2022 Report

An Evaluation of the Cost Effectiveness

of Federally Qualified Health Centers (FQHCs)

Operating in Michigan

Institute for Health Policy
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Our mission is to advance knowledge of health and well-being through policy evaluation, collaborative partnerships, quality improvement initiatives, and research.

1. EXECUTIVE OVERVIEW

Michigan Primary Care Association serves as the voice of 40 community health centers and four Native American health service providers. These providers focus on primary and preventive health care serving patients in rural and urban communities across Michigan. MPCA advocates advancing health policy through/by educating state legislative leaders in Lansing and national leaders in Washington, D.C. They also foster collaboration among health centers includes external partners in providing high-quality, patient-centered primary care services.

Michigan Primary Care Association (MPCA) contracted with the Institute for Health Policy (IHP) to update a 2014 claims-based evaluation of the cost effectiveness of Federally Qualified Health Centers (FQHC) serving Michigan's Medicaid population. This report titled "An Evaluation of the Cost Effectiveness of Federally Qualified Health Centers (FQHCs) and FQHC 'Look Alikes' Operating in Michigan," analyzed Medicaid fee-for-service claims and managed care encounters from the then Michigan Department of Community Health (MDCH) Data Warehouse using Medicaid administrative claims data.

Michigan has continued technological improvements and strengthened data reporting requirements since the original study. , Together these activities support continuous improvements in data collection and quality. This study updates the assessment of Michigan FQHCs cost effectiveness and utilization.

This study uses a propensity score matching method to construct a population of matched non-FQHC beneficiaries that had similar demographic and geographic distributions as the FQHC beneficiaries. Descriptive comparisons of medical costs and utilization between the two groups were conducted.

The main findings for cost comparison include:

- The overall per member per month (PMPM) costs were $327 for FQHC beneficiaries, compared to $378 for non-FQHC beneficiaries. The following elements produce this finding.
    - Hospital inpatient cost: The PMPM costs for FQHC beneficiaries were $141, compared to $204 for non-FQHC beneficiaries. Therefore, the calculated cost for hospital inpatient PMPM for non-FQHC beneficiaries was about 1.5 times the PMPM cost of FQHC beneficiaries.
    - Emergency department cost: The PMPM costs for FQHC beneficiaries were $47, compared to $40 for non-FQHC beneficiaries.
    - Outpatient cost: PMPM costs for FQHC beneficiaries were $55, compared to $87 for non-FQHC beneficiaries. Hence, outpatient PMPM cost for non-FQHC beneficiaries was about 1.5 times the PMPM cost for FQHC beneficiaries.
    - All primary care office/FQHC cost: PMPM costs for FQHC beneficiaries were $84, compared to $50 for non-FQHC beneficiaries. FQHC costs include the enhanced payment received by FQHCs for providing services in Medically Underserved Areas as required by CMS regulations.

The main findings for utilization comparison are the following:

- Hospital inpatient (IP) encounters:

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- o About 26.6% of FQHC beneficiaries had at least one IP encounter, compared to 29.7% for non-FQHC beneficiaries. This indicates the percentage of FQHC beneficiaries had at least one IP encounter is about 10% smaller than non-FQHC beneficiaries.
  - About 17.7% of FQHC beneficiaries had one IP encounter, which is lower than 18.8% in non-FQHC beneficiaries.
  - The percentage of FQHC beneficiaries with two IP encounters is lower than non-FQHC beneficiaries (4.7% vs. 5.46%).
  - About 1.8% of FQHC beneficiaries had three IP encounters, which is lower than 2.15% of non-FQHC beneficiaries.
  - The percentage of beneficiaries with >=4 IP encounters in FQHC beneficiaries is lower than non-FQHC beneficiaries, 2.41% vs. 3.26%.
  - o Among the subgroup of beneficiaries having at least 1 IP stay:
    - FQHC beneficiaries had an average of 1.81 IP encounters per beneficiary while non-FQHC beneficiaries had an average of 1.95 IP encounters per beneficiary, which is an almost 7% fewer.
    - FQHC beneficiaries had a nearly 30% lower average length of stay compared to non-FQHC beneficiaries (9.42 vs. 13.2).
- Emergency department (ED) visits:
  - o About 69.2% of FQHC beneficiaries had at least one ED visit, which is higher than 65.1% in non-FQHC beneficiaries.
    - About 19.5% of FQHC beneficiaries had 1 ED visit, which is lower than 20.5% in non-FQHC beneficiaries.
    - FQHC and matched non-FQHC beneficiaries had almost the same percentage of beneficiaries with 2 ED visits.
    - About 9.2% of FQHC beneficiaries had 3 ED visits, which is slightly higher than the 8.62% of non-FQHC beneficiaries.
    - The percentage of beneficiaries with >=4 ED visits in FQHC beneficiaries is higher than non-FQHC beneficiaries, 27.3% vs. 22.7%.
  - o Among the subgroup of beneficiaries having at least 1 ED visit:
    - The average number of ED visit per beneficiary is 4.41 for FQHC beneficiaries and 3.87 for matched non-FQHC beneficiaries.
    - The probability of an ED visit being primary care sensitive is very similar between FQHC and non-FQHC beneficiaries.
- Outpatient visits:
  - o About 84.4% of FQHC beneficiaries had at least one outpatient visit, compared with 90.7% of non-FQHC beneficiaries.
  - o Among those having at least 1 outpt visit:
    - FQHC beneficiaries had fewer average number of visits per beneficiary (7.48 vs. 10.80) than non-FQHC beneficiaries.
- All primary care office visits/FQHC visits:
  - o FQHC beneficiaries had an average of 16.7 visits per beneficiary, which is higher than the average of 12.2 visits among non-FQHC beneficiaries.

2. BACKGROUND

Federally Qualified Health Centers – are community-based and patient-directed organizations that deliver comprehensive primary care and other integrated healthcare services including oral health, behavioral health, substance use and more. The health centers are required to meet specific Health Resources and Services Administration (HRSA) requirements as well as meet state and federal regulations while maintaining fiscal stability to carry out the health center's mission to the communities they serve.

Health centers overcome geographic, cultural, linguistic, and other barriers to care by emphasizing care management of patients with multiple health care needs, providing supportive services such as health education, translation, and transportation that promote access to health care, and using systematic quality improvement approaches, including leveraging health information technology. Health centers operate under the direction of patient-majority governing boards and are organized as public and private non-profit organizations. All health centers serve diverse medically underserved areas and/or populations.

Most health centers receive Health Center Program federal grant funding to improve the health of underserved and vulnerable populations. Some health centers receive funding to focus on special populations including individuals and families experiencing homelessness, migratory and seasonal agricultural workers, and residents of public housing. Most health center operating funds originate with Medicaid, Medicare, private insurance, and other healthcare reimbursements. Health centers provide services regardless of patients' ability to pay and charge for services on a sliding fee scale. FQHC's by law are required to meet and maintain compliance with a strict set of administrative, clinical, and financial requirements by securely and transparently sharing information about their patients, services, and quality of care.

In late 2021, the Michigan Primary Care Association (MPCA) contracted with the Institute for Health Policy (IHP) to refresh an IHP 2014 evaluation titled; "An Evaluation of the Cost Effectiveness of Federally Qualified Health Centers (FQHCs) and FQHC 'Look Alikes' Operating in Michigan". The study utilized data from the then Michigan Department of Community Health (MDCH) Data Warehouse using Medicaid administrative claims data. Since that report, in 2015 by Executive Order, the State Michigan merged two departments. Currently the Department of Health and Human Services (MDHHS) houses the Health Services Data Warehouse. The MDHHS data warehouse has undergone further improvements to its data collection and claims quality. The 2022 study leverages elements of the 2014 study, further improves the methodology used in the analysis, and incorporates enhanced claims data. The new study can help improve our understanding of the impacts of Michigan FQHCs.

The goal of this refreshed study evaluates the differences in utilization and costs for fully eligible Medicaid beneficiaries served by FQHCs and other non-FQHC providers. This analysis identifies demographic, geographic, or health condition disparities among the beneficiaries served by FQHCs and non-FQHC providers. The study also examines variations in beneficiaries' utilization and costs of hospital inpatient encounters, emergency department visits, outpatient visits, and office visits/FQHC visits.

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3. METHODS

3.1.   Sample

This study identifies Michigan Medicaid beneficiaries' enrollment and claims data files from October 2017 to September 2019. This study period was chosen because FQHCs migrated to institutional billing effectively on 08/01/2017. Beneficiaries were classified into two categories: FQHC beneficiaries and non-FQHC beneficiaries. A FQHC beneficiary must have at least one claim that had the claim type as Federally Qualified Health Center and had the billing provider's NPI as one of the FQHC NPIs provided by MDHHS. A non-FQHC beneficiary must not have a claim that had the claim type as Federally Qualified Health Center or have the billing provider's NPI as one of the FQHC NPIs provided by MDHHS. The two groups are exclusive of each other.

Beneficiaries included in the study meet the following criteria: (1) had full Medicaid coverage; (2) had at least 20 months of full Medicaid enrollment over the two-year study period; (3) 18-64 years old during the study period; (4) had at least two qualifying primary care FQHC visits/ office visits within the study period. The detailed descriptions of inclusion criteria are shown in Appendices A, B and C.

The creation process for the study populations is shown in Figure 1. There were 87,543 unique beneficiaries included as FQHC beneficiaries and 294,047 unique beneficiaries included as non-FQHC beneficiaries in this study.

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Figure 1. Flow Charts of Assembling FQHC and Non-FQHC Study Populations

FQHC population creation process
(N: count of unique beneficiaries)

Non-FQHC population creation process
(N: count of unique beneficiaries)

FQHC population creation process	Non-FQHC population creation process
FQHC Claim N= 413,327	Non-FQHC Claim N= 1,124,666
Full Medicaid N= 376,737	Full Medicaid N= 997,413
Enrolled >=20 Months N= 155,122	Enrolled >=20 Months N= 438,886
Age between 18 and 64 N= 92,083	Age between 18 and 64 N= 436,692
>=2 Qualified Visits N= 87,543	>=2 Qualified Visits N= 294,047
	Propensity Matched (1:1) N= 87,543

3.2.   Measures

The study examines and compares demographic and clinical characteristics, and selected health care utilization and costs. Demographic characteristics and geographic information were obtained from beneficiaries' enrollment data, which include age, race/ethnicity, gender, zip code, and county. Beneficiaries' zip codes are classified to urban/rural areas based on the rural-urban commuting area (RUCA) codes, see Appendix D. Beneficiaries' counties are converted to prosperity regions. The classification of prosperity regions is illustrated as the map in Appendix E.

The pregnancy/maternity indicator is defined as having one or more maternity health diagnosis codes in the study time frame, see Appendix F. To measure the burden of comorbidity, this study calculated Charlson comorbidity score for each included beneficiary based on the diagnosis codes over the study period. The original Charlson comorbidity index (CCI) was first developed in 1987 by Mary Charlson and colleagues as a method of categorizing comorbidities of patients based on the ICD diagnosis codes (Charlson et al, 1987). The CCI is a weighted index, accounting for both the number and severity of conditions, and predicts the risk of mortality. The original CCI consisted of 19 conditions. Each condition was assigned a weight from 1 to 6, see Appendix G. The weights were summed to produce the Charlson comorbidity score for each beneficiary, with scores higher than 0 indicating increasing risk. The CCI was originally developed from chart review data, but later modified for administrative data (Deyo et al,

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1992) and for ICD-10 diagnosis codes (Quan et al, 2005). This study applies the original 19 CCI categories using ICD-10 diagnosis codes on the Medicaid claims data.

This study compares health care utilization and costs using all available claims associated with the following events.

- Hospital inpatient (IP) stays (include those admitted via ED).
- Emergency Department (ED) visits (exclude those admitted to IP).
- Outpatient (OP) visits.
- All primary care FQHC visits, which were identified using the providers' specialty types in Appendix C and all CPT codes.
- All primary care Office visits (professional claims) were identified using the providers' specialty types in Appendix C and all CPT codes.

This study uses a version of the New York University (NYU) ED visit algorithm with ICD-10 codes to classify ED visits (Johnston et al, 2017). The NYU ED algorithm assigns each ED visit a probability of being classified in each of the following 9 groups based on the primary diagnosis code on the claim: (1) Non-Emergent; (2) Emergent, primary care treatable; (3) Emergent, ED care needed, preventable/avoidable; (4) Emergent, ED care needed, not preventable/avoidable; (5) Injury; (6) Mental health related; (7) Alcohol related; (8) Substance abuse related; (9) Unclassified. For each ED visit, the probabilities assigned to the 9 groups sum to 1. Furthermore, this study calculates the probability of an ED visit being primary care sensitive by adding the probabilities for the groups of (1), (2) and (3).

For non-FQHC visits (including IP, ED, OP and non-FQHC office visits), the costs are based on the approval amounts for both the fee-for-service claims and managed care encounters. Since FQHCs are reimbursed for services using an encounter based Prospective Payment System (PPS) in Michigan, the costs for individual claims associated with FQHC visits were adjusted by enhanced payments received for providing services in Medically Underserved Areas per CMS regulations.

This study calculates cost PMPM and cost per utilizing member per month (PUMPM) in different types of utilization. If a beneficiary enrolls in one month of full Medicaid coverage, then this beneficiary contributes one member month (MM). Suppose in a year, there are 3 beneficiaries in the enrollment. Beneficiary A has 10 months full Medicaid coverage. Beneficiaries B and C have 11 months and 12 months, respectively. The total member months for that year equals 33 months calculated by 10+11+12. In this year, only beneficiary A has a hospital IP stay, which incurs a cost of $6,600. Beneficiaries B and C don't have any hospital IP utilization.

The cost PMPM is defined as the cost divided by all members' member months. Based on the previous example, the hospital IP PMPM would calculate $6,600 divided by 33 member months equaling $200.

- Cost per member per month (PMPM) = $\dfrac{\text{Total Approved Amount (Cost)}}{\text{All Members' Member Months}}$

The cost PUMPM is defined as the cost divided by the member months of only the subgroup of members who utilized the service of interest. Based on the previous example, the hospital IP PUMPM would calculate $6,600 divided by 10 member months equaling $660.

- Cost per utilizing member per month (PUMPM) = $\dfrac{\text{Total Approved Amount (Cost)}}{\text{Utilizing Members' Member Months}}$

3.3. Propensity Score Matching

Because the demographic and clinical characteristics of the FQHC beneficiaries may be dissimilar from those of non-FQHC beneficiaries, it is necessary to use a propensity score matching method to balance potential confounders when comparing the health utilization and costs between FQHC and non-FQHC beneficiaries.

Propensity scores were estimated using logistic regression based on the following variables: age, race/ethnicity, gender, urban/rural areas, prosperity areas, pregnancy/maternity indicator, and Charlson comorbidity score. This study then used the "nearest neighbor matching" method to match each FQHC beneficiaries with one non-FQHC beneficiaries (1:1 ratio) drawing from the sample of 294,047 non-FQHC beneficiaries. The propensity score matching procedure produces a group of 87,543 matched non-FQHC beneficiaries (Figure 1). The demographic and clinical characteristics of FQHC beneficiaries are similar with those in the matched non-FQHC beneficiaries.

This study makes descriptive comparison of health care utilization and costs between FQHC beneficiaries and matched non-FQHC beneficiaries.

3.4. Statistical Analyses

This study first creates two pooled samples for the statistical analyses. One pooled sample includes FQHC beneficiaries and all non-FQHC beneficiaries; another pooled sample includes FQHC beneficiaries and matched non-FQHC beneficiaries. The statistical estimations using a sample with all non-FQHC beneficiaries are considered sensitivity analyses for the utilization comparisons. That is, this study shows that the main findings are consistent when conducting the same analyses using both samples. The conclusions of this study are therefore strengthened.

Logistic regression models were used to compare the likelihood of hospital IP and ED service utilization respectively between the FQHC and non-FQHC beneficiaries. The binary outcome (Yes/No) for having a hospital IP or ED visit was adjusted for demographics, urban/rural areas, prosperity regions, pregnancy/maternity indicator, and Charlson comorbidity score in the logistic regression models.

Inpatient length of stay is required to be greater or equal to 1 day. Most beneficiaries' inpatient length of stay is clustered at the low values. Therefore, the mean does not equal the variance, that is, over-dispersion occurs. To address the phenomenon in the inpatient length of stay, this study uses zero truncated negative binomial model for analyzing length of stay.

Intercept term (the point where the function crosses the y-axis) is included in all regression models.

4. RESULTS

4.1. Demographic and Clinical Characteristics

Table 1 presents demographic and clinical characteristics, specifically age, race/ethnicity, gender, urban/rural status, prosperity regions, pregnancy/maternity indicator, Charlson comorbidity score in FQHC, unmatched non-FQHC and matched FQHC beneficiaries. The FQHC beneficiaries and the unmatched non-FQHC beneficiaries have significant differences in all characteristics. After applying the propensity score matching between FQHC and unmatched non-FQHC beneficiaries, a group of matched

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non-FQHC beneficiaries were obtained. The differences are mitigated. All the characteristics between FQHC beneficiaries and matched non-FQHC beneficiaries are closer.

4.2. Descriptive Comparison of Utilization

This study uses the FQHC and matched non-FQHC beneficiaries to make descriptive comparisons of health care utilization in hospital inpatient, emergency department outpatient visit, office visit/FQHC visit (see Table 2).

4.2.1. Hospital Inpatient Encounters

As shown in Table 2, 26.60% of FQHC beneficiaries had at least one IP encounter while 29.70% of matched non-FQHC beneficiaries had at least one IP encounter, which indicates about 10% difference (statistically significant at 0.01 level). About 17.7% of FQHC beneficiaries had one IP encounter, which is lower than 18.8% in matched non-FQHC beneficiaries (statistically significant at 0.01 level). The percentage of FQHC beneficiaries with two IP encounters is lower than matched non-FQHC beneficiaries (4.7% vs. 5.46%, statistically significant at 0.01 level). About 1.8% of FQHC beneficiaries had three IP encounters, which is lower than 2.15% of matched non-FQHC beneficiaries (statistically significant at 0.01 level). The percentage of beneficiaries with >=4 IP encounters in FQHC beneficiaries is lower than matched non-FQHC beneficiaries, 2.41% vs. 3.26% (statistically significant at 0.01 level).

FQHC beneficiaries had an average of 1.81 IP encounters per utilizing beneficiary while matched non-FQHC beneficiaries had an average of 1.95 IP encounters per utilizing beneficiary, which is an almost 7% fewer (statistically significant at 0.01 level). FQHC beneficiaries had a nearly 30% lower average length of stay per utilizing beneficiary compared to matched non-FQHC beneficiaries (9.42 vs. 13.2, statistically significant at 0.01 level). Lastly, FQHC beneficiaries had a nearly 23% lower average length of stay per IP encounter compared to matched non-FQHC beneficiaries (5.21 vs. 6.76, statistically significant at 0.01 level).

4.2.2. Emergency Department Visits

Table 2 shows that 69.20% of FQHC beneficiaries had at least one ED visit, which is higher than 65.1% in matched non-FQHC beneficiaries (statistically significant at 0.01 level). About 19.5% of FQHC beneficiaries had one ED visit, which is lower than 20.5% in matched non-FQHC beneficiaries (statistically significant at 0.01 level). FQHC and matched non-FQHC beneficiaries had almost the same percentage (13.30 and 13.20) of beneficiaries with two ED visits. About 9.2% of FQHC beneficiaries had three ED visits, which is slightly higher than the 8.62% of matched non-FQHC beneficiaries (statistically significant 0.01 level). The percentage of beneficiaries with >=4 ED visits in FQHC beneficiaries is higher than matched non-FQHC beneficiaries, 27.3% vs. 22.7% (statistically significant 0.01 level).

The average number of ED visit per utilizing beneficiary is 4.41 for FQHC beneficiaries and 3.87 for matched non-FQHC beneficiaries. The difference is statistically significant at 0.01 level.

This study classified ED visits using the NYU algorithm, which permitted the calculation of the probability of an ED visit being primary care sensitive. The results are shown in Table 3. The differences between FQHC and matched non-FQHC beneficiaries are very small.

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4.2.3. Outpatient Visits

Among FQHC beneficiaries, 84.40% had at least one outpatient visit, compared with 90.7% of matched non-FQHC beneficiaries (see Table 2, statistically significant at 0.01 level). FQHC beneficiaries had fewer average number of visits per utilizing beneficiary (7.48 vs. 10.80, statistically significant at 0.01 level) than matched non-FQHC beneficiaries.

4.2.4. All Primary Care Office Visits/FQHC Visits

FQHC beneficiaries had an average of 16.70 visits per utilizing beneficiary, which is higher than the average of 12.20 visits among utilizing matched non-FQHC beneficiaries (see Table 2, statistically significant at 0.01 level).

4.3.   Descriptive Comparisons of Medical Costs

This study uses the FQHC and matched non-FQHC beneficiaries to make descriptive comparisons of costs in hospital inpatient encounters, emergency department visits, outpatient visits, and all primary care office visits/FQHC visits, see Table 4.

The cost calculations for hospital inpatient encounters, ED visits, outpatient visits, and FQHC visits are based on both institutional and professional claims in the visits. Office visits are based on professional claims. Here all primary care FQHC and office visits include those that have primary care provider's specialty types in Appendix C and all CPT codes.

This study calculates cost per member per month and cost per utilizing member per month in different utilization settings. The main findings are the following:

- Hospital inpatient PMPM cost for matched non-FQHC beneficiaries ($204) was about 1.5 times the PMPM cost of FQHC beneficiaries. Hospital inpatient PUMPM cost for matched non-FQHC beneficiaries was about 1.3 times the PUMPM cost of FQHC beneficiaries.
- Emergency department PMPM cost and PUMPM cost for FQHC beneficiaries was about 1.2 ($47) and 1.1 ($68) times the PMPM cost and PUMPM cost of matched non-FQHC beneficiaries, respectively.
- Outpatient visits PMPM cost and PUMPM cost for matched non-FQHC beneficiaries was about 1.5 ($84) and 1.4 ($92) times the PMPM cost and PUMPM cost for FQHC beneficiaries, respectively.
- All primary care office visit/FQHC visit PMPM and PUMPM costs were $84 for FQHC beneficiaries compared to $50 for matched non-FQHC beneficiaries. The costs for FQHC visit include the wrap around adjustment.

The overall PMPM costs were $327 for FQHC beneficiaries compared to $378 for non-FQHC beneficiaries. The lower PMPM costs of FQHC beneficiaries are mainly due to reduced utilization of the highly expensive hospital inpatient services.

4.4. Statistical Analysis of Hospital Inpatient and Emergency Department Utilization

This study conducted statistical analyses using two pooled populations. One pooled population includes FQHC beneficiaries and *all* non-FQHC beneficiaries, another pooled population includes FQHC beneficiaries and *matched* non-FQHC beneficiaries.

4.4.1. Logistic Model Estimation for Hospital Inpatient Admissions

A logistic model was used to estimate the likelihood of having at least one hospital inpatient visit among matched FQHC and non-FQHC beneficiaries after controlling for age, gender, race/ethnicity, urban/rural status, geographic region, pregnancy status, and Charlson comorbidity score.

Results from Table 5 demonstrate that there are statistically significant findings in the two pooled samples namely, FQHC Beneficiaries with All Unmatched Non-FQHC Beneficiaries and FQHC Beneficiaries and matched Non-FQHC Beneficiaries:

- Non-FQHC beneficiaries are about 1.25 times more likely than their matched FQHC counterparts to have a hospital inpatient admission. This finding is consistent with those in the descriptive comparison.
- Of note, compared with male beneficiaries, females have a lower probability of having a hospital inpatient stay.
- Beneficiaries in large urban clusters are more likely to have an inpatient visit compared with beneficiaries living in rural areas.
- Compared with beneficiaries in prosperity region "R10", beneficiaries in "R6" have a higher and "R8" have a smaller probability to have an inpatient admission.

4.4.2. Zero Truncated Negative Binomial Model Estimation for Inpatient Length of Stay

A hospital IP length of stay is required to be greater or equal to 1 day, therefore a zero truncated negative binomial model was used to analyze the difference in the length of stay between FQHC and non-FQHC beneficiaries after adjusting for the age, gender, race/ethnicity, urban/rural status, geographic region, pregnancy status, and Charlson comorbidity score.

The results in Table 6 indicate the following statistically significant and notable findings in/between? the two pooled samples:

- The log count of inpatient days for a non-FQHC beneficiary is about 0.4 more than that of a FQHC beneficiary. This finding from the Zero Truncated Negative Binomial Model is consistent with the one in the descriptive comparison.
- Younger beneficiaries had more inpatient days for both FQHC and non-FQHC beneficiaries. This effect is very small. This may be because this study included inpatient stays admitted in hospitals while other studies included stays in nursing home, hospice, and inpatient psychiatry facility, where older patients have more inpatient days. Another potential cause may be related to the Healthy Michigan population as they gain eligibility for healthcare insurance. This population was not included in the previous FQHC cost-effectiveness evaluation study.

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- Compared with male beneficiaries, females experience shorter inpatient length of stays.
- Compared with Non-Hispanic Whites, the Black and Hispanic groups experience fewer IP days.
- Beneficiaries in large urban clusters have more IP days than beneficiaries living in rural areas.
- Compared with beneficiaries in prosperity region "R10", beneficiaries in "R1", "R2", "R3", "R4", "R5" and "R8" experience fewer and in "R7" experience more IP days.

4.4.3. Logistic Model Estimation for Emergency Department Visits

Table 7 presents logistic regression results for the likelihood of at least one ED visit among FQHC and non-FQHC beneficiaries after controlling their age, gender, race/ethnicity, urban/rural status, geographic region, pregnancy status, and Charlson comorbidity score.

The following findings are statistically significant and notable in/between? the two pooled samples

- FQHC beneficiaries have a higher likelihood of utilizing ED than non-FQHC beneficiaries. This finding confirms the finding in the descriptive comparison.
- Older beneficiaries are less likely to have an ED visit for both FQHC and non-FQHC beneficiaries. This study classifies those ED utilizations that subsequently transferred to hospital inpatient as inpatient visits. Consequently, older beneficiaries who were admitted to hospital inpatient directly from the ED will not be counted in the ED visits.
- Compared with male beneficiaries, females have a higher probability of going to an ED.
- Compared with Non-Hispanic Whites, the race/ethnicity group Non-Hispanic Blacks have a higher likelihood of ED utilization, the Hispanic group has a smaller probability of using emergency department services.
- Beneficiaries in urbanized areas are less likely to have an emergency department visit compared with beneficiaries living in rural areas. This may be because (i) beneficiaries living in urbanized areas may have more health care resources, that can better help manage their health conditions; (ii) Beneficiaries in urbanized areas may have more ED alternatives, like urgent care settings while beneficiaries in rural areas may have access to ED as the only form of urgent care services.
- Compared with beneficiaries in prosperity region "R10", beneficiaries in "R1", "R2", "R3", "R6" and "R7" have a smaller probability of using ED services, while beneficiaries in "R4", "R5" and "R8" have a larger odds of ED utilization.

5. CONCLUSIONS

This study compares health care utilization and costs between beneficiaries who have used FQHC and beneficiaries who have never used FQHC.

This study uses matched non-FQHC beneficiaries to make descriptive comparisons in health care utilization and costs between FQHC and non-FQHC beneficiaries. The results demonstrate that FQHC beneficiaries have lower utilization in hospital inpatient services than non-FQHC beneficiaries, the finding is confirmed by the later statistical analysis adjusting the utilization by demographic, geographic and clinical factors. This study also shows that FQHC beneficiaries have higher utilization in emergency

department visits than non-FQHC beneficiaries. This is true in both the descriptive comparison and statistical analysis. In addition, the results show that FQHC beneficiaries have lower utilization in outpatient visits and higher utilization in primary care office/FQHC visits than non-FQHC beneficiaries.

This study also finds that FQHC beneficiaries had lower PMPM and PUMPM costs of hospital inpatient and outpatient than non-FQHC beneficiaries. FQHC beneficiaries' PMPM and PUMPM costs of emergency department visit and all primary care office visit/FQHC visit were higher than non-FQHC beneficiaries. The costs of FQHC visit were adjusted by the wrap around PPS payments. The adjustment increases the amount that Medicaid pays for these visits. The overall PMPM costs were lower for FQHC beneficiaries compared to non-FQHC beneficiaries. This is mainly due to reduced utilization of the highly expensive hospital inpatient services.

Table 1: Characteristics of FQHC and Non-FQHC Beneficiaries

Characteristics		FQHC Beneficiaries N=87,543		Unmatched Non-FQHC Beneficiaries N=294,047		Matched Non-FQHC Beneficiaries N=87,543	
		Percent (%)	Case Count (n)	Percent (%)	Case Count (n)	Percent (%)	Case Count (n)
Age	18-24	14.4	12,597	11.5**	33,700	12.9**	11,258
	25-34	22.9	20,029	23.3**	68,584	23.5**	20,569
	35-44	20.3	17,788	22.0**	64,746	20.4	17,851
	45-54	20.5	17,968	21.5**	63,138	20.7	18,128
	55-64	21.9	19,161	21.7	63,879	22.5**	19,737
Race/ Ethnicity	Non-Hispanic White	57.2	50,047	66.7**	196,074	59.8**	52,317
	Non-Hispanic Black	36.2	31,728	22.8**	67,136	33.0**	28,910
	Hispanic	0.2	136	0.7**	1,986	0.2	134
	Unknown/Others	6.4	5,632	9.8**	28,851	7.1**	6,182
Gender	Female	66.2	57,925	64.8**	190,442	65.9	57,677
	Male	33.8	29,618	35.2**	103,605	34.1	29,866
Urban/ Rural	Urbanized Area	79.1	69,258	84.7**	248,964	77.9**	68,182
	Large Urban Clusters	8.0	7,032	7.9	23,152	8.6**	7,487
	Small Urban Clusters	6.0	5,269	3.6**	10,663	6.3*	5,526
	Rural	6.8	5,982	3.8**	11,264	7.2**	6,345
	Unknown	0.0	2	0.0	4	0.0	3
Prosperity Region	R1	1.9	1,695	2.8**	8,091	2.0	1,755
	R2	4.1	3,566	2.2**	6,605	4.9**	4,314
	R3	6.3	5,489	1.5**	4,333	4.9**	4,327
	R4	16.7	14,588	7.9**	23,275	17.7**	15,463
	R5	11.1	9,740	5.3**	15,651	10.2**	8,935
	R6	9.4	8,213	12.7**	37,208	11.2**	9,768
	R7	4.4	3,884	4.2**	12,448	5.0**	4,388
	R8	17.3	15,126	4.3**	12,605	12.6**	11,004
	R9	5.3	4,681	5.8**	17,078	6.5**	5,726
	R10	23.5	20,542	53.3**	156,700	25.0**	21,846
	Unknown	0.0	19	0.0	53	0.0	17
Pregnancy/maternity indicator		11.7	10,274	9.3**	27,308	11.3**	9,885
Charlson Comorbidity Score Median (25th percentile, 75th percentile)		1 (0, 2)		0 (0, 1) **		1 (0, 2) **	

**denotes statistically significant at 0.01 level; *denotes statistically significant at 0.05 level; ◊ denotes statistically significant at 0.10 level; otherwise not statistically significant.

Table 2: Comparison of Utilization between FQHC and Matched Non-FQHC Beneficiaries

Utilizations During 2-year Study Period		FQHC Beneficiaries N=87,543	Matched Non-FQHC Beneficiaries N=87,543
Hospital Inpatient Encounters	% of beneficiaries with at least one encounter	26.60	29.7**
	% of beneficiaries with 1 encounter	17.70	18.8**
	% of beneficiaries with 2 encounters	4.71	5.46**
	% of beneficiaries with 3 encounters	1.80	2.15**
	% of beneficiaries with ≥4 encounters	2.41	3.26**
	Average number of encounters per utilizing beneficiary	1.81	1.95**
	Average length of stay per utilizing beneficiary	9.42	13.2**
	Average length of stay per encounter	5.21	6.76**
Emergency Department Visits	% of beneficiaries with at least one visit	69.20	65.1**
	% of beneficiaries with 1 visit	19.40	20.5**
	% of beneficiaries with 2 visits	13.30	13.20
	% of beneficiaries with 3 visits	9.16	8.62**
	% of beneficiaries with ≥4 visits	27.30	22.7**
	Average number of visits per utilizing beneficiary	4.41	3.87**
Outpatient Visits	% of beneficiaries with at least one visit	84.40	90.7**
	Average number of visits per utilizing beneficiary	7.48	10.8**
All Primary Care Office Visits/ FQHC visits	% of beneficiaries with at least one visit (inclusion criteria)	100.00	100.00
	Average number of visits per utilizing beneficiary	16.70	12.2**

** denotes statistically significant at 0.01 level; * denotes statistically significant at 0.05 level; ◊ denotes statistically significant at 0.10 level; otherwise not statistically significant.

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Table 3: Classification of Emergency Department Visits by New York University Algorithm among FQHC and Matched Non-FQHC Beneficiaries

Classification of Emergency Department Visits by New York University Algorithm	FQHC Beneficiaries N=87,543 Percent (%)	Matched Non-FQHC Beneficiaries N=87,543 Percent (%)
Non-Emergent	20.60	20.30
Emergent, Primary care treatable	23.40	23.90
Emergent, ED care needed, preventable/avoidable	6.50	6.58
Emergent, ED care needed, not preventable/avoidable	14.60	16.00
Injury	13.40	13.20
Mental health related	3.84	2.89
Alcohol related	2.39	1.30
Substance abuse related	0.51	0.30
Unclassified	14.80	15.50
Primary Care Sensitive (Non-Emergent + Emergent Primary care treatable + Emergent ED care needed preventable/avoidable)	50.50	50.78

Table 4: Comparisons of Medical Costs between FQHC and Matched Non-FQHC Beneficiaries

	FQHC Beneficiaries N=87,543		Matched Non-FQHC Beneficiaries N=87,543	
	PMPM Cost	PUMPM Cost	PMPM Cost	PUMPM Cost
Hospital Inpatient Encounters	$141	$532	$204	$686
Emergency Department Visits	$47	$68	$40	$62
Outpatient Visits	$55	$65	$84	$92
All Primary Care Office Visits/ FQHC visits	$84	$84	$50	$50
Sum	$327	-	$378	-

Table 5: Logistic Regression of Hospital Inpatient Visit

Coefficient		Pooled Sample of FQHC Beneficiaries and All Unmatched Non-FQHC Beneficiaries (N=381,590)					Pooled Sample of FQHC Beneficiaries and Matched Non-FQHC Beneficiaries (N=175,086)				
		Estimate	Odds Ratio	P-Value	95% Confidence Limits		Estimate	Odds Ratio	P-Value	95% Confidence Limits	
FQHC (reference=Yes)		0.23	1.26	<.0001**	1.228	1.283	0.21	1.24	<.0001**	1.208	1.267
Age		0.01	1.01	<.0001**	1.008	1.010	0.01	1.01	<.0001**	1.008	1.010
Gender (ref=Male)		-0.14	0.87	<.0001**	0.856	0.888	-0.14	0.87	<.0001**	0.844	0.890
Race/Ethnicity (ref=White)	Black	0.07	1.07	<.0001**	1.048	1.092	-0.09	0.92	<.0001**	0.890	0.945
	Hispanic	-0.14	0.87	0.0198*	0.775	0.978	0.03	1.03	0.8677	0.754	1.399
	Others	-0.16	0.85	<.0001**	0.827	0.880	-0.16	0.85	<.0001**	0.807	0.893
Urban/Rural Areas (ref=Rural)	Urbanized Area	0.02	1.03	0.2940	0.979	1.074	0.07	1.07	0.0264*	1.008	1.132
	Large Urban Clusters	0.05	1.05	0.0596◊	0.998	1.106	0.06	1.06	0.0803◊	0.993	1.130
	Small Urban Clusters	0.01	1.01	0.6499	0.957	1.073	0.03	1.03	0.3466	0.965	1.106
Prosperity Region (ref=R10)	R1	0.05	1.05	0.1270	0.986	1.120	-0.08	0.92	0.1116	0.831	1.019
	R2	-0.04	0.97	0.2587	0.906	1.027	-0.10	0.91	0.0122**	0.840	0.979
	R3	-0.01	0.99	0.7982	0.929	1.058	-0.10	0.91	0.0085**	0.841	0.975
	R4	0.01	1.01	0.6877	0.975	1.038	-0.08	0.92	0.0001**	0.886	0.961
	R5	0.08	1.08	<.0001**	1.044	1.122	0.03	1.03	0.2764	0.980	1.073
	R6	0.11	1.11	<.0001**	1.084	1.145	0.08	1.09	0.0002**	1.041	1.137
	R7	-0.01	0.99	0.4922	0.944	1.028	-0.08	0.92	0.0096**	0.868	0.981
	R8	-0.08	0.93	<.0001**	0.894	0.962	-0.15	0.86	<.0001**	0.822	0.895
	R9	0.03	1.03	0.1096	0.993	1.072	-0.03	0.97	0.2342	0.912	1.023
Pregnancy/Maternity (ref=No)		2.87	17.68	<.0001**	17.195	18.172	2.84	17.18	<.0001**	16.531	17.864
Charlson Comorbidity Score		0.45	1.57	<.0001**	1.561	1.579	0.41	1.51	<.0001**	1.501	1.522

** denotes statistically significant at 0.01 level; * denotes statistically significant at 0.05 level; ◊ denotes statistically significant at 0.10 level; otherwise not statistically significant.

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Table 6: Zero Truncated Negative Binomial Regression of Inpatient Length of Stay

Coefficient		Pooled Sample of FQHC Beneficiaries and All Unmatched Non-FQHC Beneficiaries (N=381,590)					Pooled Sample of FQHC Beneficiaries and Matched Non-FQHC Beneficiaries (N=175,086)				
		Estimate	Standard Error	P-Value	95% Confidence Limits		Estimate	Standard Error	P-Value	95% Confidence Limits	
FQHC (reference=Yes)		0.400	0.014	<.0001**	0.373	0.428	0.376	0.015	<.0001**	0.347	0.404
Age		-0.009	0.001	<.0001**	-0.010	-0.008	-0.011	0.001	<.0001**	-0.012	-0.010
Gender (ref=Male)		-0.225	0.013	<.0001**	-0.251	-0.200	-0.245	0.017	<.0001**	-0.278	-0.211
Race/Ethnicity (ref=White)	Black	-0.039	0.013	0.0034**	-0.065	-0.013	-0.030	0.018	0.083$^{\lozenge}$	-0.065	0.004
	Hispanic	-0.354	0.078	<.0001**	-0.508	-0.201	-0.455	0.185	0.0139*	-0.817	-0.092
	Others	-0.060	0.021	0.0046**	-0.102	-0.019	-0.072	0.032	0.0234*	-0.135	-0.010
Urban/Rural Areas (ref=Rural)	Urbanized Area	0.002	0.031	0.9516	-0.059	0.063	0.026	0.035	0.4629	-0.043	0.096
	Large Urban Clusters	0.198	0.035	<.0001**	0.130	0.266	0.247	0.040	<.0001**	0.168	0.326
	Small Urban Clusters	0.014	0.038	0.7171	-0.061	0.089	-0.055	0.043	0.1952	-0.139	0.028
Prosperity Region (ref=R10)	R1	-0.585	0.042	<.0001**	-0.668	-0.502	-0.481	0.063	<.0001**	-0.605	-0.357
	R2	-0.238	0.042	<.0001**	-0.321	-0.155	-0.250	0.047	<.0001**	-0.342	-0.157
	R3	-0.320	0.044	<.0001**	-0.406	-0.235	-0.252	0.046	<.0001**	-0.342	-0.162
	R4	-0.222	0.021	<.0001**	-0.262	-0.182	-0.207	0.024	<.0001**	-0.254	-0.159
	R5	-0.025	0.024	0.2948	-0.072	0.022	-0.070	0.027	0.0091**	-0.123	-0.018
	R6	0.002	0.018	0.9221	-0.034	0.037	0.028	0.026	0.2752	-0.023	0.079
	R7	0.339	0.029	<.0001**	0.282	0.396	0.108	0.037	0.0036**	0.035	0.181
	R8	-0.148	0.024	<.0001**	-0.195	-0.101	-0.129	0.026	<.0001**	-0.180	-0.079
	R9	-0.099	0.026	0.0001**	-0.150	-0.049	0.004	0.035	0.9152	-0.065	0.072
Pregnancy/Maternity (ref=No)		-0.460	0.016	<.0001**	-0.492	-0.429	-0.521	0.021	<.0001**	-0.563	-0.480
Charlson Comorbidity Score		0.240	0.003	<.0001**	0.234	0.246	0.227	0.004	<.0001**	0.220	0.234

** denotes statistically significant at 0.01 level; * denotes statistically significant at 0.05 level; ◊ denotes statistically significant at 0.10 level; otherwise not statistically significant.

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Table 7: Logistic Regression of Emergency Department Visit

Coefficient		Pooled Sample of FQHC Beneficiaries and All Unmatched Non-FQHC Beneficiaries (N=381,590)					Pooled Sample of FQHC Beneficiaries and Matched Non-FQHC Beneficiaries (N=175,086)				
		Estimate	Odds Ratio	P-Value	95% Confidence Limits		Estimate	Odds Ratio	P-Value	95% Confidence Limits	
FQHC (reference=Yes)		-0.15	0.86	<.0001**	0.841	0.873	-0.16	0.85	<.0001**	0.834	0.869
Age		-0.02	0.98	<.0001**	0.978	0.980	-0.02	0.98	<.0001**	0.978	0.980
Gender (ref=Male)		0.20	1.22	<.0001**	1.205	1.240	0.25	1.28	<.0001**	1.252	1.309
Race/Ethnicity (ref=White)	Black	0.57	1.77	<.0001**	1.734	1.797	0.46	1.59	<.0001**	1.550	1.633
	Hispanic	-0.13	0.88	0.004**	0.804	0.959	-0.33	0.72	0.0089**	0.559	0.920
	Others	-0.22	0.81	<.0001**	0.786	0.824	-0.31	0.74	<.0001**	0.706	0.765
Urban/Rural Areas (ref=Rural)	Urbanized Area	-0.27	0.77	<.0001**	0.736	0.794	-0.14	0.87	<.0001**	0.830	0.915
	Large Urban Clusters	-0.01	0.99	0.7389	0.952	1.035	0.05	1.05	0.0795◊	0.994	1.107
	Small Urban Clusters	0.03	1.03	0.1536	0.987	1.083	0.06	1.06	0.0481**	1.000	1.119
Prosperity Region (ref=R10)	R1	-0.12	0.89	<.0001**	0.847	0.938	-0.11	0.90	0.011*	0.823	0.975
	R2	-0.21	0.81	<.0001**	0.775	0.856	-0.13	0.88	<.0001**	0.822	0.935
	R3	-0.31	0.73	<.0001**	0.694	0.770	-0.25	0.78	<.0001**	0.730	0.825
	R4	0.25	1.29	<.0001**	1.257	1.324	0.24	1.28	<.0001**	1.232	1.324
	R5	0.12	1.13	<.0001**	1.098	1.166	0.13	1.14	<.0001**	1.095	1.187
	R6	-0.13	0.88	<.0001**	0.856	0.895	-0.12	0.89	<.0001**	0.853	0.922
	R7	-0.07	0.93	<.0001**	0.900	0.964	-0.10	0.90	<.0001**	0.857	0.950
	R8	0.12	1.13	<.0001**	1.097	1.164	0.12	1.13	<.0001**	1.087	1.170
	R9	0.04	1.05	0.0053**	1.013	1.078	0.02	1.02	0.4564	0.970	1.069
Pregnancy/Maternity (ref=No)		0.84	2.31	<.0001**	2.243	2.376	0.79	2.20	<.0001**	2.114	2.298
Charlson Comorbidity Score		0.24	1.27	<.0001**	1.259	1.273	0.23	1.25	<.0001**	1.244	1.262

** denotes statistically significant at 0.01 level; * denotes statistically significant at 0.05 level; ◊ denotes statistically significant at 0.10 level; otherwise not statistically significant.

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7. APPENDIX A. Inclusion Criteria for FQHC and Non-FQHC Population

This study applied the following inclusion criteria for the FQHC population:

1. Beneficiary must have at least one FQHC claim between 10/2017 and 09/2019. FQHC claims are identified by (i) claim type as Federally Qualified Health Center AND (ii) billing provider NPI as one of the FQHC NPIs provided by Michigan Department of Health and Human Services.
2. Beneficiary must have full Medicaid coverage in the study time frame.
3. Beneficiary must have at least 20 months full Medicaid enrollment between 10/2017 and 09/2019.
4. Beneficiary's age must be between 18 and 64 years old. Age is calculated at the end month of FY2019.
5. Beneficiary must have at least 2 qualified primary care visits in FQHC/non-FQHC office throughout the study time frame. Definition of qualified primary care visit is described in Appendix B.

This study applied the following inclusion criteria for the non-FQHC population:

1. Beneficiary must not have a claim that had (i) claim type as Federally Qualified Health Center OR (ii) billing provider NPI as one of the FQHC NPIs provided by Michigan Department of Health and Human Services.
2. Beneficiary must have full Medicaid coverage in the study time frame.
3. Beneficiary must have at least 20 months full Medicaid enrollment between 10/2017 and 09/2019.
4. Beneficiary's age must be between 18 and 64 years old. Age is calculated at the end month of FY2019.
5. Beneficiary must have at least 2 qualified primary care visits in non-FQHC office throughout the study time frame. Definition of qualified primary care visit is described in Appendix B.

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8. APPENDIX B. Qualified Primary Care Visit

Qualified primary care visit in FQHC or other non-FQHC office is defined using both provider's specialty type and visit type.

This study identifies the "specialty_subspecialty" groups in Appendix C for rendering provider, or billing provider when rendering provider is missing in Medicaid claims

Visit types include evaluation and management, consultation, preventive care, and immunizations, which are defined using the following CPT codes

- Office Visit (New patient): 99201 through 99205
- Office Visit (Established patient): 99211 through 99215
- Consultations: 99241 through 99245
- Preventative (Initial): 99381 through 99387
- Preventative (Periodical): 99391 through 99397
- Telephone E&M visit: 99441 through 99443
- Preventative Consultations: 99401 through 99429
- Immunization and Vaccination: 90281 through 90756
- Online E&M visit/E-visit: 99421 through 99423

In compliance with MDHHS Medicaid Policy Bulletin MSA 17-10, FQHCs migrated to institutional billing for dates of service on or after August 1, 2017. The following G codes were required to accompany the CPT codes of all rendered services when submitting claims.

- G0466: FQHC visit, new patient
- G0467, FQHC visit, established patient
- G0468, FQHC visit, Initial Preventative Physical Exam (IPPE) or Annual Wellness Visit (AWV)

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9. APPENDIX C. Specialty types

The primary care provider type is identified using the following "specialty_subspecialty" groups for rendering provider, or billing provider when rendering provider is missing in Medicaid claims

- "Family Medicine / Adolescent Medicine"
- "Family Medicine / Geriatric Medicine"
- "Family Medicine / No Subspecialty"
- "Family Medicine / Primary Specialty"
- "Family Medicine / Sports Medicine"
- "Internal Medicine / Adolescent Medicine"
- "Internal Medicine / Geriatric Medicine"
- "Internal Medicine / No Subspecialty"
- "Internal Medicine / Primary Specialty"
- "General Practice / No Subspecialty"
- "General Practice / Primary Specialty"
- "Preventive Medicine / No Subspecialty"
- "Preventive Medicine / Preventive-Medicine"
- "Preventive Medicine / Primary Specialty"
- "Preventive Medicine / Public Health & General"
- "Pediatrics / Adolescent Medicine"
- "Pediatrics / No Subspecialty"
- "Pediatrics / Primary Specialty"
- "Physician Assistants / No Subspecialty"
- "Physician Assistants / Primary Specialty"
- "Nurse Practitioners / Adult"
- "Nurse Practitioners / Advanced Diabetes Management"
- "Nurse Practitioners / Family"
- "Nurse Practitioners / Medical/Surgical"
- "Nurse Practitioners / No Subspecialty"
- "Nurse Practitioners / Pediatric"
- "Nurse Practitioners / Public/Community Health"
- "Clinical Nurse Specialist / No Subspecialty"
- "Clinical Nurse Specialist / Primary Specialty"
- "Private Duty Nursing - LPN / No Subspecialty"
- "Private Duty Nursing - LPN / Primary Specialty"
- "Private Duty Nursing - RN / No Subspecialty"
- "Private Duty Nursing - RN / Primary Specialty"
- "Child and Adolescent Health Center & Programs (CAHCP) / No Subspecialty"
- "Children's Waiver / No Subspecialty"
- "Childrens Multidisciplinary Services (CMDS) / No Subspecialty"
- "Federally Qualified Health Center (FQHC) / No Subspecialty"
- "Federally Qualified Health Center (FQHC) / School Based"
- "Independent / No Subspecialty"
- "Local Health Department / No Subspecialty"
- "MIChoice Waiver / No Subspecialty"
- "Maternal and Infant Health Program / HMHB Pilot"
- "Maternal and Infant Health Program / MIHP General Services"
- "Maternal and Infant Health Program / No Subspecialty"
- "Medical / No Subspecialty"
- "Rural Health Clinic (RHC) / No Subspecialty"
- "Rural Health Clinic (RHC) / Provider Base"
- "Tribal Health Center (THC) / FQHC"
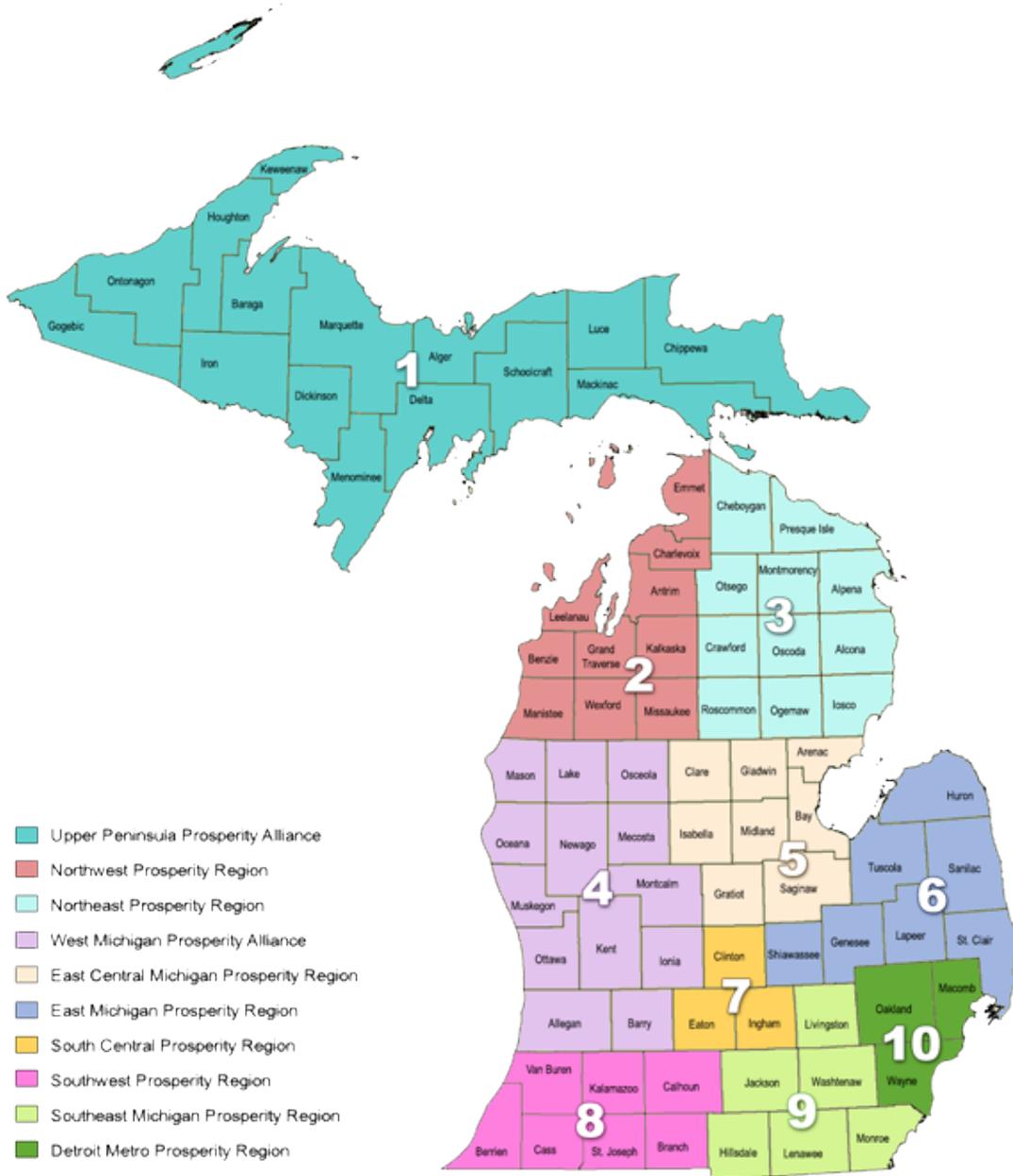- "Tribal Health Center (THC) / No Subspecialty"

10. APPENDIX D. Rural-Urban Commuting Area Codes

The rural-urban commuting area (RUCA) codes classify U.S. census tracts using measures of population density, urbanization, and daily commuting. The zip code level of RUCA codes data file is obtained from the Economic Research Service, U.S. Department of Agriculture (https://www.ers.usda.gov/data-products/rural-urban-commuting-area-codes.aspx).

Code	Classification description
1	Metropolitan area core: primary flow within an urbanized area (UA)
2	Metropolitan area high commuting: primary flow 30% or more to a UA
3	Metropolitan area low commuting: primary flow 10% to 30% to a UA
4	Micropolitan area core: primary flow within an urban cluster of 10,000 to 49,999 (large UC)
5	Micropolitan high commuting: primary flow 30% or more to a large UC
6	Micropolitan low commuting: primary flow 10% to 30% to a large UC
7	Small town core: primary flow within an urban cluster of 2,500 to 9,999 (small UC)
8	Small town high commuting: primary flow 30% or more to a small UC
9	Small town low commuting: primary flow 10% to 30% to a small UC
10	Rural areas: primary flow to a tract outside a UA or UC
99	Not coded: Census tract has zero population and no rural-urban identifier information

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11. APPENDIX E. Map of Prosperity Regions

Legend:
- Upper Peninsula Prosperity Alliance
- Northwest Prosperity Region
- Northeast Prosperity Region
- West Michigan Prosperity Alliance
- East Central Michigan Prosperity Region
- East Michigan Prosperity Region
- South Central Prosperity Region
- Southwest Prosperity Region
- Southeast Michigan Prosperity Region
- Detroit Metro Prosperity Region

12. APPENDIX F. Maternity Health Diagnosis Coding

Defining the pregnancy and maternity indicator by having one of the following ICD-10 diagnosis codes

- Gestational age: Z3A
- Prenatal care for normal pregnancy: Z34
- Conditions related to complicating or conditions complicated by pregnancy: O00-O9A

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13. APPENDIX G. Assigned Weights for Charlson Comorbidity Conditions

Conditions	Assigned weights for each condition
Myocardial infarction	1
Congestive heart failure	1
Peripheral vascular disease	1
Cerebrovascular disease	1
Dementia	1
Chronic pulmonary disease	1
Connective tissue disease	1
Peptic ulcer disease	1
Mild liver disease	1
Diabetes without chronic complications	1
Hemiplegia or paraplegia	2
Moderate or severe renal disease	2
Diabetes with chronic complications	2
Any tumor without metastasis	2
Leukemia	2
Lymphoma	2
Moderate or severe liver disease	3
Metastatic solid tumor	6
AIDS/HIV	6

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