

Ohio community pathway HUB: The cost benefit of supporting minority mothers

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Abstract: Ohio has a persistent infant mortality problem. A Pathway Community HUB model of care is used across the state of Ohio to provide supports to at-risk minority women during their pregnancies and after the birth of their children. To measure the success of the Pathways HUB Community Action, a cost-benefit analysis assesses the benefits resulting from the investment in the program. Using provider data and national, state, and county-level birth statistics, a cost-benefit analysis was conducted. Results indicate that the cost benefit of these services is a safe investment at a 4.4 return on cost saving. Public funding for infant mortality prevention reaps not only improved birth outcomes but financial rewards far exceeding the costs of investment, justifying further investment. A full breakdown of the results is presented, and the implications for the level of cost saving is provided.

Keywords: *Birth outcomes, Cost benefit analysis, Infant mortality, Minority health, Return on investment.*

1. Introduction

Ohio has a persistent infant mortality problem. A recent report by the CDC identified Ohio as having the second highest rate of infant mortality in the United States amongst non-Hispanic Black women (Centers for Disease Control and Prevention (CDC), 2018). Many of the identified causes of infant mortality, such as lack of access to prenatal care and postnatal care, poor health of expectant mothers, the effect of substance abuse, low birth weight, and premature births, are difficult to impact in the short term (Nash, Fabius, Skoufalos, Clarke, & Horowitz, 2017; Rose, 2018). Currently, much of the focused efforts regarding infant mortality target the pre-natal to birth health of the mother and child, even though the most recent data suggests that upwards of 45% of these infants in Ohio are perishing after they are one month old (Centers for Disease Control and Prevention (CDC), 2018). The Summit County Health District reported 44 infant deaths in 2017 and 42 in 2018. Additionally, the Summit County Health District reported 44 fetal deaths (Summit County Public Health (SCPH), 2019).

The state of Ohio is ranked 6th in infant mortality rates, with one of the highest in the United States (Centers for Disease Control and Prevention (CDC), 2021). While some reports suggest that the rate of infant mortality in Ohio is trending downward, a recent report indicated that the number of infant deaths rose in 2016, relative to 2015 (Ohio Department of Health, 2018). And while the rate of infant mortality declined slightly for Caucasian infants, the report indicates that the rate continues to rise substantially for minorities. The most recent report by the CDC identified Ohio as currently having the second highest rate of infant mortality in the United States amongst non-Hispanic black women (Centers for Disease Control and Prevention (CDC), 2018). The trends for infant mortality in Summit County were relatively unchanged from 2014-2018 (Summit County Public Health (SCPH), 2019); however, the trends for non-Hispanic Black women continue too upward.

The rate of infant mortality for non-Hispanic Black infants has increased from 11.01/1000 in 2014 to 13.43/1000 in 2018. While the 2018 rate is an improvement relative to 2016 and 2017, the 2018 rate of infant mortality among non-Hispanic Black women in Summit County is on par with the average for the state of Ohio during that same period of time (Ohio Department of Health, 2018).

1.1. Causal Factors

Healthy People 2020 documents the impact of social determinates of health. The extant research has indicated that how much income someone has and where they live have a profound impact on their health outcomes, including birth outcomes (HP2020, 2018). The subsequent health inequities are compounded by factors such as poor access to quality food, insecurities regarding housing and safety, lack of medical and prenatal care, and poor employment opportunities (World Health Organization (WHO), 2018). While the results indicate that the lower an individual is on the socio-economic ladder, the greater the detrimental health outcomes they are likely to experience, the impacts of structural racism make it clear that these negative impacts are compounded for minority individuals (Prather, Fuller, Marshall, & Jeffries, 2016). From conception to casket, minorities, and specifically those in the Black community, will experience a worse outcome relative to their peers of other racial groups (Rose, 2018). These social and economic realities have made it imperative that greater supports are provided to Black mothers during their pregnancies.

In response, several different models have been developed and implemented to support minority mothers during their pregnancies (Gleason & Jones, 2019). These at-risk mothers are dealing with economic vulnerability, discrimination, racism, and all of this results in ongoing stress that has a negative impact on their pregnancies and birth experiences (Prather et al., 2016). As such, the introduction of community health workers has been found to help these mothers navigate their pregnancies so that their likelihood of positive birth outcomes is increased. Gleason and Jones (2019) suggest that enrolled mothers see their community health workers as their “pregnancy navigators” who will support them and advocate for them (Gleason & Jones, 2019). This is needed, according to Prather et al. (2016), because the women in this population are not trusting of the medical community, do not have the resources to attend to their physical and mental health, and do not always receive care specific to their level of risk. According to Gleason and Jones (2019) the community health workers “enhance access to care, promotes [the] client’s self-efficacy, and encourages the client’s sustain engagement with care” (Gleason & Jones, 2019). While these models of support or “pregnancy navigation” are being more widely used to ameliorate the minority infant mortality rate, little known empirical research has studied the impact of these services on birth outcomes (Chiyaka, 2019; Redding et al., 2015); no known research has explored the cost-benefit of these services. The current investigation focuses on the cost-benefit of the Community Pathways HUB model in Northeast Ohio.

1.2. Community Pathway HUB Model

The Ohio Commission on Minority Health has partially funded Pathway HUBs to provide wrap-around social services for at-risk pregnant women. The HUB is so named because it serves as the center (hub) from which the wrap-around services emanate. The focus of this cost-benefit analysis is on one Pathway HUB (maternal and infant) in one Northeast Ohio County. The Pathway HUB Community Action (PHCA) has been in existence since 2016 and operates a model of wrap-around service that provides each mother with a community health worker who supports her in navigating 20 identified pathways. The pathways include:

- Education
- Social Service Referral
- Medical Referral
- Pregnancy
- Postpartum

- Housing
- Medical Home
- Family Planning
- Adult Learning
- Tobacco Cessation
- Medication
- Assessment
- Health Insurance
- Behavioral Health
- Employment
- Immunization Screening
- Medication Management
- Lead
- Developmental Referral
- Developmental Screening
- Immunization Referral.

A full description of each pathway is provided in the [Appendix](#). Since its inception in 2016, the PHCA has enrolled more than one thousand at-risk pregnant women.

2. Methods

This study investigated the assumption that women actively enrolled in the PHCA had improved birth outcomes for Black families while reducing overall healthcare costs. In addition, the study examined whether the net decrease in healthcare costs exceeded the PHCA program costs. The analyses examined all births and premature births. Direct medical costs were estimated using three data sources: actual PHCA participant medical cost data provided by a manage care provider utilized in the PHCA, a study published by Buckeye Health Plan, and a March of Dimes analysis of the costs of premature birth. To achieve this goal, the following analysis plan was implemented:

- Estimate the direct medical costs of the PHCA and non-PHCA mothers and infants.
- Estimate the direct and indirect costs associated with premature birth.
- Estimate the expected savings from lower premature birth rates among the PHCA participants.
- Determine the costs of the PHCA implementation.
- Calculate the net financial benefit of the PHCA participation in Akron and Summit County.

Cost-benefit analysis estimates a program's dollar costs and its benefits expressed in financial terms. Cost and benefits can be direct, indirect, or intangible. Direct benefits are typically measured as reductions in participant medical costs compared to non-participants. Indirect benefits accrue when an individual's productivity and lifetime earnings are not impacted due to problems associated with premature birth. Intangible benefits (e.g., psychological well-being) are difficult to measure, so they are not usually included in cost-benefit studies.

3. Results

3.1. All Births: Based on Manage Care Provider

The direct financial benefits of the PHCA model were found using medical cost data supplied by Manage Care Provider (MCP) Healthcare. The MCP data represent 25 of 374 Black mothers within the PHCA network who gave birth between September 2016 and December 2019. While the PHCA MCP patients comprised only 7% of all patients, the validity of using the PHCA MCP data to predict cost savings was confirmed by comparing birth outcomes among the PHCA participants with and without the PHCA MCP as their health plan, as indicated in [Table 1](#).

Table 1.
Comparison of birth outcomes for manage care provider and non- manage care provider infants.

Provider	Number of full-term births	Number of premature births	Total number of births	Prematurity rate
PHCA MCP	26	2	28	7.1%
All other	311	47	358	13.1%

As indicated in [Table 1](#), the MCP's prematurity rate is significantly lower than that of the non-PHCA MCP infants. Prematurity is costly; using the PHCA MCP data will likely underestimate cost savings due to lower rates of prematurity. Likewise, NICUs (Neonatal Intensive Care Units) are expensive. The PHCA MCP data shows an average cost of almost \$48,000 for NICU stays longer than two weeks. A breakdown of NICU stays in the existing data reveals that the PHCA MCP infants were less likely than the non-PHCA MCP infants to experience long NICU stays, as indicated in [Table 2](#).

Table 2.
Comparison of NICU stays for PHCA MCP and non-PHCA MCP infants.

NICU days	Manage care provider		Non- manage care provider	
	# of infants	% of total	# of infants	% of total
1-7	7	64%	39	51%
8-14	2	18%	16	21%
> 14	2	18%	22	29%
All days	11	100%	77	100%

Based on the results presented in [Table 2](#), the PHCA MCP data is considered to underestimate cost savings due to shorter NICU stays. To further investigate the cost differential, the MCP's reported medical costs were compared for the PHCA and non-PHCA mothers and infants, as indicated in [Table 3](#).

Table 3.
Average medical cost savings from PHCA minus managed care provider.

Provider	Mothers	Infants
PHCA	\$ 18,656	\$ 7,995
Non-PHCA	\$ 19,724	\$ 12,635
PHCA cost savings	\$ 1,068	\$ 4,640

Between March 2017 and October 2019, these results indicate a savings average of \$1,068 for mothers and \$4,640 for infants. Therefore, to understand the potential cost savings, these results were used to compute the cost savings when applied to the 374 mothers and 386 infants in the PHCA for a total savings of \$2,190,472 due to the PHCA participation. These results are provided in [Table 4](#).

Table 4.
Cost reduction all PHCA births - manage care provider.

Year	Number of mothers	PHCA savings mothers	Number of infants	PHCA savings infants	Total PHCA savings
2016	34	\$ 36,312	35	\$ 162,400	\$ 198,712
2017	86	91,848	90	417,600	509,448
2018	130	138,840	134	621,760	760,600
2019	124	132,432	127	589,280	721,712
Total	374	\$ 399,432	386	\$ 1,791,040	\$ 2,190,472

3.2. Based on Buckeye Health Plan Data

The Buckeye Health Plan analysis of Northwest Ohio infant inpatient costs were applied to the PHCA data. The analysis used breaks down the cost differential between the PHCA participants and non-participants by risk level. This analysis was applied to enrollment status at delivery for babies born between 2013 and 2016.

The results indicate that 74% high risk and 26% medium risk pregnancies are included in this sample of women. This differential was applied to the number of infants born in each year to estimate the number of births in each risk category, as indicated in [Table 5](#).

Table 5.
Estimates of PHCA births by risk category.

Year	# infants	High risk (74%)	Medium risk (26%)
2016	35	25.9	9.10
2017	90	66.6	23.40
2018	134	99.16	34.84
2019	127	93.98	33.02

Based on the provided Buckeye data, savings due to the PHCA participation at delivery were \$403 per member per month (PMPM) for high-risk infants and \$252 PMPM for medium-risk infants. Health care inflation and cost of living differences between Toledo and Akron were applied to the cost differentials to obtain more current and location specific estimates of cost savings. Health care inflation rate calculations were computed as follows: the annual Producer Price Index ([PPI, 2020](#)) for inpatient care, which reflects actual prices paid to hospitals, was used to estimate inpatient cost inflation. Personal Consumption Expenditure – Health ([PCE, 2020](#)) was used to estimate outpatient cost inflation. MCP's data reveals that 73% of total costs are inpatient costs, and 12% are outpatient costs. Limiting the estimations to these two categories to represent all costs yields results in 86% inpatient and 14% outpatient costs. These are the factors which were applied to PPI and PCE growth rates to obtain blended inflation rates from 2016 to 2019. These results are presented in [Table 6](#).

Table 6.
Health care inflation calculation.

Year	PPI	PPI growth	PCE	PCE growth	Blended inflation rate vs. 2016 ²
2016	139.0	-	105.43	-	-
2017	141.5	1.80%	107.73	2.20%	1.85%
2018	145.0	4.30%	109.11	3.50%	4.20%
2019	147.8	6.30%	-	4.8% ¹	6.09%

Note: ¹ 2019 growth extended 1.3% year-over-year increase from 2018.

² For example, 1.85% = (0.86) x (1.8%) + (0.14) x (2.2%).

Next, the blended inflation rates were applied to the cost savings by risk category which were annualized and augmented by a cost-of-living adjustment (COLA) of 3.79% to reflect the difference in the general price levels in Akron vs. Toledo. This is provided in [Table 7](#).

Table 7.
Annualized cost savings by risk category.

Year	Health care inflation vs. 2016	High risk cost savings	Medium risk cost savings
2016	-	\$5,019	\$3,139
2017	1.85%	5,112	3,197
2018	4.20%	5,230	3,271
2019	6.09%	5,324	3,330

Using these results, the estimates of births in each risk category and year were multiplied by their respective cost savings to obtain total expected cost savings. These results are presented in [Table 8](#).

Table 8.
Cost reduction all risks – buckeye.

Year	High risk	Medium risk
2016	\$129,999	\$28,561
2017	\$340,482	\$74,805
2018	\$518,633	\$113,945
2019	\$500,416	\$109,943
Total	\$1,489,530	\$327,255
All risks		\$1,816,785
Savings per infant		\$4,707

As indicated above, the result is an estimated total savings across risk categories of \$1,816,785, which is only 1.6% higher than MCP's infant cost savings. Dividing total savings by 386 infants yields an average cost savings of \$4,707 per infant due to a mother's active enrollment in the PHCA at birth. This figure is \$67 higher than that obtained with the PHCA MCP data.

3.3. Cost Difference for Premature Births

Prematurity is the leading cause of infant mortality in Ohio with nearly one-third of all infant deaths attributable to premature birth. Premature birth analysis relied heavily on [Waitzman, Jalali, and Grosse \(2021\)](#) March of Dimes report on state-level preterm birth costs (provided in [Table 9](#)).

Table 9.
National per capita cost of preterm birth.

Cost category	Cost	% of total cost
Medical care	\$44,116	68%
Maternal delivery	5,024	8%
Early intervention services	1,808	3%
Special education	1,604	2%
Devices	28	0%
Lost labor market productivity	12,236	19%
Total	\$64,816	

Note: [Waitzman et al. \(2021\)](#).

According to the [Waitzman et al. \(2021\)](#) report, they included indirect costs resulting from lost labor market productivity and heightened morbidity over a lifetime, as well as direct medical costs, early intervention, and special education services. Waitzman and Jalali's differential cost of prematurity is used in estimating cost/savings the PHCA, relative to the local community, the state of Ohio, and the United States.

The PHCA's prematurity rate for black infants was lower than the national average, the state average, and the overall Summit County average in each year from 2016 to 2019, are provided in [Table 10](#).

Table 10.
Percentage of preterm births among black infants.

Year	PHCA	US ³	Ohio ⁴	Summit	PHCA vs. US	PHCA vs. Ohio	PHCA vs. Summit
2016	12.1%	13.6%	14.2%	17.7%	1.5%	2.1%	5.6%
2017	6.1%	13.6%	14.2%	14.1%	7.5%	8.1%	8.0%
2018	9.5%	13.6%	14.2%	13.6%	4.1%	4.7%	4.1%
2019	13.3%	13.6%	14.2%	13.5%	0.3%	0.9%	0.2%

Note: PHCA vs. US; PHCA vs. OH; and PHCA vs summit are difference in rate of preterm births in PHCA
^{3, 4}Average of years 2015-2017.

The estimates of the expected reductions in preterm births due to the PHCA participation was computed by using the difference in preterm birth rates in the PHCA versus the country, state, and county. Multiplying these differences by the number of births in each year yields estimates of the reduction in the number of premature births due to the HUB's presence. These results are provided in [Table 11](#).

Table 11.
Difference in the number of premature births due to PHCA.

Year	PHCA births	Versus US	Versus Ohio	Versus Summit County
2016	33	0.45	0.69	1.84
2017	82	6.15	6.64	6.56
2018	126	5.14	5.89	5.14
2019	120	0.32	1.04	0.20

These estimates assume that for the given population, the rate of prematurity would be at least the level reported for the prior year. Therefore, a 17.7% prematurity rate in Summit County in 2016 would suggest 17.7% of the HUB's 33 births to be premature. However, the actual data indicates that the PHCA had only four premature births represent 1.84 fewer premature births due to the lower prematurity rate or the impact of active enrollment in the PHCA. Therefore, this is better than the expected rate of 5.84 premature births expected (i.e., $0.177 * 33$).

Using the differential cost of prematurity suggested by [Waltzman et al. \(2021\)](#), the differential cost of prematurity in Ohio in 2016 was \$62,389 per birth more than the cost of a full-term birth. [Table 12](#) provides the likely additional costs of a premature birth when applying health care inflation factor.

Table 12.
Additional costs due to premature birth.

Year	Inflation vs. 2016	\$ per preterm birth
2016	--	\$62,389
2017	1.85%	\$63,543
2018	4.20%	\$65,009
2019	6.09%	\$66,188

Therefore, multiplying the reduction in births by the cost per preterm birth gives expected savings resulting from the active enrollment in the PHCA vs. the country, state, and county. These results are provided in [Table 13](#).

Table 13.
Expected cost savings due to lower premature birth rates in HUB.

Year	Versus US	Versus Ohio	Versus Summit
2016	\$30,446	\$42,799	\$114,858
2017	\$390,918	\$422,181	\$416,970
2018	\$333,888	\$383,035	\$333,888
2019	\$21,180	\$68,836	\$13,238
Total	\$776,432	\$916,851	\$878,954

3.4. Total Cost Savings and Return on Investment (ROI)

Total cost savings, comprising the savings for all births due to the PHCA participation plus the cost savings due to lower premature birth rates in the PHCA, was computed and compared to program costs to obtain net financial benefit and ROI. The results indicate that net benefits and ROIs are favorable using any of the premature birth rate comparisons. Likewise, the results indicate that when excluding the additional benefits accruing from fewer premature births, the ROI is favorable. These results are outlined in [Table 14](#).

Table 14.
Total cost savings and return on investment due to lower premature births, based on the PHCA MCP data.

Cost metric/Benefit	All births	PHCA vs. US	PHCA vs. Ohio	PHCA vs. Summit
Total cost savings	\$2,190,472	\$2,966,904	\$3,107,323	\$3,069,426
Program costs	\$700,000	\$700,000	\$700,000	\$700,000
Net benefit	\$1,490,472	\$2,266,904	\$2,407,323	\$2,369,426
ROI	3.13	4.24	4.44	4.38

For every dollar spent on actively-enrolled mothers in the PHCA, costs fall by \$3.13 to \$4.44 using the PHCA MCP data. The same savings was revealed when examining the available Buckeye's data, as shown in [Table 15](#).

Table 15.
Total cost savings and return on investment, Buckeye data ⁵

Cost metric/Benefit	All births	PHCA vs. US	PHCA vs. Ohio	PHCA vs. Summit
Total savings	\$2,216,117	\$2,992,649	\$3,133,068	\$3,095,171
Program costs	\$700,000	\$700,000	\$700,000	\$700,000
Net benefit	\$1,516,217	\$2,292,649	\$2,433,068	\$2,395,171
ROI	3.17	4.28	4.48	4.42

Note: ⁵Mothers' medical cost savings used actual data from manage care provider. Buckeyes did not include mothers.

4. Discussion

The net financial benefit of active enrollment in the PHCA for at-risk minority women who had a full-term birth is approximately \$1.5 million. This result is based on the provided program costs of \$700K subtracted from savings of \$2.2 million. When premature birth rates are considered, the net financial benefit of the PHCA grows to \$2.27 to \$2.43 million. The return on investment (i.e., benefits divided by costs) is 3.15 exclusive of premature births and 4.4 with premature births included. Therefore, for every dollar spent on this program, \$4.40 is returned in cost savings. A \$1 million investment would be expected to yield \$4.4 million in cost savings due to improved birth outcomes and lower premature birth rates.

These financial results are likely to be underestimated due to limited data. The analysis relied on cost data from a provider representing a small percentage of the PHCA population. The PHCA data

reveals lower prematurity rates and shorter NICU stays for this provider versus other providers, which potentially biases the cost estimates downward. While lower cost estimates translate to lower cost savings estimates (benefits) than expected, it is safe to conclude that the investment in at-risk minority women and the health of their pregnancies provides a societal, as well as safe, financial benefit for the overall healthcare costs that will be ensued throughout the life of the mother and the child.

Potential limitations include the reliance on data from a health plan representing a small percentage of the population could bias the results. Analysis comparing the birth outcomes and NICU stays for participants using MCP's plan vs. others has attempted to alleviate any concerns related to relying on this data. Additionally, published results from the Buckeye study may not apply to the data in the same way. However, a small gap between the results lends credence to the estimates. Finally, the preterm data has its own limitations which are listed in the March of Dimes study (Waitzman et al., 2021). However, as indicated above, the data was computed to downward bias the cost benefit for the PHCA rather than overestimate.

5. Conclusion

The reduction in costs associated with membership in the PHCA has far exceeded program costs. Due to the limitations discussed, estimated savings are likely even higher than the results provided. Strongly positive financial results justify continued and substantial investment in the PHCA to improve outcomes for Black infants and families in Summit County. These positive results suggest that the services provided to actively-enrolled mothers in the PHCA can begin to ameliorate the impact of social determinates and structural racism on the birth outcomes of these infants.

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Institutional Review Board Statement:

The Ethical Committee of the Youngstown State University IRB, United States has granted approval for this study on 26 August 2020 (Ref. No. 013-21).

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

Competing Interests:

The authors declare that they have no competing interests.

Authors' Contributions:

All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.

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APPENDIX

Appendix 1. HUB pathways.

Adult education	<p>Confirm that client successfully completes stated education goal:</p> <ul style="list-style-type: none"> • Course / Class completed • Quarter / Semester completed • Training program completed
Behavioral health	<p>Client has kept three scheduled behavior health appointments:</p> <ul style="list-style-type: none"> • Developmental Referral • Document the date and results of the completed developmental evaluation • Developmental Screening • Child successfully screened using the age appropriate ASQ (Ages & Stages Questionnaire) or ASQ-SE (Ages & Stages Questionnaire: Social Emotional)
Education	<p>Client reports he/she understands the educational information presented (document and format).</p> <p>Education needs to be provided at each visit. Topics should include: infant mortality; safe sleep; breastfeeding; and other appropriate topics to meet the client's needs.</p> <p>An education pathway should be opened and closed the same day as provided.</p>
Employment	<p>Client has obtained steady income and has been employed for period of 3 months.</p>
Family planning	<p>Confirm that client has kept appointment and document family planning method:</p> <ul style="list-style-type: none"> • Completed with permanent sterilization or LARC (Long-acting reversible contraceptive) • All other methods, completed if client is still successfully using the method after 30 days

Health insurance	Completed if client has received health insurance document plan and insurance number.
Housing	Confirmation that client and/or family has moved into an affordable suitable housing unit for a minimum of 3 months.
Immunization referral	Client who was behind on immunizations has his/her immunization record reviewed and date is verified.
Immunization screening	Client is up to date on all age-appropriate immunizations. <ul style="list-style-type: none"> • Confirm that appointment was kept and document results of lead blood test
Medical home	Confirm client in need of ongoing primary care has kept first appointment with medical home.
Medical referral	Verify with primary care provider that client has kept appointment.
Medication assessment	Verify with primary care provider that medication chart was received (Requires chart).
Medication management	Verify with primary care provider that client is taking medication as prescribed (Requires chart).
Postpartum	Confirm that client has kept postpartum appointment.
Pregnancy	Confirm that client has delivered a healthy baby weighing more than 5 pounds 8 ounces (2500 grams).
Smoking / Tobacco / Cessation	Confirm that client has stopped using tobacco products for at least 6 months.
Social service referral	Verify client has kept scheduled appointment with social service provider by calling the referral and asking if client kept the appointment.