the clinical care.

Exhibit 48. Impact of spending on clinical care.

	Non-weighted	Population-weighted
Core Staff	↑↑	↑
Core Spending	↑↑↑	↑↑↑
Clinical Staff	↑↑↑	↑↑↑
Clinical Spending	↑↑↑	↑

4.3 Limitations

- AFR. Epidemiology and Emergency Preparedness
  - Epidemiology and Emergency Preparedness expenditures and service counts may not be properly aligned by LHD (See section 2.2). These services are sometimes shared, but the accounting may not bring costs back to the right place.
  - Sometimes, LHDs subcontract with other LHDs for epidemiology services. The most accurate way to represent this is as follows:
    - LHD-SUBCONTRACT pays LHD-DO to have the services covered, and recognizes those payments as an expense.
    - LHD-DO recognizes payments received as a reduction to expenses (and an increase to revenue).
  - Unfortunately, it is believed that such accounting procedures are not routinely followed. This means that some districts (DO) over-report expenses and others (SUBCONTRACT) under-report expenses.
  - There is no easy solution to this problem. Ohio officials would have to check with each individual district. And even then, they may be forced to estimate transfer amounts when no cash actually changed hands.

- AOHC Collaboration Survey - LHD shared service survey (Not used)
  - The AOHC Collaboration Survey from 2012 was not used as part of this project. It shows for each LHD which services they share with other LHDs. It also indicates the 'direction' of the sharing; does the LHD provide the service to other LHDs, or do other LHDs provide the service to them?
  - Although it has many service classifications, the services do not align to AFR service classes.
  - Finally, it does not indicate the value of shared services, so it not helpful in re-allocating expenditures where services are actually consumed.
  - The misalignment of services and lack of costs make it difficult to reallocate expenses for shared services (see comments on " AFR. Epidemiology and Emergency Preparedness").

- ODH LHD Improvement Standards (IS)
    - ODH Improvement Standards do not align to AFR service classes (see section 2.3).
    - It seems that Improvement Standards are better suited to measuring foundational capabilities and core services. NACCHO services do not align as well with foundational capabilities.

- Agency Type Classification and expense alignment
    - In Ohio, all counties have a general health district (county) that provides coverage until a city becomes incorporated. Mergers have brought the number of LHDs from a high of over 150 in the 1980s to a current 125.
    - Some city health district do not provides all services to the covered area. Some of those services may be covered by the surrounding county. The city may still report that it meets 'core' services because it has negotiated an agreement with the county for the county to provide coverage. Both districts are then listed as assuring the provision of 'core' services even though only one bears the expense.
    - The revenue alignment issue underneath this problem is already mentioned above. But this draws attention to the way that such misclassification could cloud the analysis of agency type.
    - So until expense alignment is better understood (and corrected), it is probably not good to include agency type in future models of cost.

5 Future Analysis

The models developed from this project are an important first step in understanding local health district cost of providing core public health services. Future work could improve these models, deepen understanding and answer critical questions.

- Is there an optimal mix of services and staffing?
  - This initial study found, for example, that LHDs with a higher proportion of administrative staff may have greater efficiency.
  - The study also found that providing more clinical services is associated with higher core resource use, indicating that there may be spillover effects across service lines.
  - At times, this study had to use arbitrary estimates of staffing allocation among core and clinical services. It is hoped that more detailed information will be available in the future.
  - Further analysis will allow more precise understanding of these factors.

- Financial or operating motives to consolidate health districts.
  - Although initial indications in this study find neither advantage nor disadvantage for larger health districts, further investigation is warranted.
  - Areas with high populations also have higher proportions of non-white residents. This makes it hard to distinguish between areas with high population and areas with a high proportion of non-whites, making it hard to definitively say whether there are financial and operating advantages to consolidating health districts.

- Accreditation and resource use
  - Accreditation requires LHDs to provide certain core services and have certain capabilities. Does it cost more or require more staff to operate an accredited health district?

- Outcomes and resources[12].
  - Little is known about the link between resource use and public health outcomes. Do changes in public health resource use make a difference in the health of the public? If so, what changes have the greatest impact?
  - What is the return on investment for various classes of service?

6 Appendix

6.1 Statistical models

Exhibit 49. Summary of detailed models			
	What is estimated?	Explanatory variables	Model IDs
Exhibit 50 Exhibit 51 Exhibit 52 Exhibit 53	Core Staffing Core Spending Clinical Staffing Clinical Spending	• Basics (LHD characteristics, demographics)	01-03
Exhibit 54 Exhibit 55 Exhibit 56 Exhibit 57	Core Staffing Core Spending Clinical Staffing Clinical Spending	• Core-plus scale. Breadth of services. % of core services filled. • Basics (LHD characteristics, demographics)	10-13
Exhibit 58 Exhibit 59 Exhibit 60 Exhibit 61	Core Staffing Core Spending Clinical Staffing Clinical Spending	• Scope scale. Service mix, staffing mix, Capabilities. • Basics (LHD characteristics, demographics)	21-26

Exhibit 50. Model base. Core Staffing.

Core & Foundational FTEs	Non-weighted (each LHD = _01	_02	_03	Population-weighted _01	_02	_03
Agency characteristics						
Type of agency =city	-0.45 *	-0.44 *	-0.03	0.26	0.26	0.64 ***
Type of agency =county	0.00	0.00	0.00	0.00	0.00	0.00
Population characteristics						
Population size (log)	0.82 ***	0.82 ***	0.93 ***	1.01 ***	1.01 ***	1.10 ***
Percent population rural	0.36	0.39	0.54 *	0.90 ***	0.89 ***	0.86 **
Percent population nonwhite	2.75 ***	2.71 ***		2.55 ***	2.54 ***	
Average years of education	-0.04			0.03		
Percent non-English speaking	-4.74	-4.43	-1.85	-19.86 ***	-20.02 ***	-21.18 ***
Percent 65+years old (%)	1.41	1.59	1.22	1.28	1.20	-0.09
Income per capita ($100,000)	-1.51	-1.90 *	-2.01 *	0.10	0.32	-1.50
Percent uninsured (%)	0.51	0.25	-1.23	7.88 ***	7.97 ***	8.49 ***
Physicians per 100,000 population	0.00	0.00	0.00	0.00	0.00	0.00
Run summary						
Constant	-5.56 *	-6.09 ***	-7.14 ***	-9.84 ***	-9.56 ***	-10.02 ***
F	44.26 ***	49.63 ***	49.38 ***	68.96 ***	77.37 ***	79.18 ***
r2	0.81	0.81	0.79	0.87	0.87	0.86
adjusted r2	0.79	0.80	0.78	0.86	0.86	0.85
N	113.00	113.00	113.00	113.00	113.00	113.00
FTEs per capita						
Population size (log)	-0.18 **	-0.18 **	-0.07	0.01	0.01	0.10
Run summary						
F	3.73 ***	4.18 ***	2.96 ***	8.99 ***	10.09 ***	9.35 ***
adjusted r2	0.20	0.20	0.12	0.42	0.42	0.37

Exhibit 51. Model base. Core Spending.

Core & Foundational Spending	Non-weighted (each LHD = _01	_02	_03	Population-weighted _01	_02	_03
Agency characteristics						
Type of agency =city	-0.46 *	-0.46 *	-0.03	0.00	0.00	0.00
Type of agency =county	0.00	0.00	0.00	-0.08	-0.10	-0.53 ***
Population characteristics						
Population size (log)	0.92 ***	0.92 ***	1.04 ***	1.03 ***	1.04 ***	1.14 ***
Percent population rural	0.31	0.30	0.47	0.73 **	0.70 **	0.66 *
Percent population nonwhite	2.83 ***	2.84 ***		2.99 ***	2.96 ***	
Average years of education	0.01			0.09		
Percent non-English speaking	0.97	0.89	3.71	-9.91 **	-10.43 ***	-11.77 ***
Percent 65+years old (%)	-2.66	-2.70	-3.04	1.19	0.93	-0.58
Income per capita ($100,000)	-2.60	-2.50 **	-2.64 **	-1.28	-0.57	-2.69 **
Percent uninsured (%)	-1.92	-1.86	-3.39	3.75	4.05	4.65 *
Physicians per 100,000 population	0.00	0.00	0.00 *	0.00	0.00	0.01 ***
Run summary						
Constant	4.90	5.03 ***	3.88 ***	1.20	2.11 *	1.99 *
F	58.45 ***	65.58 ***	65.60 ***	104.45 ***	117.01 ***	115.85 ***
r2	0.85	0.85	0.83	0.91	0.91	0.90
adjusted r2	0.84	0.84	0.82	0.90	0.90	0.89
N	114.00	114.00	114.00	114.00	114.00	114.00
Spending per capita						
Population size (log)	-0.08	-0.08	0.04	0.03	0.04	0.14 *
Run summary						
F	3.05 ***	3.42 ***	2.16 **	8.31 ***	9.29 ***	7.79 ***
adjusted r2	0.15	0.16	0.08	0.39	0.40	0.32

Exhibit 52. Model base. Clinical Staffing.

Clinical FTEs	Non-weighted (each LHD = _01	_02	_03	Population-weighted _01	_02	_03
Agency characteristics						
Type of agency =city	-0.98	-0.98	-0.47	0.41	0.65	0.68
Type of agency =county	0.00	0.00	0.00	0.00	0.00	0.00
Population characteristics						
Population size (log)	0.68 ***	0.68 ***	0.83 ***	1.05 ***	1.16 ***	1.16 ***
Percent population rural	-0.14	-0.12	0.10	1.66 **	1.25	1.25
Percent population nonwhite	2.64	2.62		0.74	0.16	
Average years of education	-0.02			1.16 **		
Percent non-English speaking	-5.60	-5.40	-5.68	-18.41 *	-25.96 ***	-26.06 ***
Percent 65+years old (%)	2.82	2.91	2.86	8.29 *	4.77	4.70
Income per capita ($100,000)	-5.65	-5.83 **	-5.86 **	-11.85 **	-2.60	-2.72
Percent uninsured (%)	2.42	2.28	1.64	6.13	10.42 *	10.46 *
Physicians per 100,000 population	0.00	0.00	0.00	0.00	0.00	0.00
Run summary						
Constant	-4.87	-5.11	-6.79 **	-24.80 ***	-12.99 ***	-13.02 ***
F	6.21 ***	6.97 ***	7.53 ***	12.19 ***	12.57 ***	14.29 ***
r2	0.41	0.41	0.39	0.57	0.55	0.55
adjusted r2	0.34	0.35	0.34	0.53	0.51	0.51
N	102.00	102.00	102.00	102.00	102.00	102.00
FTEs per capita						
Population size (log)	-0.32	-0.32	-0.17	0.05	0.16	0.16
Run summary						
F	2.11 **	2.37 **	2.40 **	2.98 ***	2.71 ***	3.08 ***
adjusted r2	0.10	0.11	0.10	0.16	0.13	0.14

Exhibit 53. Model base. Clinical Spending.

Clinical Spending	Non-weighted (each LHD = _01	_02	_03	Population-weighted _01	_02	_03
Agency characteristics						
Type of agency =city	-2.12 **	-2.25 **	-1.07	-1.44 *	-1.45 *	-0.37
Type of agency =county	0.00	0.00	0.00	0.00	0.00	0.00
Population characteristics						
Population size (log)	-0.03	-0.15	0.48	0.54	0.53 *	0.90 ***
Percent population rural	-1.38	-1.07	-0.86	-1.20	-1.20	-1.38
Percent population nonwhite	11.43 ***	11.02 ***		8.78 ***	8.78 ***	
Average years of education	-1.28			-0.04		
Percent non-English speaking	-21.26	-6.70	-16.04	-34.20 **	-33.95 **	-43.60 ***
Percent 65+years old (%)	-11.06	-8.87	-12.01	-22.99 ***	-22.92 ***	-27.77 ***
Income per capita ($100,000)	13.72	3.16	-2.81	-4.80	-5.13	-11.78 ***
Percent uninsured (%)	-2.09	-9.02	-2.45	11.29	11.17	17.16 *
Physicians per 100,000 population	0.00	0.00	0.00	-0.02 **	-0.02 **	0.00
Run summary						
Constant	28.38 **	15.96 ***	10.33 *	11.81	11.42 **	8.95 *
F	3.12 ***	3.37 ***	2.57 **	10.46 ***	11.79 ***	11.21 ***
r2	0.30	0.29	0.22	0.59	0.59	0.54
adjusted r2	0.20	0.20	0.13	0.53	0.54	0.50
N	84.00	84.00	84.00	84.00	84.00	84.00
Spending per capita						
Population size (log)	-1.03 **	-1.15 ***	-0.52	-0.46	-0.47	-0.10
Run summary						
F	1.74 *	1.83 *	0.99	8.67 ***	9.77 ***	9.14 ***
adjusted r2	0.08	0.08	0.00	0.48	0.49	0.44

Exhibit 54. Model adjusted for core-plus scale. Core Staffing.

Core & Foundational FTEs	Non-weighted (each LHD = 1) _10	_11	_12	_13	Population-weighted _10	_11	_12	_13
Agency characteristics								
Type of agency =city	-0.45 *	-0.42	-0.42 *	-0.41	0.22	0.25	0.12	0.14
Type of agency =county	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Population characteristics								
Population size (log)	0.73 ***	0.84 ***	0.79 ***	0.71 ***	0.92 ***	1.01 ***	0.91 ***	0.85 ***
Percent population rural	0.32	0.43	0.33	0.32	0.80 ***	0.88 **	0.71 **	0.75 ***
Percent population nonwhite	2.25 ***	2.78 ***	2.55 ***	2.28 ***	1.56 **	2.53 ***	2.41 ***	2.22 ***
Average years of education								
Percent non-English speaking	-3.84	-4.40	-4.48	-4.28	-13.59 ***	-19.85 ***	-18.39 ***	-14.03 ***
Percent 65+years old (%)	1.96	1.84	0.99	2.26	0.41	1.05	-0.24	0.42
Income per capita ($100,000)	-1.37	-1.87 *	-2.24 **	-1.55	-0.06	0.29	0.18	-0.40
Percent uninsured (%)	0.41	0.17	1.22	0.91	6.07 ***	7.93 ***	8.40 ***	7.22 ***
Physicians per 100,000 population	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Core-Plus Scale measures								
NACCHO breadth of coverage	0.02 ***				0.02 ***			
Improvement Standards breadth		-0.23				0.09		
AFR - Breadth of expenditures			-0.90 ***				-1.59 ***	
NACCHO % of Core Svc				1.41 ***				1.72 ***
Run summary								
Constant	-5.89 ***	-6.22 ***	-5.53 ***	-5.99 ***	-8.94 ***	-9.49 ***	-7.99 ***	-8.45 ***
F	51.86 ***	44.37 ***	49.16 ***	53.63 ***	94.15 ***	68.98 ***	85.00 ***	101.36 ***
r2	0.84	0.81	0.83	0.84	0.90	0.87	0.89	0.91
adjusted r2	0.82	0.79	0.81	0.83	0.89	0.86	0.88	0.90
N	111.00	113.00	113.00	111.00	111.00	113.00	113.00	111.00
FTEs per capita								
Population size (log)	-0.27 ***	-0.16 *	-0.21 ***	-0.29 ***	-0.08	0.01	-0.09	-0.15 **
Run summary								
F	6.44 ***	3.76 ***	4.98 ***	6.91 ***	15.70 ***	9.00 ***	12.88 ***	17.48 ***
adjusted r2	0.33	0.20	0.26	0.35	0.57	0.42	0.51	0.60

Exhibit 55. Model adjusted for core-plus scale. Core Spending.

Core & Foundational Spending	Non-weighted (each LHD = 1) _10	_11	_12	_13	Population-weighted _10	_11	_12	_13
Agency characteristics								
Type of agency =city	-0.45	-0.43	-0.45 *	-0.43	0.00	0.00	0.00	0.00
Type of agency =county	0.00	0.00	0.00	0.00	-0.06	-0.09	0.02	0.00
Population characteristics								
Population size (log)	0.87 ***	0.95 ***	0.90 ***	0.86 ***	0.96 ***	1.03 ***	0.95 ***	0.91 ***
Percent population rural	0.29	0.37	0.26	0.27	0.63 **	0.69 **	0.54 *	0.58 **
Percent population nonwhite	2.49 ***	2.93 ***	2.72 ***	2.57 ***	2.14 ***	2.96 ***	2.84 ***	2.71 ***
Average years of education								
Percent non-English speaking	1.47	0.93	0.85	1.09	-5.02	-10.36 **	-9.03 **	-5.52
Percent 65+years old (%)	-2.20	-2.30	-3.13	-2.11	0.28	0.87	-0.31	0.30
Income per capita ($100,000)	-2.25 *	-2.45 **	-2.74 **	-2.39 **	-0.89	-0.58	-0.69	-1.15
Percent uninsured (%)	-1.71	-2.00	-1.18	-1.36	2.46	4.03	4.41 *	3.44
Physicians per 100,000 population	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Core-Plus Scale measures								
NACCHO breadth of coverage	0.01 ***				0.02 ***			
Improvement Standards breadth		-0.37				0.03		
AFR - Breadth of expenditures			-0.64 **				-1.36 ***	
NACCHO % of Core Svc				1.00 ***				1.41 ***
Run summary								
Constant	4.98 ***	4.83 ***	5.43 ***	4.98 ***	2.57 **	2.13 *	3.34 ***	2.90 ***
F	62.24 ***	58.85 ***	61.12 ***	61.53 ***	127.28 ***	104.30 ***	120.92 ***	131.22 ***
r2	0.86	0.85	0.86	0.86	0.93	0.91	0.92	0.93
adjusted r2	0.85	0.84	0.84	0.85	0.92	0.90	0.91	0.92
N	112.00	114.00	114.00	112.00	112.00	114.00	114.00	112.00
Spending per capita								
Population size (log)	-0.13	-0.05	-0.10	-0.14	-0.04	0.03	-0.05	-0.09
Run summary								
F	4.25 ***	3.13 ***	3.57 ***	4.11 ***	12.44 ***	8.28 ***	10.98 ***	13.08 ***
adjusted r2	0.23	0.16	0.19	0.22	0.51	0.39	0.47	0.52

Exhibit 56. Model adjusted for core-plus scale. Clinical Staffing.

Clincial FTEs	Non-weighted (each LHD = 1) _10	_11	_12	_13	Population-weighted _10	_11	_12	_13
Agency characteristics								
Type of agency =city	0.00	-1.00	-0.98	0.00	0.60	0.63	0.36	0.46
Type of agency =county	0.63	0.00	0.00	0.73	0.00	0.00	0.00	0.00
Population characteristics								
Population size (log)	0.68 ***	0.66 ***	0.67 ***	0.63 ***	1.00 ***	1.15 ***	0.97 ***	0.90 ***
Percent population rural	0.13	-0.17	-0.15	0.01	1.10	1.22	0.94	1.01
Percent population nonwhite	1.31	2.57	2.56	1.82	-1.55	0.13	0.07	-0.28
Average years of education								
Percent non-English speaking	-4.33	-5.07	-5.74	-3.80	-14.65	-25.57 **	-22.87 **	-15.93 *
Percent 65+years old (%)	4.78	2.68	2.65	4.66	3.48	4.46	1.94	3.59
Income per capita ($100,000)	-5.45 **	-5.92 **	-5.86 **	-5.84 **	-3.16	-2.68	-2.59	-3.63
Percent uninsured (%)	2.33	2.26	2.72	2.56	6.97	10.31 *	11.14 **	8.88
Physicians per 100,000 population	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Core-Plus Scale measures								
NACCHO breadth of coverage	0.02 ***				0.03 ***			
Improvement Standards breadth		0.24				0.17		
AFR - Breadth of expenditures			-0.31				-3.02 ***	
NACCHO % of Core Svc				1.69 **				2.66 ***
Run summary								
Constant	-7.21 ***	-4.95	-4.93	-6.76 **	-12.00 ***	-12.86 ***	-10.02 ***	-11.19 ***
F	7.36 ***	6.22 ***	6.24 ***	7.04 ***	14.87 ***	11.20 ***	14.14 ***	14.71 ***
r2	0.45	0.41	0.41	0.44	0.62	0.55	0.61	0.62
adjusted r2	0.39	0.34	0.34	0.38	0.58	0.50	0.57	0.58
N	101.00	102.00	102.00	101.00	101.00	102.00	102.00	101.00
FTEs per capita								
Population size (log)	-0.32	-0.34	-0.33	-0.37 *	0.00	0.15	-0.03	-0.10
Run summary								
F	2.98 ***	2.12 **	2.14 **	2.74 ***	4.56 ***	2.42 **	4.09 ***	4.47 ***
adjusted r2	0.17	0.10	0.10	0.15	0.26	0.12	0.23	0.26

Exhibit 57. Model adjusted for core-plus scale. Clinical Spending.

Clinical Spending	Non-weighted (each LHD = 1) _10	_11	_12	_13	Population-weighted _10	_11	_12	_13
Agency characteristics								
Type of agency =city	0.00	-2.26 **	-2.40 **	0.00	-1.48 **	-1.48 *	-1.41 *	0.00
Type of agency =county	2.13 **	0.00	0.00	2.18 **	0.00	0.00	0.00	1.57 **
Population characteristics								
Population size (log)	-0.23	-0.16	-0.14	-0.27	0.41	0.52	0.50	0.35
Percent population rural	-0.93	-1.07	-1.09	-1.00	-1.25	-1.22	-1.19	-1.30
Percent population nonwhite	9.38 **	11.03 ***	11.45 ***	9.65 **	6.91 **	8.78 ***	8.34 ***	7.88 **
Average years of education								
Percent non-English speaking	-6.49	-6.64	-6.91	-7.71	-25.83 *	-33.51 **	-34.09 **	-28.82 **
Percent 65+years old (%)	-7.75	-8.89	-9.68	-6.70	-24.25 ***	-23.14 ***	-22.20 ***	-23.64 ***
Income per capita ($100,000)	2.44	3.15	2.56	1.40	-6.17	-5.30	-4.44	-7.07
Percent uninsured (%)	-7.41	-8.99	-8.74	-4.93	9.24	11.24	12.58	12.37
Physicians per 100,000 population	0.00	0.00	0.00	0.00	-0.01 *	-0.02 **	-0.02 **	-0.01 *
Core-Plus Scale measures								
NACCHO breadth of coverage	0.03 **				0.03 **			
Improvement Standards breadth		0.06				0.25		
AFR - Breadth of expenditures			1.06				-1.63	
NACCHO % of Core Svc				2.79 **				2.08 **
Run summary								
Constant	13.20 ***	15.97 ***	15.96 ***	13.00 ***	12.21 ***	11.50 **	11.50 **	10.96 ***
F	3.81 ***	2.99 ***	3.06 ***	3.98 ***	12.20 ***	10.47 ***	10.71 ***	11.99 ***
r2	0.35	0.29	0.30	0.36	0.63	0.59	0.59	0.62
adjusted r2	0.26	0.19	0.20	0.27	0.58	0.53	0.54	0.57
N	83.00	84.00	84.00	83.00	83.00	84.00	84.00	83.00
Spending per capita								
Population size (log)	-1.23 ***	-1.16 **	-1.14 ***	-1.27 ***	-0.59 **	-0.48	-0.50	-0.65 **
Run summary								
F	2.46 **	1.62	1.68	2.61 ***	10.48 ***	8.68 ***	8.90 ***	10.29 ***
adjusted r2	0.15	0.07	0.08	0.16	0.54	0.48	0.49	0.53

Exhibit 58. Model adjusted for service scope. Core Staffing.

Core & Foundational FTEs	Non-weighted (each LHD = 1) _21	_22	_23	_24	_25	_26	Population-weighted _21	_22	_23	_24	_25	_26
Agency characteristics												
Type of agency =city	-0.47 *	-0.47 *	-0.43 *	-0.49 *	-0.40	-0.36	0.23	0.26	0.21	0.22	0.25	-0.14
Type of agency =county	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Population characteristics												
Population size (log)	0.73 ***	0.65 ***	0.72 ***	0.72 ***	0.77 ***	0.79 ***	0.93 ***	0.88 ***	0.92 ***	0.91 ***	0.93 ***	0.85 ***
Percent population rural	0.29	0.14	0.29	0.31	0.43	0.44	0.76 ***	0.75 ***	0.75 ***	0.86 ***	0.86 ***	0.51
Percent population nonwhite	2.30 ***	2.34 ***	2.26 ***	2.31 ***	2.43 ***	2.14 ***	1.53 **	1.53 **	1.67 **	1.55 **	1.59 **	2.11 ***
Average years of education												
Percent non-English speaking	-3.34	-2.80	-3.36	-3.21	-3.73	-3.72	-12.93 ***	-12.74 ***	-13.74 ***	-12.21 ***	-14.01 ***	-14.09 ***
Percent 65+years old (%)	1.51	1.71	1.91	1.93	2.80	3.25	0.37	0.86	0.18	0.96	0.83	1.47
Income per capita ($100,000)	-1.57	-1.44	-1.21	-1.19	-1.15	-1.14	-0.13	-0.05	0.10	0.22	0.05	-0.04
Percent uninsured (%)	0.53	1.20	0.37	0.05	0.18	0.75	6.00 ***	6.59 ***	6.18 ***	5.37 **	6.17 ***	5.58 **
Physicians per 100,000 population	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Core-Plus Scale measures												
NACCHO breadth of coverage	0.02 ***	0.01 ***	0.02 ***	0.01 ***	0.02 ***	0.02 ***	0.02 ***	0.02 ***	0.02 ***	0.02 ***	0.02 ***	0.02 ***
Scope of Service												
% spending on direct patient care	0.19 **						0.38 ***					
Staffing Mix - Admin		-1.46 ***						-1.63 **				
% staffing on direct patient care			0.69 **						0.68 *			
Case complexity				0.45						0.40		
Foundational Capability Strength					-0.73 *						-0.26	
Foundational Capability Mix												
QA						0.17						0.34
Information Mgt						0.04						-0.75
Policy Development						-0.36						-0.50
Resource Development						0.66						0.88 *
Legal Support						-0.51 *						-0.90 ***
Lab Capacity						-0.36						-0.08
Comm Engage						-0.17						0.84
Run summary												
Constant	-5.85 ***	-4.70 ***	-5.93 ***	-5.77 ***	-6.26 ***	-6.70 ***	-9.08 ***	-8.42 ***	-8.96 ***	-8.99 ***	-9.11 ***	-8.04 ***
F	49.52 ***	53.34 ***	49.41 ***	47.43 ***	48.28 ***	32.01 ***	93.27 ***	89.00 ***	88.13 ***	86.00 ***	85.12 ***	62.16 ***
r2	0.85	0.86	0.85	0.84	0.84	0.85	0.91	0.91	0.91	0.91	0.90	0.92
adjusted r2	0.83	0.84	0.83	0.82	0.83	0.83	0.90	0.90	0.90	0.89	0.89	0.90
N	111.00	111.00	111.00	111.00	111.00	111.00	111.00	111.00	111.00	111.00	111.00	111.00
FTEs per capita												
Population size (log)	-0.27 ***	-0.35 ***	-0.28 ***	-0.28 ***	-0.23 ***	-0.21 **	-0.07	-0.12	-0.08	-0.09	-0.07	-0.15 *
Run summary												
F	6.55 ***	7.57 ***	6.52 ***	6.00 ***	6.22 ***	4.49 ***	16.23 ***	15.18 ***	14.96 ***	14.44 ***	14.22 ***	11.22 ***
adjusted r2	0.36	0.40	0.36	0.33	0.34	0.35	0.60	0.59	0.58	0.57	0.57	0.61

Exhibit 59. Model adjusted for service scope. Core Spending.

Core & Foundational Spending	Non-weighted (each LHD = 1) _21	_22	_23	_24	_25	_26	Population-weighted _21	_22	_23	_24	_25	_26
Agency characteristics												
Type of agency =city	-0.45	-0.45	-0.40	-0.49 *	-0.38	-0.33	0.00	0.11	0.05	0.00	0.00	0.00
Type of agency =county	0.00	0.00	0.00	0.00	0.00	0.00	-0.06	0.00	0.00	-0.06	-0.09	0.21
Population characteristics												
Population size (log)	0.87 ***	0.80 ***	0.85 ***	0.86 ***	0.91 ***	0.92 ***	0.96 ***	0.91 ***	0.95 ***	0.95 ***	0.97 ***	0.89 ***
Percent population rural	0.29	0.14	0.23	0.28	0.41	0.46	0.63 **	0.56 *	0.51 *	0.65 **	0.68 **	0.42
Percent population nonwhite	2.49 ***	2.51 ***	2.45 ***	2.56 ***	2.64 ***	2.44 ***	2.15 ***	2.08 ***	2.31 ***	2.14 ***	2.17 ***	2.51 ***
Average years of education												
Percent non-English speaking	1.47	2.34	2.33	2.25	1.58	1.58	-5.13	-4.00	-5.30	-4.41	-5.44	-4.84
Percent 65+years old (%)	-2.20	-2.45	-2.33	-2.24	-1.34	-1.06	0.28	0.82	-0.14	0.52	0.71	0.81
Income per capita ($100,000)	-2.25 *	-2.30 **	-1.95 *	-2.03 *	-2.01 *	-2.21 *	-0.88	-0.88	-0.60	-0.76	-0.78	-1.22
Percent uninsured (%)	-1.71	-1.07	-1.82	-2.14	-1.97	-1.62	2.47	3.07	2.65	2.14	2.56	2.54
Physicians per 100,000 population	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Core-Plus Scale measures												
NACCHO breadth of coverage	0.01 ***	0.01 **	0.01 ***	0.01 **	0.01 ***	0.02 ***	0.02 ***	0.02 ***	0.01 ***	0.02 ***	0.02 ***	0.02 ***
Scope of Service												
% spending on direct patient care	0.00						-0.06					
Staffing Mix - Admin		-1.24 **						-1.96 **				
% staffing on direct patient care			1.26 ***						1.22 ***			
Case complexity				0.56						0.18		
Foundational Capability Strength					-0.77						-0.26	
Foundational Capability Mix												
QA						-0.35						-0.15
Information Mgt						0.76						-0.28
Policy Development						0.17						0.10
Resource Development						0.63						1.51 ***
Legal Support						-0.67 **						-1.00 ***
Lab Capacity						-0.30						0.02
Comm Engage						-0.81						-0.20
Run summary												
Constant	4.98 ***	6.01 ***	4.93 ***	5.12 ***	4.60 ***	4.14 ***	2.60 **	3.15 ***	2.49 **	2.55 **	2.43 **	2.96 **
F	56.02 ***	57.63 ***	62.43 ***	57.12 ***	57.72 ***	39.28 ***	114.84 ***	120.29 ***	126.90 ***	114.86 ***	115.04 ***	81.05 ***
r2	0.86	0.86	0.87	0.86	0.86	0.88	0.93	0.93	0.93	0.93	0.93	0.94
adjusted r2	0.85	0.85	0.86	0.85	0.85	0.85	0.92	0.92	0.93	0.92	0.92	0.92
N	112.00	111.00	111.00	112.00	112.00	112.00	112.00	111.00	111.00	112.00	112.00	112.00
Spending per capita												
Population size (log)	-0.13	-0.20 **	-0.15 *	-0.14	-0.09	-0.08	-0.04	-0.09	-0.05	-0.05	-0.03	-0.11
Run summary												
F	3.83 ***	4.56 ***	5.54 ***	4.05 ***	4.16 ***	3.36 ***	11.24 ***	12.33 ***	13.42 ***	11.24 ***	11.27 ***	8.67 ***
adjusted r2	0.22	0.26	0.31	0.23	0.24	0.27	0.50	0.53	0.55	0.50	0.50	0.54

Exhibit 60. Model adjusted for service scope. Clinical Staffing.

Clincial	Non-weighted (each LHD = 1)						Population-weighted					
FTEs	_21	_22	_23	_24	_25	_26	_21	_22	_23	_24	_25	_26
Agency characteristics												
Type of agency =city	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.70	0.42 *	0.60	0.66	0.08
Type of agency =county	0.84	0.33	0.50	0.77	0.59	0.45	0.00	0.00	0.00	0.00	0.00	0.00
Population characteristics												
Population size (log)	0.71 ***	0.47 **	0.78 ***	0.63 ***	0.71 ***	0.76 ***	1.05 ***	0.93 ***	1.07 ***	0.95 ***	1.03 ***	0.88 ***
Percent population rural	0.00	0.13	0.17	0.14	0.20	0.21	1.03	1.20 *	0.76 **	1.38 *	1.19	0.78
Percent population nonwhite	1.84	1.55	1.25	1.38	1.35	0.60	-1.57	-1.43	-0.07	-1.62	-1.51	-0.56
Average years of education												
Percent non-English speaking	-2.22	0.95	-3.52	0.38	-4.78	-3.46	-12.83	-12.18	-17.42 ***	-7.70	-15.43	-17.85 *
Percent 65+years old (%)	1.98	4.55	1.82	5.11	5.18	6.15	3.26	4.83	-0.04	6.13	4.19	3.98
Income per capita ($100,000)	-6.36 ***	-3.90 *	-3.30 **	-4.25 *	-5.30 **	-5.44 **	-3.29	-2.74	-1.09	-1.77	-2.98	-3.99
Percent uninsured (%)	2.50	5.87	0.44	-0.01	2.37	3.45	6.71	8.80	8.23 ***	3.46	7.18	7.46
Physicians per 100,000 population	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.01	0.01
Core-Plus Scale measures												
NACCHO breadth of coverage	0.02 **	0.01	0.01 ***	0.01	0.02 ***	0.03 ***	0.03 ***	0.03 ***	0.02 ***	0.03 ***	0.04 ***	0.04 ***
Scope of Service												
% spending on direct patient care	0.86 ***						1.05 ***					
Staffing Mix - Admin		-10.14 ***						-5.66 **				
% staffing on direct patient care			6.55 ***						7.46 ***			
Case complexity				2.59 ***						1.91 **		
Foundational Capability Strength					-0.35						-0.41	
Foundational Capability Mix												
QA						0.00						0.31
Information Mgt						0.44						-0.03
Policy Development						-0.35						0.49
Resource Development						1.66						2.61 **
Legal Support						-0.73						-1.93 **
Lab Capacity						-0.60						-0.29
Comm Engage						-0.05						-1.43
Run summary												
Constant	-7.23 ***	-4.18 *	-9.23 ***	-6.90 ***	-7.46 ***	-8.65 ***	-12.54 ***	-11.17 ***	-13.40 ***	-12.15 ***	-12.31 ***	-10.30 ***
F	10.81 ***	11.19 ***	47.84 ***	8.10 ***	6.64 ***	4.42 ***	16.34 ***	14.44 ***	72.35 ***	14.59 ***	13.41 ***	9.35 ***
r2	0.57	0.58	0.86	0.50	0.45	0.47	0.67	0.64	0.90	0.64	0.62	0.66
adjusted r2	0.52	0.53	0.84	0.44	0.38	0.37	0.63	0.60	0.89	0.60	0.58	0.59
N	101.00	101.00	101.00	101.00	101.00	101.00	101.00	101.00	101.00	101.00	101.00	101.00
FTEs per capita												
Population size (log)	-0.29	-0.53 ***	-0.22 *	-0.37 *	-0.29	-0.24	0.05	-0.07	0.07	-0.05	0.03	-0.12
Run summary												
F	5.75 ***	6.02 ***	32.85 ***	3.76 ***	2.69 ***	1.92 **	5.79 ***	4.71 ***	37.60 ***	4.79 ***	4.12 ***	3.20 ***
adjusted r2	0.34	0.36	0.78	0.23	0.16	0.14	0.34	0.29	0.80	0.29	0.26	0.27

Exhibit 61. Model adjusted for service scope. Clinical Spending.

Clinical Spending	Non-weighted (each LHD = 1) _21	_22	_23	_24	_25	_26	Population-weighted _21	_22	_23	_24	_25	_26
Agency characteristics												
Type of agency =city	0.00	-1.98 *	-2.33 **	0.00	0.00	0.00	-1.27 **	0.00	0.00	-1.25 *	-1.45 *	-2.07 **
Type of agency =county	2.61 ***	0.00	0.00	2.33 **	2.06 *	1.93 *	0.00	1.35 *	1.44 **	0.00	0.00	0.00
Population characteristics												
Population size (log)	0.08	-0.28	-0.02	-0.27	-0.18	-0.07	0.69 ***	0.32	0.57 *	0.33	0.42	0.19
Percent population rural	-1.08	-0.89	-0.94	-0.94	-0.88	-0.57	-0.87	-1.13	-1.28	-0.73	-1.23	-1.18
Percent population nonwhite	8.29 ***	10.37 ***	8.37 **	9.34 **	9.21 **	8.92 **	5.62 **	7.22 **	5.97 *	6.03 **	6.88 **	8.88 ***
Average years of education												
Percent non-English speaking	-6.89	-4.81	-12.92	2.77	-7.04	-12.33	-25.29 **	-22.69 *	-30.14 **	-8.81	-26.14 *	-29.24 *
Percent 65+years old (%)	-15.91 **	-6.12	-10.94	-6.26	-7.28	-5.88	-23.64 ***	-21.73 ***	-25.94 ***	-18.22 ***	-24.06 ***	-16.98 **
Income per capita ($100,000)	-2.98	2.17	0.66	5.88	2.66	4.00	-5.93	-5.96	-5.72	0.78	-6.02	-0.36
Percent uninsured (%)	-3.16	-2.25	1.14	-13.88	-7.73	-4.82	10.68	12.73	12.29	-2.48	9.16	7.15
Physicians per 100,000 population	0.00	0.00	0.00	0.00	0.00	0.00	-0.01 *	-0.01 *	-0.01 *	-0.01 *	-0.01 *	-0.01
Core-Plus Scale measures												
NACCHO breadth of coverage	0.03 **	0.02	0.03 *	0.01	0.03 **	0.03 *	0.02 **	0.02 *	0.02 **	0.02	0.03 **	0.03 **
Scope of Service												
% spending on direct patient care	1.56 ***						2.13 ***					
Staffing Mix - Admin		-7.99 **						-8.99 **				
% staffing on direct patient care			4.09 ***						2.63 *			
Case complexity				4.05 ***						4.05 ***		
Foundational Capability Strength					-0.68						-0.21	
Foundational Capability Mix												
QA						0.38						-0.20
Information Mgt						1.53						0.28
Policy Development						-2.54						-2.71
Resource Development						-0.33						-1.84
Legal Support						-1.38						-1.60
Lab Capacity						-0.58						0.77
Comm Engage						2.94						4.16
Run summary												
Constant	11.21 ***	16.11 ***	12.44 **	13.16 ***	12.94 ***	9.97 *	7.97 **	11.80 ***	8.61 **	11.06 ***	12.13 ***	11.62 **
F	8.82 ***	4.21 ***	4.96 ***	4.39 ***	3.43 ***	2.56 ***	19.20 ***	12.17 ***	11.58 ***	13.01 ***	10.94 ***	8.11 ***
r2	0.58	0.40	0.44	0.41	0.35	0.40	0.75	0.66	0.65	0.67	0.63	0.68
adjusted r2	0.51	0.30	0.35	0.31	0.25	0.24	0.71	0.60	0.59	0.62	0.57	0.60
N	83.00	82.00	82.00	83.00	83.00	83.00	83.00	82.00	82.00	83.00	83.00	83.00
Spending per capita												
Population size (log)	-0.92 ***	-1.28 ***	-1.02 ***	-1.27 ***	-1.18 ***	-1.07 **	-0.31	-0.68 **	-0.43	-0.67 **	-0.58 *	-0.81 **
Run summary												
F	6.95 ***	2.90 ***	3.55 ***	3.07 ***	2.22 **	1.78 *	16.92 ***	10.53 ***	10.00 ***	11.28 ***	9.40 ***	7.05 ***
adjusted r2	0.44	0.20	0.26	0.22	0.14	0.14	0.68	0.56	0.55	0.58	0.53	0.56

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